EXPLORING REAL-TIME MUSIC COMPOSITION THROUGH COMPETITIVE GAMEPLAY INTERACTIONS

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A thesis submitted in partial fulfillment of the requirements for the degree of

Doctor of Philosophy in Music

December 2020

This research was supported by an Australian Government Research Training Program (RTP) Scholarship

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Acknowledgements

I would like to give thanks to my supervisory team, whose continued guidance and counsel has been invaluable to my candidature. To Jon Drummond, for bringing enthusiasm, expertise, and direction to the project when joining as principal supervisor. To Nathan Scott, for your continued guidance since my undergraduate years and for the many opportunities in teaching and beyond. To Keith Nesbitt, for encouraging my first publication and for your timely aid in all things studies, statistics, and submissions – no matter how near the deadline. And to Richard Vella, for convincing me to brave postgraduate research, for seeing me through to confirmation, and for your continued time and counsel even after your supervisory duties had ended.

I would also like to thank my friends and fellow gamers, whom I have variably come to know as Stinky Rats, Feisty Fivers, Fireflies, and more. Thank you for being pirates, guardians, cowboys, legends, monster hunters, and trivia masters. Your companionship and camaraderie have seen me through the hardest moments of this journey with all of my joy and playfulness intact.

Finally, I would like to thank my family – Laurie, Sharon, and Joshua Studley – and my dearest friend Caitlin Francis, whom I count amongst them. Thank you for the time, love, patience, and support that made this journey possible. Though my words here could never do justice to all that you’ve given me, know that my gratitude is endless and that I love you with all of my heart.
Statement of Originality

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision. The thesis contains no material which has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made. I give consent to the final version of my thesis being made available worldwide when deposited in the University’s Digital Repository, subject to the provisions of the Copyright Act 1968 and any approved embargo.

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Thomas John Studley
Abstract

Musical apps, interfaces, and installations have opened real-time music composition to non-experts through the use of game-like interactions. Few of these systems harness competitive game elements, reflecting an assumption that the aesthetic experience and mechanical demands of competitive gameplay are incongruous with musical creativity. Limited research or practice has explored this interplay, revealing a gap for new understandings of musical games and interactive composition. My research aims to address this gap through a body of original works – *EvoMusic*, *Chase*, and *Idea* – that explore the potential for competitive human-computer dialogues to support accessible, creatively stimulating composition experiences.

Each work takes a divergent approach to competitive gameplay. In *EvoMusic*, players cannot win or lose, but contest the inexorable growth of an evolving musical population to curate and defend a desired sonic output. *Chase* introduces notions of danger and defeat, assigning musical outcomes to the player’s attempts to evade a pursuing hostile agent. *Idea* then adds elements of progression and victory; players manipulate musical motifs to navigate mazes, defeat enemies, and earn new creative resources. The games were evaluated in two mixed-methods comparative user studies to investigate how these divergent approaches influence the compositional experience.

Players did not reflect the literature’s aesthetic opposition to the synthesis of composing and competing, but noted that sufficiently strong game incentives could overpower musical decision-making. The traditional game structures of *Chase* and *Idea* were viewed as more engaging overall, yet only *EvoMusic* engendered interaction that was at once creatively and competitively stimulating. These findings reveal a more complex interplay between accessible music-making and competitive gameplay than previously assumed, unearthing new challenges and potentials for interactive composition that I explore herein.
Related Publications

**In Order of Publication**

A literature review and discussion of the ontology of musically creative games, outlining a conceptual prototype for *EvoMusic* as a demonstrative case:


A paper detailing the system design and implementation for the first functional prototypes of *EvoMusic* and *Chase*:


A discussion of *EvoMusic* and *Chase* as musically metacreative systems, explicating the nature of the compositional “contest” between player and game system:


An article reporting on a comparative user study (n=24) evaluating *EvoMusic* and *Chase* for perceptions of musical control, creativity, and ownership:

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Creative Works

Accompanying this thesis are three original games as creative research: *EvoMusic*, *Chase*, and *Idea*. Video demonstrations of my interaction with these works, along with playable versions for Windows and macOS, are available at the following:

https://uonstaff.sharepoint.com/:u:/s/SOCI-PHDFiles/ESKG3MXtcJ9GguNF3A_du0BQ5VH56VccXKMLsSdRcPCfg

Each video demonstration includes:

1) A commentated overview of the game’s concepts and mechanics.
2) An extended excerpt of my own gameplay, without commentary, to demonstrate the system’s sonic output and user interaction.

The games themselves are located in the folders:

1) “Original Works – MAC”
2) “Original Works – PC”

Both folders contain identical game builds, but each is only compatible with its respective operating system. Either version of the games may be used for examination purposes.

Running the Games

Each game folder includes a “README” text file with instructions for game setup and troubleshooting. In general, game setup involves:

1) Opening a “Max” application.
2) Opening a “Unity” application.

The “Unity” app is the game interface where user interaction occurs. The “Max” app generates music in response to gameplay, and does not require direct interaction outside of troubleshooting. The two applications are required to run simultaneously to complete the composition game experience. Details of this implementation are discussed in Section 3.2.3.
Instructions for Mac Users

Due to the security behaviour of macOS, attempting to open either the “Max” or “Unity” application may result in the following dialogue:

![Application can't be opened dialog](image)

This occurs because the applications do not have permission to execute. To avert security threats from malicious software, some versions of macOS prevent apps from executing if they were downloaded directly from a browser without a verified publisher.

Execute permission can be given manually via the following steps:

1) Right-click the application
2) Select “Show Package Contents”
3) Open the “Contents” folder
4) Open the “MacOS” folder
5) You should now see a text file. This will be needed shortly (do not open the file).
6) Open the Terminal by pressing Command + Spacebar, then typing “terminal”, then pressing Enter
7) In the Terminal, type “sudo chmod +x ” without quotations, ensuring that there is a space at the end.
8) Drag the text file from Step 5 into the Terminal window and press Enter.
9) Type your computer login or administrator password and press Enter.
10) Close the Terminal.

The applications can now run, but must be opened for the first time as follows:

1) Right-click the application
2) Select “Open” in the pop-up menu
3) Select “Open” in the following pop-up dialogue
Attempting to open the applications by any other standard means, such as double-clicking, will result in the following dialogue:

In this case, select “Cancel” and re-open the application by Right-clicking and selecting “Open” from the pop-up menu. This should result in the following dialogue:

Selecting “Open” in this dialogue will launch the application, and should also allow it to be opened by standard means in the future.

**Development Information**

The “Max” applications were developed in Max 8 version 8.0.1.

The “Unity” applications were developed in Unity version 2017.3.1.

**macOS** applications were tested on Catalina version 10.15.5 using a MacBook Pro (Retina, 15-inch, 2014, 2.5 GHz Quad-Core Intel Core i7, 16 GB 1600 MHz DDR3, NVIDIA GeForce GT 750M 2 GB).

**Windows** applications were tested on Windows 10 version 1909 (Ryzen 9 3900x 3.8GHz 12-Core, 32 GB 3600 MHz DDR4, MSI GeForce RTX 2080 Ti 11 GB).
Chapter 1: Introduction

I am a practitioner of music composition. I am also an avid player of digital games. In both of these acts, in composition and gameplay, I find an escape from the quotidian: a delimited space to indulge in autotelic rituals of creation, competition, and catharsis. In both I find the elusive “Flow” state (Csikszentmihályi, 1990), an all-encompassing absorption where the passing of time is distorted and the ego recedes. In both I find an uncanny union of challenge and creativity, whether in the search for novel sonic outcomes or new game strategies. And in both, most simply, I find play.

It seems only natural that “play” has been characterised as intrinsic or even analogous to musical activity by scholars of play (Huizinga, 1955), games (Bogost, 2011), and music alike (Austin, 2016a; Kassabian & Jarman, 2016). Indeed, philosopher Hans-Georg Gadamer has suggested that play gives meaning to art itself (2013 [1975]). Playful designs, practices, and identities now suffuse contemporary culture (de Lange et al., 2015), pervading work, health, education, and other spheres of life once demarcated as “serious”. This “ludification”¹ (Raessens, 2006) has propagated to a diversity of musical activity, from the rise of game-based learning in music education to a growing convergence of playful design and interactive sound art within the twenty-first century, as I will demonstrate herein.

It is my shared passion for the experiences of digital gameplay and composition that first kindled an interest in exploring their intersection. Over the course of my candidature, I have endeavoured through my practice to unearth an as yet unrealised potential for digital “composition games” as a novel platform for human-computer music creation. This aim has motivated the research and original works presented in this thesis, which found their genesis in the question: What can digital gameplay bring to interactive composition?

¹ “Ludification” is derived from lūdus, from the Latin lūdus (“game”) and lūdō (“I play”).
1.1 Overview of Research Area

Digital games have much to contribute to the domains of interactive composition and human-computer co-creation. The use of game structures to generate and organise composition long precedes digital computation, with precedents in Danckerts’ sixteenth-century chessboard canon (Westgeest, 1986), the eighteenth-century tradition of musical dice games (Hedges, 1978) and the twentieth-century game pieces of John Zorn and Iannis Xenakis (Sluchin & Malt, 2011). Following the proliferation of digital games, however, participation in interactive music composition has attained an unprecedented level of access. A rich landscape of digital “sound toys” (Dolphin, 2014), physical game installations (Berry et al., 2006; Bown & Ferguson, 2016; Cera, 2013) and myriad music-making apps (Kassabian & Jarman, 2016) now contribute to a growing participatory culture of playful, computer-assisted music composition. For the novice user, this access is typically predicated upon the use of symbolic gameplay interactions to influence the real-time output of a music generation system.

A defining characteristic of these playful music-making media is their rejection of a competitive game framework (Dolphin, 2014), seemingly informed by the presumption that challenge and conflict are somewhat antithetical to musical creativity. This intuition, shared pervasively by designers and scholars, appears to emerge from positions of both ontological and aesthetic tension. Ontologically, it is problematic to conceive of a digital game system capable of fairly “scoring” a player’s musical creativity, and thus assigning positive or negative game outcomes, without imposing arbitrary limitations or biases that would restrict free musical exploration. Aesthetically, we tend not to associate creativity with the stress or pressure invited by this form of gameplay, nor would we want to create within such competitive contexts. From a design perspective, musically creative games have addressed these issues through two common design aims: 1) avoid ludic “goals”, “scoring”, “contest”, and other competitive elements to ensure a focus on sound composition; and 2) avoid experiences of “challenge”, “stress” and “pressure” to lower creative inhibitions and invite free exploration.

2 “System” here refers to a designed structure of rules and logic, not to a physical gaming device/console.
1.1.1 Research Gap

Non-competitive music-making games have undoubtedly advanced participation in computer music creation, and it is by no means my intention to denounce such media.\(^3\) The result, however, is a lack of research or practice interrogating their underlying assumptions. The potential for an interplay between competitive gameplay and interactive composition is seldom explored, even at a time when digital games are near ubiquitous and generative composition tools are more democratised than ever before (Bray & Bown, 2015). Further, there is little empirical work exploring the player experience of composing within competitive game settings, and thus a lack of practical insights for how such environments might influence perceptions of musical control, creative ownership, or overall engagement. At this juncture lies an opportunity to investigate new forms of human-computer co-creation.

1.2 Aims and Objectives

This research aims to conceptualise a digital game wherein a single novice player can exercise musical creativity in contest with an opposing compositional agent – or at least, through meaningfully competitive gameplay interactions. I develop three original composition games to explore this notion: *EvoMusic, Chase,* and *Idea.* In each, the game state persistently influences the sonic outcome of a stochastic music generation system, allowing players to easily create music in real-time by interacting with the gameworld.\(^4\) In turn, the rules and game logic are designed to encourage the music generation to follow its own creative trajectory, which players then contest in an effort to realign the generated music with their own musical goals. In sharing a single evolving musical output with the player,\(^5\) the system’s compositional gestures variably collide or comply with the player’s aesthetic intentions. The system thus acts as both collaborator and opponent, inviting a novel dialogue between player and computer that is at once musically competitive and co-creative.

The purpose of the works is to interrogate the prevalent assumption that competitive gameplay either precludes, or is aesthetically unconducive to, the realisation of accessible composition experiences within interactive digital media. Each game

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\(^3\) I have enjoyed a great many hours with casual music-making apps like *Scape* (Eno & Chilvers, 2012), *Biophilia* (Björk, 2011), and *Sequencer* (Okaynokay, 2017).

\(^4\) I use the term “gameworld” herein to denote the internal environment and reality of a digital game.

\(^5\) The player and system do not compose discrete music, where the result would be two separate outputs. Rather, they “compete” for creative control over a single, shared musical output.
employs a contrasting approach to musical control and ludic contest. I conduct two comparative user studies to evaluate these divergent approaches, allowing their juxtaposition by participants to reveal new insights regarding the player experience of composing through competitive gameplay. Specifically, the user studies investigate how player perceptions of system usability, challenge, musical control, musical creativity, and ownership over system output differ between the works. From a practitioner position, the development process also generates new understandings of the inherent design tensions emerging from interactive systems which aspire simultaneously to be accessible, compositional, competitive, and gameful.⁶

Through this synthesis of designer and player perspectives, my research aims to provide an empirical, practice-based exploration of the complex relationship between musical creativity and competitive gameplay. The objectives are as follows:

a) Distil the aesthetic assumptions underpinning game-based composition in competitive contexts – addressed by tracing the lineage of game-based composition, reviewing how musical creativity has been mapped to notions of “play” and “game”, and unpacking the design goals of related works.

b) Test these assumptions in a practical design context to further understandings of the relationship between musical creativity and competitive gameplay – addressed by synthesising practitioner-generated design insights and player feedback to reflect on prevailing literature perspectives.

c) Chart the design space for competitive, game-based composition – addressed by delineating successful features, design challenges, conceptual tensions, and pertinent player values to inform future development of such media.

1.2.1 Research Questions

The following questions guided the research and creative works presented in this thesis. Each assumes the overarching goal of designing interactive composition experiences for a single, novice user:

Q1) What are the aesthetic assumptions and design challenges underpinning interactive composition in competitive game settings? – explored through a

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⁶The term “gameful” denotes the quality of evoking, relating to, or being characteristic of the structure, outcomes, or experience of games and game playing.
review of related works and literature perspectives on musical creativity, competition, play, and games.

Q2) How can musical creativity and competitive gameplay be reconciled in a digital game while maintaining a focus on accessible sound composition? – explored through the development of three original composition games with diverging implementations of musical control and ludic contest.

Q3) How do competitive game settings shape player perceptions of musical control, creativity, and ownership? – explored through two mixed-methods, comparative user studies which generate quantitative and qualitative insights on the player experience of interacting with the original works.

1.2.2 Introducing a Conceptual Framework

Approaching the research questions requires a diverse conceptual lens. Foremost, any conception of a competitive “composition game” must first address the amorphous phenomena of play and game themselves, such that an understanding of the design elements and experiences constituting competitive gameplay may be reached. It must then be understood how notions of play and games have: 1) interfaced with the practice of interactive sound art; and 2) been used to characterise musical activity more broadly, including performance, composition, and improvisation. Such a synthesis is found in the field of ludomusicology, which – though initially founded on analyses of video game soundtracks and underscore – has increasingly sought to navigate the wider nexus of music and play (Austin, 2016a; Kassabian & Jarman, 2016; Moseley, 2016). These scholarly efforts offer crucial insight into the presumed tensions between musical creativity and competitive gameplay.

A complete picture of this complex relationship cannot be drawn from a musicological charting of play and games alone. My research is further informed by psychological investigations of creativity and competition beyond game contexts (2.4), as well as literature on the role of challenge and conflict in models of player experience and engagement. I have also taken as significant the overarching goals and practice of “gamification” in music (1.4, 1.5), particularly as applied to the democratisation of interactive composition (1.6). Each of these areas contribute to an understanding of the promise and challenges of competitive, game-based composition.
As outlined prior (1.2), the original games explore an accessible yet adversarial composition experience by allowing player interactions to shape the live output of a music generation system that simultaneously posits its own compositional gestures. In this way, the works can be understood as interactive, generative, and musically metacreative systems; the latter referring to the idea of endowing machines with musically creative behaviour (Pasquier et al., 2016). Perspectives, models, and approaches from these domains are critical in positioning the original works and interpreting their implications as a novel form of human-computer co-creation.

To summarise, the research and practice presented herein is informed by the intersection of: interactive sound art; theories of play and games; ludomusicology; gamification; psychologies of creativity, challenge, and player experience; generative music practice; and musical metacreation. The interrelations between these areas and their significance to this research are unpacked in the literature review (Chapter 2).

1.3 Thesis Structure

Chapter 1 – having outlined the research area and guiding questions, the remainder of this chapter articulates the wider context of gamification and game-based interactive composition to preface a more focused examination of competitive design in Chapter 2. Gamification is defined and discussed (1.4) with specific reference to diverse musical applications (1.5), providing an overview of what game design and culture can offer to traditionally non-game contexts. A practical history of gamified interactive composition is then outlined, addressing also the contribution of gameful design and digital media to the democratisation of interactive music-making (1.6).

Chapter 2 – offers a detailed review of literature and selected works pertinent to the notion of competitive, game-based competition. Conceptions of play and games are first examined to arrive at an understanding of the competitive game framework. The mechanical and aesthetic challenges of reconciling this framework with accessible composition are then explored. Empirical research on the psychology of competitive creativity is briefly outlined before a survey of playful music-making media reveals a network of interrelated design dimensions pertinent to competitive composition games. Concepts from musical metacreation are then used to articulate a point of departure for my original works, concluding with a summary of literature review insights.
Chapter 3 – develops an exploratory, hybridised methodology capable of addressing the research questions (1.2.1). An iterative, mixed-methods research design is outlined before discussing the conceptual and methodological approaches for three original composition games. The design of two comparative user studies is then detailed, explicating the mixed data collection and analytic methods employed to evaluate the original works and explore the player experience of composing within competitive game settings. The research scope is delimited through a discussion of alternative methods and further research avenues.

Chapter 4 – discusses EvoMusic and Chase, the first two creative works developed together as contrasting implementations of competitive, game-based composition. Their differing conceptual goals, game rules, and music systems are described before positioning the works along design dimensions pertinent to competitive composition games. Practitioner insights generated through the design process are then discussed.

Chapter 5 – presents the results of the first user study, a comparative evaluation of EvoMusic and Chase. Player perceptions of musical control, creativity, and ownership are reported with reference to how the competitive game framework influenced these themes. The study results are then discussed: I draw preliminary design implications, compare the reported player experience with the literature assumptions identified in Chapter 2, and conclude by addressing the research questions (1.2.1).

Chapter 6 – discusses Idea, a third creative work conceived as: 1) a synthesis of successful features from EvoMusic and Chase; and 2) a further exploration of novel insights revealed through the first user study (Chapter 5). As before, the conceptual goals, game rules, and music system are described before positioning Idea along pertinent design dimensions. I then discuss the practitioner insights gleaned through the development process, revisiting also the Chapter 4 insights, before concluding with the consolidated findings of my creative research.

Chapter 7 – presents the results of a second user study comparing Idea to EvoMusic, the more successful of the two games compared in Chapter 5. Player perceptions are reported with a focus on the interplay between composition and the competitive game framework. The results of both studies are then discussed with reference to salient literature and practitioner insights. I conclude by consolidating these findings to address the research questions (1.2.1) through a series of design recommendations and theoretical insights.
Chapter 8 – presents a conclusion and summary of the research. After revisiting the research aims and questions, the thesis concludes by outlining the contribution to interactive composition practice, identifying avenues for future research, and summarising the broader challenges and potentials of competitive, game-based composition.

1.4 Gamification: What Do Games Have to Offer?

Following is a broad overview of the motivations and perceived benefits of introducing game design approaches to non-game contexts. My intent is to illuminate game design as a rich platform for uncovering new design potentials, and so contextualise my decision to take digital game-based composition as a starting point in this research.

1.4.1 Industry and Cultural Context

From their humble beginnings with Spacewar! (Russell, 1962), digital games have grown to command a dominant pop-cultural and global economic presence. The digital games market is valued at $148.8B USD (Newzoo, 2019), now larger than the $103bn film (IBISWorld, 2019) and $19.1bn music (IFPI, 2019) industries combined. Half of the ten highest earning YouTube influencers draw primary revenue from digital gaming channels (Berg, 2019; Webb, 2019). Academic institutions are increasingly offering eSports scholarships, including the University of California Irvine (Kerr, 2017a), University of Utah (Kerr, 2017b), and Stephens College (McAlloon, 2017). Digital games research has also attracted prestigious public funding, such as the European Research Council Advanced Grant awarded to Espen Aarseth’s five-year project “Making Sense of Games” (Arildsen, 2016).

Emerging from the proliferation of digital gaming is what media scholars have coined a “ludification” of culture (de Lange et al., 2015; Raessens, 2006). They observe that digital games have become a source of formative experience comparable to literature and film in past generations, shaping the human mind and culture (Murray, 2006) through the shared metaphors, mindsets and practices flowing from digital gaming (Deterding et al., 2011). In turn, an interest has grown in harnessing this cultural

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7 An earlier precedent for electronic visual games is often noted in Tennis for Two (Higinbotham, 1958), played on a triggered-sweep cathode-ray oscilloscope with an analogue display (Moseley 2016). I have referenced Spacewar! (Russell, 1962) as the first game programmed for a digital computer.

8 A contraction of “electronic sports” which refers specifically to professional digital gaming in competitive sport settings, such as sponsored tournaments.
capital for use in non-game contexts. Gameful design and practice now suffuse the traditionally “serious” domains of work, health, and education. This trend, and the theories informing it, is known as gamification.

1.4.2 Defining Gamification

Gamification is most often defined as the “use of game design elements in non-game contexts” (Deterding et al., 2011). This typically manifests as the introduction of game-like reward systems – such as points, badges, levels, or leaderboards – to non-game products, services or tasks as a strategy to increase engagement, motivation, efficiency, acquisition, or retention. Like “serious games” (Abt, 1970), the intention is to harness games for purposes beyond purely autotelic entertainment. However, whereas “serious games” denotes the development of whole games for non-entertainment purposes, gamification introduces elements of games into new contexts (Deterding et al., 2011).

Ge Wang, a prolific designer of gamified musical experiences for mobile devices, identifies two distinct approaches to incorporating game elements: peripheral and core gamification (Wang, 2016). Peripheral gamification refers to imposing elements that orbit, but are not essential to, the core user interaction; this includes achievements, badges, in-game reputation,⁹ or the use of game terminology such as “quest” or “mission” to reframe non-game tasks. Core gamification instead refers to a deep integration of game elements so as to be inseparable from the experience itself. The intended interaction becomes the gameplay of a more explicit game structure, often in a ludic contest where the interaction has quantifiable stakes; Guitar Hero (Harmonix, 2005), for instance, represents a core gamification of music performance wherein players can “fail” songs and lose the game.

This element-centric conception of gamification is one useful frame for apprehending the research gap (1.1.1). Among the cornucopia of game-like compositional media, there is not so much a harnessing of formal game “elements” but an adoption of gameful technologies, platforms, and interfaces to invoke cultural associations of playfulness and lower the entry barrier for novice musicians (1.6.2.1). Game competition is rarely explored as a core element of interactive composition, presenting an opportunity for unearthing new creative potentials.

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⁹ In-game reputation refers to incremental ranks or “experience levels” earned by participating in particular tasks. Progress may be scaled by the user’s performance or rely on simple repetition.
1.4.3 What Does Gamification Offer?

The most general goal of gamification is to motivate users, workers, or learners to engage with a laborious or undesirable task. This is typically achieved through two approaches, which are not mutually exclusive: 1) by reframing the activity itself as intrinsically playful and enjoyable; or 2) through the allure of competing to outperform a benchmark, one’s peers, or past self. While both methods pervade gamified applications, the latter – motivation through challenge – bears further discussion.

1.4.3.1 Challenge, Flow, and Mastery

Scholars studying the gameplay experience have persistently noted the capacity for challenge to engage and immerse players (Corcos, 2018; Cox et al., 2012; Ermi & Mäyrä, 2005; Nacke & Lindley, 2010). When optimally balanced with player skill, game challenges afford a positive and intrinsically motivating experience. This closely reflects the theory of Flow (Csíkszentmihályi, 1990), a state of intense absorption predicated upon the presence of clear goals, immediate feedback, and a skill-challenge balance. Games naturally excel in these areas, and so Flow has been seminal in both game and gamification research – even being framed as the “holy grail” of game design (Nacke & Lindley, 2010; Wagner, 2016). The flow conditions found in games also give rise to the potential for mastery and skill development, particularly in digital game-based learning (Shroff, Ting, & Lam, 2019). Beyond simply enjoyment and motivation, then, games offer the potential for flow, desirable challenge, and personal development.

1.4.3.2 Games as Access

Not all gamification is about adding intrinsic or extrinsic value to unenjoyable tasks. Gameful design can also grant entry to desirable experiences that are traditionally inaccessible to novice users, such as music performance or composition. Gamification in this sense does not rely as heavily on the integration of formal game elements like contest, scoring, or rules. Instead, it harnesses gameful props and technologies to create abstractions of expert processes which players can then control through accessible, symbolic interactions. Compositional organisation is achieved via dice roll in the tradition of Musikalisches Würfelspiel (Hedges, 1978), while the mobile app Magic Fiddle (Smule, 2010) renders the unforgiving physical idiosyncrasies of violin

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10 Csíkszentmihályi (1990) describes a total of nine elements characteristic of the flow experience, including a distortion of the passage of time and a loss of self-consciousness.
performance as simple touch interactions without forgoing instrumental expressivity (Wang, 2016). Beyond their design and technology, these efforts also rely on a cultural perception of games as democratised to lower player inhibitions about participating in activities normally viewed as “specialised” (Wang, 2016). This notion of games as a point of access has been central to the practice game-based interactive composition (1.6).

1.4.3.3 Games as Social Connection

Though not a focus of this research,\(^{11}\) it would be remiss to neglect the social connections afforded by games. Relatedness is considered one of three basic human needs within self-determination theory (Ryan & Deci, 2000), which has widely influenced models of player engagement both generally (Ryan, Rigby, & Przybylski, 2006) and in digital games specifically (Przybylski, Rigby, & Ryan, 2010). Relatedness can be found in direct multiplayer interactions, integrated social features such as leaderboards, engagement with fan communities, or even a sense of belonging to a shared gaming culture.\(^ {12}\) Gamification efforts often seek to engender social connection; for instance, the mobile app *Leaf Trombone: World Stage* (Smule, 2009) features a social ecosystem where players can assume the role of musical performer, spectator, judge, or composer as regulated by earnable tokens.

1.4.4 Summary

The practice of gamification, and by extension the medium and culture of digital games, can be understood to harbour at least the following potentials for non-game contexts:

- Enjoyment (or engagement)
- Motivation
- Flow
- Challenge
- Mastery (skill development)
- Access
- Social Connection

\(^{11}\) The three original works presented in this thesis are designed for a single player and do not feature any integrated social systems. The intent is to allow a focused exploration of the research questions within the constrained context of single users.

\(^ {12}\) By extension, single-player games can also foster a sense of relatedness.
Digital game experiences also hold a remarkable potential for powerful narrative and immersive experiences, though these are rarely the primary goal of gamification and are not considered in this research. Each of the above potentials are widespread in the diverse musical applications of gameful design (1.5). With regard to composition specifically, however, two trends are apparent: first, that providing access is a principal design aim of gamified composition (1.6); second, that the potential for games to engage through challenge and conflict is rarely explored (1.6.4.1).

1.5 Musical Gamification Outside of Composition

In the past decade, gamification strategies have spread rapidly throughout musical practice. This expansion is emblematic of the potential for games to lead to new discoveries and understandings in non-game contexts, and so is reviewed here to preface a discussion of gamified composition specifically (1.6).

1.5.1 Education

Unequivocally, the most direct application of gamification to musical practice has been the rise of game-based learning in music education (Lesser, 2019). Ludomusicologists have suggested that all musical games exhibit at least a subliminally didactic function (Kassabian & Jarman, 2016), insofar as improving musical cognition, rhythmic acuity, or hand-eye coordination. However, there are many gamified designs in which musical education is the explicit intention. These applications address pedagogies as diverse as musical performance, creation, history, industry, and even musical machine learning concepts.

Instrumental tuition is arguably the most popular site for exploring game-based music learning. Birch (2013) developed a game with points, achievements, avatars, and a social leaderboard to encourage technical practice in piano students, finding a positive effect on both technical development and student attitudes toward practice. Others have explored the potential for specifically digital gameplay in private tuition (Wagner, 2016), or the integration of existing commercial musical games like Rocksmith (Ubisoft, 2014) into instrumental learning (Havre et al., 2019). Beyond performance, scholars also highlight musical games as a means of engendering musical creativity in the classroom (Fleshner, 2016; Roesner, Paisley, & Cassidy, 2016). In fact, the design process of digital games itself has been adopted as a creative development framework for students learning to build interactive music experiences (Atherton & Wang, 2018;
Brown, 2016). Chunity,\textsuperscript{13} a plug-in for the Unity game engine which allows integration of the ChucK\textsuperscript{14} audio programming language (Wang, 2008), has been evaluated as a platform for the student design of interactive audiovisual games in a tertiary computer music course (Atherton & Wang, 2018). Brown (2016) similarly considers the potential for Scratch\textsuperscript{15}, an accessible programming environment for young or inexperienced programmers (Resnick et al., 2009), to introduce students to advanced generative music concepts when situated within a game development context.

Gamified strategies are also employed in music history and industry education. Herzig (2019) evaluated a classroom game simulating the contractual and economic relationships between artists, labels, and consumers, finding evidence of deeper student engagement with the subject. Filimon, Iftene, and Trandabät (2019) have designed a joint music history and geography game for the Alexa software assistant, which generates quiz questions from open data resources DBpedia and Wikidata. Designers have even applied educational gamification to musical machine learning concepts. The browser-game “Sornting”\textsuperscript{16} (Thio, 2019), for instance, tasks players with correctly ordering a set of interpolations between two melodies with increasing levels of difficulty. The designer’s intent was to help players understand the model being used (MusicVAE\textsuperscript{17}) while presenting machine learning algorithms as “fun” (Thio, 2019).

1.5.2 Health

Though less than education, there is notable gamification activity in the domains of healthcare and music therapy. Practitioners have long maintained the efficacy of musical activity for aiding psychological and physiological wellness (Agres, Lui, & Herremans, 2019), yet only recently has interest arisen in the use of computer-mediated interactive audio (Andersson & Cappelen, 2014). Recent applications include “MyoBeats”, a rhythm-based mobile game for improving myoelectric prosthesis control during rehabilitation (Prahm, Kayali, & Aszmann, 2019), and “Musiquence”, a serious

\footnotesize{\textsuperscript{13} The Chunity plug-in, tutorials, and documentation can be found at: http://chuck.stanford.edu/chunity/ (retrieved 28 December, 2019).}

\footnotesize{\textsuperscript{14} The ChucK programming language and documentation can be found at: https://chuck.cs.princeton.edu/ (retrieved 28 December, 2019).}

\footnotesize{\textsuperscript{15} The “Scratch” programming environment is accessible online as a web application: https://scratch.mit.edu/projects/editor/ (retrieved 28 December, 2019).}

\footnotesize{\textsuperscript{16} “Sornting” can be played at: https://vibertthio.com/sornting/ (retrieved 28 December, 2019).}

\footnotesize{\textsuperscript{17} Developed under Google’s Magenta project, MusicVAE (\textit{variational autoencoder}) allows for a blending of two or more musical score fragments like melodies, basslines, or drum beats. Several demonstrations are available at: https://magenta.tensorflow.org/music-vae (retrieved 28 December, 2019).}
music game system for stimulating reminiscence in people with dementia (Ferreira, Cavaco, & i Badia, 2019). A particularly novel design has been developed by Agres et al. (2019) to support cognitive and motor function in the elderly; users are required to mimic instrumental performance through physical gestures, which are then captured and evaluated using the Microsoft Kinect sensor.

1.5.3 Democratising Musical Activity

As I have alluded, digital games can provide novice users with access to specialised musical experiences with otherwise prohibitively high entry barriers. Instrumental anthologies like the Guitar Hero (Harmonix, 2005) and Rock Band (Harmonix, 2007) series offer an unintimidating simulation of live performance without the years of gruelling practice. Mobile strategy games like Music Inc. (UK Music, 2014) allow players to immerse themselves in the life of a start-up music producer, nurturing artists and growing a label without any of the real risk or capital. It is for such reasons that scholars studying the impact of music games (Cassidy & Paisley, 2013) describe them as powerful vehicles for inviting formal and informal music participation – itself a valuable endeavour given the noted intellectual, social, and personal benefits of active music engagement throughout the lifespan (Hallam, 2010).

1.6 Games as Access to Interactive Composition

Democratising musical activity is one of the great potentials of the game medium. Unsurprisingly, the aim of providing access to non-experts has emerged as central to the contemporary practice of gamified interactive composition. The pervasion of this design goal is critical to understanding the aesthetic presumptions underscoring the research gap explored herein – the rejection of competitive elements in digital composition games (1.1.1). I provide here an overview of accessible, gamified composition to elucidate this context.
1.6.1 A History in Selected Works

1.6.1.1 An Origin in Dice Games

While earlier precedents exist, the salient origin for contemporary composition games is found in the Western European tradition of *Musikalisches Würfelspiel* (translated to “musical dice games”). These popular game systems, of which at least twenty were published between 1757 and 1812 (Hedges, 1978), were designed to provide musically inexperienced participants with a novel point of access to composition. Through the chance operation of a dice roll, players could sequentially construct their own minuet, waltz, and so forth from a set of corresponding musical fragments. Importantly, the systems were meticulously designed to ensure that all permutations would result in a syntactically sound outcome. The aleatoric nature of the musical dice games did not afford true compositional agency beyond the choice to “play” or “not play”. Yet in these systems lies the essence of wielding games as access to interactive composition: the use of symbolic interactions to affect complex musical creation.

1.6.1.2 Game Pieces of the Twentieth Century

Gameful strategies then re-emerged in the experimental practice of twentieth century composers. John Cage conceived of *Reunion* (1968), a sonified game of chess played on a modified board where piece movements triggered pre-composed musical excerpts (Cross, 1999). Iannis Xenakis’ *Duel* (1959) and *Stratège* (1962) explored a numerically scored combat between opposing orchestras with “points” and a victor awarded using pre-determined payoff matrices (Sluchin & Malt, 2011). John Zorn continued the “game piece” tradition with *Cobra* (1984), a controlled improvisation where players can initiate temporary, pre-defined rules for performance that a prompter organises using symbolic cue cards (Brackett, 2008). However, these games were situated in formal performance contexts and, with the exception of *Reunion*, were playable only by experienced musicians – democratising music creation was not their goal.

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18 An earlier example of game-based composition is evident in Ghiselin Danckerts’ chessboard canon *Ave maris stella* (1535), while playful musical contests date back to antiquity with the ancient Greek myth of Apollo and Marsyas (Moseley 2016).

19 Mozart’s dice game, for example, restricts all 11 options for the penultimate bar to the dominant (V) chord, and all 11 options for the final bar to the tonic (I). This ensures that the piece will always end in a perfect cadence, no matter which of the 121 permutations for these final bars is divined by the dice roll.

20 Though John Cage conceived the work, it was “composed” by Lowell Cross, David Behrman, Gordon Mumma, and David Tudor, who designed and constructed the modified chessboard as well as providing the 16 musical excerpts triggered by the game (Cross, 1999).
1.6.1.3 Accessible Music-Making in Early Video Games

*Otocky* (Iwai, 1987), designed by media artist Toshio Iwai for Nintendo’s FamiCom Disk System, is a musical side-scrolling shooter often regarded as the first video game to exhibit procedural music (Collins, 2009; Herremans & Chew, 2017; Lasser, 2013). The player’s firing actions generate melodic tones which are both harmonically constrained and strictly quantised, affording a small measure of accessible, musically creative play – albeit heavily instrumental in nature. Iwai would continue on to design *SimTunes* (Iwai, 1996), a creative sequencer in which insects could be placed atop a grid canvas to crawl over colours and objects “painted” by the player with varying sonic outcomes. Players can change the insects used to influence timbre as well as manipulate their behaviour on the canvas, allowing quite complex compositions to emerge from a novice-friendly and easily explorable ecosystem.

A related effort emerged in *Mario Paint* (Nintendo, 1992), which alongside a rudimentary painting program includes a constrained music creation sandbox (Plank, 2016). Players place graphical stickers on a musical stave, with each sticker symbolising a distinct timbre – for instance, mushrooms for drums, hearts for bass, and cats for pitched “meows”. Note placement is again strictly quantised and harmonically constrained for the benefit of musical novices, with choice of metre restricted to 3/4 or 4/4. Yet despite releasing on video game hardware (SNES) and featuring playful iconography, interaction with *Mario Paint* rather resembles that of a musical tool. This is exemplified in the extreme by *MTV Music Generator* (Codemasters, 1999), which in essence presents an accessible digital audio workstation (DAW) programmed for the original PlayStation console (Collins, 2008). While these software spawned dedicated fan communities, the original thread of abstracting musical decisions behind gameplay interaction is somewhat lost.

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21 *SimTunes* (1996) was conceptually derived from Iwai’s earlier sound installation *Music Insects* (1992), displayed at the Exploratorium in San Francisco, California. Iwai originally adapted elements of work as into the video game *Sound Fantasy* (1994) for Nintendo, though this was never commercially released.

22 In 2007, fans of *Mario Paint* isolated the music creation component and released a new version with greatly expanded functionality, such as chromatic tones (Plank, 2016). Laborious renditions of commercial songs using the software have since gained popularity on YouTube, and browser-based iterations have also been developed: see https://danielx.net/composer/ (retrieved 30 December, 2019).
1.6.1.4 Accessible Music-Making in Interactive Sound Art

Simultaneously, interactive sound installations at the turn of the millennium showed increasing interest in non-expert music participation. Toshio Iwai’s *Composition on the Table* (1999) presented four mixed reality interfaces where dynamic computer-generated images were projected onto large white tables. The images responded to participant gestures in real-time and produced corresponding sonic outcomes, allowing for intuitive and accessible musical play. In the first interface “Push”, for instance, participants would manipulate the path of four moving lights on a 6x6 omni-directional music sequencer reminiscent of Iwai’s earlier *SimTunes* (1996), with each node producing a discrete pitch when crossed.

The tabletop proved to be a powerful metaphor for collaborative musical spaces (Drummond, 2009), spawning several further accessible installations such as the *AudioPad* (Patten, Recht, & Ishii, 2002) and *reactTable* (Kaltenbrunner et al., 2006). Most salient, though, are the *Jam-O-Drum* (Blaine & Perkis, 2000) and *The Music Table* (Berry et al., 2003). The *Jam-O-Drum*, beginning as a multi-player music controller, was adapted into a four-person gaming interface with the aim of empowering “novice players to participate in immersive musical gaming experiences” (Blaine & Forlines, 2002). Interaction with the augmented reality *Music Table* involves organising cards and blocks on a tabletop, the position and orientation of which are tracked by an overhead camera and displayed on a screen with accompanying graphic simulations for the purpose of visual feedback. Acting as another playful step sequencer, the player can move, rotate, and tilt the game props to create looping musical patterns. Both works were explicitly designed for inexperienced musicians to compose music through intuitive, tactile, and visually stimulating gameplay (Berry et al., 2006). As such, they advance the original spirit of the dice games with the innovation of precise, predictable musical control – and thus, compositional intentionality.

1.6.1.5 *Electroplankton*, *Bloom*, and the Mobile Revolution

Soon after, Toshio Iwai would continue to pioneer game-based composition with the development of *Electroplankton* (Iwai, 2005) for the hand-held Nintendo DS. The game features ten modes (or mini-games), each an isolated system offering a discrete form of

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23 This supported a number of different multiplayer mini-games. One such game, “Bounce About”, involved the sonification of a 4-way, free-for-all rendition of the classic arcade game *Pong* (1972).
musical play in a carefully constrained sonic world. “Luminaria” (No. 3), for instance, is a recreation of the “Push” installation from Iwai’s *Composition on the Table* (1999). Most notable is “Hanenbow” (No. 2), where the player launches musical plankton at a manipulable plant structure to generate diatonic tones; pitch is determined by the angle of each plant leaf when struck by the plankton, and timbre may be influenced by repeatedly striking a particular leaf. Hanenbow’s abstraction of musical processes moves beyond the playful step sequencer by instead employing a prototypical gameplay metaphor – aiming for targets\(^{24}\) – as a musical control. Critical also is the abstract ludic interface\(^{25}\) and use of simulated physics, which more closely approach the interface aesthetics of digital games than of musical tools (D'Errico, 2016). All the while, Hanenbow’s symbolic representations of pitch and timbre remain easily decodable, allowing quick comprehension and exploration of the environment’s musical affordances by non-experts.

*Electroplankton* is a seminal predecessor to a rich landscape of mobile music-making apps – though not only in its interaction design. Iwai’s handheld game also prefigured the role of portable, single-user platforms as a site for the convergence of interactive composition, playful design, digital game technologies, and participatory music culture. The arrival of the iPhone in 2007 marked a radical disruption with its full-screen touch interface, facilitating an unmediated tactile connection between the content and user without the distraction of peripheral keys or buttons (D'Errico, 2016). Media artists were quick to answer with designs like *Ocarina* (Smule, 2008), taking advantage of the multi-touch screen and accelerometer to transform the smartphone into an accessible musical instrument\(^{26}\). The generative music app *Bloom* (Eno and Chilvers, 2008) then emerged as a prescient demonstration of the platform’s potential for artful audiovisual experiences at a time when apps were still considered “novelties” (Fingas, 2018).

*Bloom* presents the user with an ambient canvas upon which their touch interactions generate harmonically constrained tones, with pitch mapped intuitively to the vertical axis. The interaction seems at first instrumental, though the user quickly learns that their

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\(^{24}\) This interaction has proven popular in mobile puzzle games like *Angry Birds* (2009), to which the interface of Hanenbow bears some resemblance.

\(^{25}\) By this I mean the representation of a virtual game world or environment, which include the plants, organisms, and body of water, as opposed to a functional, tool-like interface such as the musical stave in *Mario Paint* or the implicit sequencer layout of the *Music Table*.

\(^{26}\) To use *Ocarina*, the player blows into the device’s microphone while placing multiple fingers on the screen to produce constrained pitches dependent on the specific finger configuration used. They can also tilt the device to influence articulation, such as vibrato.
generated tones persist as evolving perturbations in a shifting sonic texture – an emergent interaction that sound artist Norbert Herber would describe as a “composition-instrument” (Herber, 2008). Non-expert users can thus set complex sonic patterns into motion while preserving the relationship between their initial touch interactions and the evolving musical outcome. Although interaction with Bloom is not explicitly gameful, it laid the conceptual groundwork for a generation of mobile music-making apps and digital “sound toys” (Dolphin, 2014) to democratise musical composition en masse.

1.6.1.6 Music Apps and Sound Toys

The corpus of playful, musically creative mobile software grew rapidly as smartphones and tablets suffused media culture. Some apps, like Balls (iotic, 2009), render the device itself as an infantile sonic toy to be tilted and shaken.27 Others rely on the manipulation of simulated physics to explore sonic outcomes: players in Soundrop (Develoe LLC, 2010) draw beams to direct falling musical balls which generate pitched tones upon bouncing,28 while players in Pulsate (Audiotool, 2012) create arrays of expanding and contracting pulses that produce tones as they collide with one another.29 Gamified step sequencers also persisted: Chiptune Runner (Evil Indie Games, 2013) involves using a step sequencer as platforms to guide an automated running character, while Sequence (Okaynokay, 2017) is a loop-based ecosystem populated by musical organisms each containing an editable step sequencer. Such designs are practically innumerable, though some warrant further discussion.

Scape (Eno & Chilvers, 2012) – though still accessible – presents a comparatively advanced platform for composition. Players construct audiovisual “scapes” using a library of varied musical geometry, each with their own rules and behaviours for generating sound and interacting with one another. Björk’s interactive app-album Biophilia (2011) is also notable as a nexus of commercial music and gameful composition. Comparable to Iwai’s Electroplankton, Biophilia is a collection of nine discrete audiovisual experiences allowing players to deconstruct and remix Björk’s music – or in some cases, compose new music – using the sonic materials provided by

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27 A demonstration of Balls is available at: https://www.youtube.com/watch?v=T3yoZjFv7U (retrieved 1 January, 2020).
28 A demonstration of Soundrop is available at: https://www.youtube.com/watch?v=63FyqOMpORI (retrieved 1 January, 2020).
29 A demonstration of Pulsate is available at: https://www.youtube.com/watch?v=hDIq3ESVRt0 (retrieved 1 January, 2020).
the artist. The interactions range from gameful, such as navigating tunnels to collect items in “Crystalline”, to distinctly tool-based, such as the abstract score-editor “Sacrifice”; but all provide novice access to at least rudimentary musical construction. Finally, Andrew Dolphin’s SpiralSet (2009) and ResOscope (2016) demonstrate that democratised composition need not rely upon a diatonic and timbrally unchallenging sound world. Both involve passing game objects through rotateable structures to generate sound, though instead posit a deliberately abstract sonic character with a focus on “evolving textures…spectral development, progression and layering” (Dolphin, 2014).

1.6.1.7 Games in Contemporary Interactive Composition

Interactive sound art of the past decade, perhaps catalysed by the proliferation of mobile music creation, has shown great interest in game metaphors and non-expert participation. Some works incorporate multiple mobile devices in the creation of large multi-player systems. In SoundBounce (Dahl & Wang, 2010), participants in a mobile orchestra gesture with their smartphones to bounce and throw virtual balls, which generate sound using their simulated physics. Audiences found the intuitive metaphor to be engaging and accessible (Dahl & Wang, 2010), and the work also includes a competitive game section where players try to “knock out” one another’s sound balls. In Sound Games 1 & 2 (Gimenes, 2018), players tap and tilt their mobile devices to produce tones from within a perpetually shifting harmonic constraint shared by all participants. Performing collaboratively with other players earns game points, while each individual also competes to obtain “leading instruments” – worth more points – from Bluetooth emitters installed around the performance space.

Several other works have explored the sonification of familiar pre-digital game designs – as with Cage’s Reunion (1968). Dale Parson developed systems for sonifying computer-emulations of Chess (Parson, 2009) and Scrabble (Parson, 2010) in an effort to “introduce non-musicians to musical composition and performance by way of an interactive computer…game” (Parson, 2009). Kirsty Keatch (2014) sonifies player movements in Peg Solitaire, a single-player puzzle game, by extending the physical board with Arduino microcontrollers and a Pure Data patch. Beyond boardgames, artists have sonified sporting interactions by replacing their respective game props with networked audio devices. Urban Musical Game (Cera, 2013) uses balls augmented by

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30 The constraint can be allowed to progress automatically through a pre-programmed sequence after “n” seconds, or can be established manually in real-time by a “manager” using a MIDI controller.
wireless sensor technology to manipulate audio rendering in Max/MSP through real-time motion analysis,\(^{31}\) while *Bowls* (Bown & Ferguson, 2016) uses six distributed interactive audio devices\(^{32}\) (DIADs) to create a non-competitive, musicalised adaption of lawn bowls. The latter was notably featured at *Musify+Gamify*, a mini-festival held in Sydney, Australia to explore the intersection of games and music through accessible audience participation.

1.6.1.8 A Digital Renaissance for Game Pieces

Recent work demonstrates a resurgence of the twentieth century tradition of game pieces: that is, exploring game structures as a means of organising expert performance and improvisation rather than providing access for the musically experienced. Kallionpää et al. (2017) developed the game piece *Climb!* for Disklavier and digital interactive engine, in which a pianist attempts to perform technically challenging excerpts to progress towards a figurative mountain summit. Players quickly advance to the summit when performing excerpts correctly, but are otherwise diverted to a suboptimal path with additional challenges, thus taking longer to “win”. Notably, *Climb!* was also developed with the aim of lowering the technical barriers that discourage composers and performers from engaging with computers in their musical practice. This shows that the access afforded by gameful design extends beyond musical non-experts.

Related is the publicly funded research project “Gamified Audiovisual Performance and Performance Practice”.\(^{33}\) The GAPPP project produced several audiovisual game pieces which harness digital games as an organisational framework (Lüneburg, 2018). Christof Ressi’s *game_over_1.0.0* (2017), for instance, tasks an expert clarinettist with using improvised sonic gestures to pilot an on-screen spacecraft and fire projectiles at oncoming hostiles.\(^{34}\) This reflects a growing tradition of live musical performance as abstract videogame controllers, explored in earlier works like Joost van Dongen’s *Cello*.

\(^{31}\) A demonstration of interaction with the balls is available at: https://vimeo.com/22120867 (retrieved 2 January, 2020).

\(^{32}\) The DIADs are battery powered, wireless, single board systems with attached loudspeakers. For *Bowls*, they were encased within elliptical 3D-printed enclosures.

\(^{33}\) The project aims, research questions, methodology and researcher team can be found at: http://gappp.net/index.html (retrieved 8 April, 2020).

Fortress (2012)\textsuperscript{35}. Although such works are intended for formal performance settings rather than accessible interactive composition, the GAPPP project is emblematic of a rising interest in digital gameplay as a site for practice-led arts research.

1.6.1.9 Dreams as Access to the Design of Composition Games

I conclude this brief history by drawing attention to Dreams (Media Molecule, 2020), an ambitious hybrid between a game and game-development platform released for the PlayStation 4. Dreams consists of an exhaustive library of accessible development tools to support non-expert engagement with all aspects of game creation. Incredibly, this includes not only a fully-featured DAW with novice-friendly controls,\textsuperscript{36} but the means to easily attach created music to objects and actions within the player’s constructed game environment. Perseverant players could quite easily recreate designs like Otacky (1987), Electroplankton (2005), or Soundrop (2010) with little knowledge of game development or music creation. The games can then be played within Dreams or shared with other community members. In this way, platforms like Dreams offer not only a gameful access to composition, but to the design of composition games themselves.

1.6.2 Technology Convergence

1.6.2.1 Access through Digital Computation

As I have outlined, gameful designs and approaches have played a significant historical role in democratising music composition. This is not owed merely to the adoption of elements of games and play, but to a broader convergence of technology towards the non-expert user – to the masses. In the mobile age, most of the Western populace carry with them a portable device that is at once a powerful computer and audiovisual system. This offers two notable innovations for composition games: 1) the automation of complex processes and repetitive tasks; and 2) the self-contained playback, processing, and generation of audio data interactively and in real-time. Taking Mozart’s dice game as an example, the iOS adaption\textsuperscript{37} Mozart Dice Game (Weixelbaum, 2015) not only removes the need for manually consulting charts to arrange score fragments, but allows

\textsuperscript{35} Cello Fortress involves defending a virtual, on-screen fortress from multiple attacking players by using cello improvisations to control guns, flamethrowers and other defences. A video demonstration is available at: http://www.cellofortress.com/ (retrieved 7 February, 2020).

\textsuperscript{36} Functionality includes sampling, MIDI performance and recording, piano roll editing, effects manipulation, envelope manipulation, and more – all easily operated using the PlayStation 4 controller.

\textsuperscript{37} A comparable browser-based adaption is also available at: https://mozart.qvwx.de/index.en.html (retrieved 3 January, 2020).
for instantaneous playback of the constructed piece without procuring a musician. In this way, personal computing devices offer a particularly potent access by placing the entire encapsulated composition game system at the disposal of a single user.

Beyond simply streamlining pre-digital composition games, these technological affordances have also enabled a recontextualisation of past works into more accessible settings. Xenakis’ *Duel* (1959) has been translated into the interactive installation *Playing Music* (Liuni & Morelli, 2006), allowing direct participation in what was previously demarcated as a formal performance by expert musicians. Installations themselves can then be translated into a portable, single-user format for greater personal access; this is seen with Iwai’s adaption of *Composition on the Table* into *Electroplankton*’s “Luminaria”, and with the mobile app recreation of the original *reactTable* installation as *Reactable mobile* (Reactable Systems, 2010). The proliferation of mobile devices and personal computers means that these experiences have become available to most, advancing significantly a culture of participation in music-making. It is clear, then, that the technological platform plays as much a role in the game-based democratisation of composition as the game elements themselves.

### 1.6.2.2 Democratisation of Computer Music Tools

As designers have predicted (van Geelen, 2014), computer music tools are similarly converging towards non-specialist use. Musical machine learning researchers have shown increasing interest in making their models available for user interaction (Tchemeube, Ens, & Pasquier, 2019; Thio et al., 2019), while advancing web technologies for multi-media support have made this practicable through easily distributed web-apps. Non-experts can explore matrices of looping harmonic patterns in *Latent Cycles*, generate drum machine loops using seed patterns in *Neural Drum Machine*, or interact with machine learning processes themselves using *Apollo* (Tchemeube et al., 2019). Generative composition tools are also becoming available for use by musicians in established audio production environments. *Magenta Studio* (Roberts et al., 2019) is a suite of five deep learning plug-ins for extending, generating,

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40 This includes uploading a corpus of audio files, training the model, setting parameters for generation, saving generated songs and trained models, and streaming MIDI data to DAWs like Ableton Live.
and interpolating between MIDI material in Ableton Live, and the comparable *Splash Pro*\(^{41}\) plug-in even offers vocal generation and manipulation with customisable text. Bray and Bown (2015) have proposed that engagement with these creative systems be understood as ludic interactions motivated through play. More directly, though, the increasing usability and availability of these tools opens new potentials for integrating advanced computer music practice into gameful designs and contexts.

### 1.6.3 Summary

1.6.3.1 Timeline of Works Reviewed

Figure 1 is a timeline of selected works discussed in this section (1.6.1, 1.6.2). Multi-user systems are placed on the left and single-user systems on the right; these are not always clear or mutually exclusive distinctions, so here “single-user” refers to systems which *could* be played by a single human without other human players, conductors, or game masters. Systems exhibiting competitive game elements, whether *core* or *peripheral* (1.4.2) and no matter how minor, are in bold.

1.6.3.2 Summary: How Can Games Provide Access?

Considering systems accessible to non-experts, it appears that games can provide access to interactive composition through four avenues related to design, technology, and culture:

1. Symbolic abstraction of musical systems and processes through game props, metaphors, or interactions (Dolphin, 2014).
2. Harmonically constrained and timbrally unchallenging sound worlds to ensure a broadly appealing output; shown in *Bloom* and much of Iwai’s work.
3. Digital technology platforms, particularly: the ubiquity of mobile and personal computing devices, their capacity for automating complex tasks, and their power for real-time audio playback, processing, and generation.
4. Cultural associations of games as non-specialist, as being “disarming” or “for everyone” (Wang, 2016), lowering inhibition to participate in the perceived specialist act of music composition.

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These are not all essential conditions for access; Dolphin’s sound toys *SpiralSet* and *ResOscope* are not harmonically constrained (2), and the original dice games are a pre-digital democratisation of composition (3). Nonetheless, a symbolic abstraction of musical processes (1) should be understood as necessary to enabling non-expert participation in composition.

### 1.6.4 Implications for this Research

#### 1.6.4.1 Competitive Elements in Accessible Composition Games

As shown in Figure 1, most systems with competitive game elements (in bold) are designed for multiple users. The gameplay interactions generating the sound output are enacted either in contest with other human agents, as in *SoundBounce*, or against a system controlled by a human conductor or gamemaster, as in *game_over_1.0.0*. Comparatively, single-player systems for accessible, gamified composition appear generally to avoid competitive elements. To consider the exceptions listed in Figure 1: *Otocky* offers only rudimentary and instrumentalised music creation, *Climb!* is only accessible to expert pianists, and *Sounds of Solitaire* requires the author’s custom extended Peg Solitaire board which is hardly available to the general user. This leaves *Chiptune Runner* as one of the scarce few precedents\(^{42}\) for a competitive composition game that is at once accessible to non-experts, commercially available, and designed for single users. There is an opportunity here to explore the untapped creative potentials of these settings, which informs my second research question (1.2.1) paraphrased here as: How can we design a competitive digital game for single users that maintains a focus on accessible sound composition?

The lack of competitive elements in accessible composition games is underpinned by aesthetic intuitions regarding the relationship between contest and musical creativity. Apprehending these intuitions requires a thorough examination of how theories of play and games have been mapped to composition by designers and scholars of musical games, which follows in Chapter 2. My interest in interrogating these assumptions through practice is the launching point for the creative research presented herein.

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\(^{42}\) Other related designs will be explored in detail in Chapter 2, once a framework for appropriately discussing competitive game elements has been established.
Figure 1: Timeline of selected works from 1.6.1, 1.6.2. Systems with competitive game elements are shown in bold.
1.6.4.2 Original Works as Accessible to Non-Experts

As this chapter has explored, there is a growing convergence between games (1.4.3.2), interactive composition (1.6.1), and computer music technologies (1.6.2) at the nexus of democratised music-making. Designer Ge Wang (2016) in particular describes an opportunity to “bring music-making back”\(^{43}\) by using “everyday technology” and “disarming game-like qualities” to lower inhibitions and barriers to entry, perceived or otherwise. I consider this to be a broader potential for any union between gameful design and interactive composition: to engender access to music creation and so advance a culture of musical participation. This democratising potential of games first motivated my focus on accessible interaction design within this research, yet it will also prove instrumental in unpacking the perceived incongruities between composition and competitive gameplay (2.3.4). As such, engagement by non-expert players should be understood as an overarching goal of the original works discussed herein.

### 1.7 Chapter Summary

This chapter has outlined the research area (1.1), problem (1.1.1), and questions (1.2.1) explored in this thesis. I have introduced gamification (1.4), summarising its cultural context (1.4.1) and potential benefits (1.4.3), before outlining recent applications in musical practice (1.5) to demonstrate the promise of games as a research platform. I then overviewed the cultural and technological context of using gameful design to allow non-musicians to participate in interactive composition (1.6), revealing a broad avoidance of competitive gameplay elements in single-user systems (1.6.4.1). Chapter 2 reviews the theories and aesthetic assumptions underpinning this avoidance in detail.

This chapter has also given brief introduction to a body of three original works forming the creative research – *EvoMusic, Chase*, and *Idea*. I have outlined the design goals of the works as single-player game systems for the competitive human-computer co-creation of music in real-time (1.2). I have also articulated the works’ research purpose as leading a mixed methods investigation into the complex relationship between musical creativity and competitive gameplay (1.2). Chapter 3 further elucidates the role of the creative works within the research methodology. Chapters 4 (EvoMusic, Chase) and 6 (Idea) discuss the individual works in detail.

\(^{43}\) Wang (2016) here is responding to a broader cultural shift observed by musicologists following the advent of phonographic recording technologies: a shift from participatory “music-making” to a culture of passive and commodified “music-taking” (Cook, 2001; Landy, 2004), or private consumption.
Chapter 2: Literature Review

This chapter reviews in detail the theoretical and practical contexts of designing competitive composition games for single novice players. Theories of play and games are first surveyed (2.1) to reach an understanding of the competitive game framework (2.2). I then review how scholars and designers of musical games have mapped these theories to various forms of musical activity, positing such associations as the site of a perceived incongruity between musical creativity and competitive gameplay (2.3). Empirical psychologies of creativity and competition are surveyed to contextualise these assumptions (2.4), suggesting a more complex relationship between the two than is presented in ludomusicological discourse. The above concepts are then explored in related works, games, and apps (2.5) before an overview of musical metacreation (2.6) is used to articulate a point of departure for the three original composition games.

2.1 Play and Games

At the core of this research lie the nebulous phenomena of play and games. The two are closely entangled, and neither can be formally delimited with any ease. Accordingly, a multiplicity of theories, typologies, and perceptions of play and games have emerged in the decades following *Homo Ludens* (1955), Johan Huizinga’s seminal examination of play in culture. In the twenty-first century, the locus of this work has been the field of game studies – or, ludology – in which scholars have sought to apprehend the essential nature of games and the act of playing them. I review these efforts here as a theoretical grounding for the complex discourse surrounding the use of competitive elements in composition games.

2.1.1 Understanding Play

Play is the broader framing for all other notions discussed here, encompassing within it all games as a subset (Salen & Zimmerman, 2003) and thus all composition games and competitive gameplay. Huizinga’s *Homo Ludens* posits the central claim that all of human culture and civilisation “arises in and as play, and never leaves it” (Huizinga, 1938).

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44 The German term “spiel” expresses the concepts of both play and game, as do the French terms “jeux” and “jouer”. The English language’s separation of “play” and “game” seems an exception.
45 *Homo Ludens* was originally published in 1938.
1955, p. 173). Given this exceptionally broad scope, most scholars disavow the possibility of reaching any general definition of play at all (Grieshaber & McArdle, 2010; Kassabian & Jarman, 2016), with some suggesting that play’s resistance to definition is itself a defining quality (Moseley, 2016). Efforts to understand play have instead focused on delineating the agreeable characteristics of play, on identifying playful activities, and on constructing taxonomies to chart the different forms of play. Among the earliest to attempt this was Roger Caillois (2001) in his foundational text _Man, Play and Games_ (originally published in 1958).

2.1.1.1 *Paidia* and *Ludus*

Caillois proposed the notions of *paidia* and *ludus* as two opposing poles of playful activity. *Paidia*46 represents an unstructured or semi-structured playfulness that is free, spontaneous, exploratory, improvisational, and expressive. An appropriate analogue is the sandbox, which has been applied as a metaphor and genre descriptor for open-ended games like _The Sims_ (Maxis, 2000) due to their reliance on free experimentation and player-defined goals. In contrast, *ludus*47 embodies the willing submission to highly structured activities with explicit rules, objectives, and competitive strife – epitomised by classical games such as Chess. Based on these descriptions, it seems reasonable to suggest that musical creativity has an affinity with *paidia* whereas competition has an affinity with *ludus*. This intuition polarises creativity and competition from the onset, bearing aesthetic implications that I will discuss further in (2.2.3.2).

Paidia and ludus do not function as discrete or dichotomous categories; rather, they characterise the extremities of a continuous spectrum, such that an activity or system could exhibit traits of each in any proportion. _Minecraft_ (Mojang, 2011), for instance, is well known for its blending of paidic sandbox elements, such as exploration, creation, and player-set goals, with ludic constraints, such as combat and survival. This means that paidia and ludus do not map directly onto the notions of play and game. Nonetheless, their polarity offers a useful apparatus for characterising different forms of interaction in composition games. _Bloom_ (Eno & Chilvers, 2008) and _Electroplankton_ (Iwai, 2005) are paradigmatically paidic due to their exploratory design, non-competitive interactions, and lack of system-defined goals. Alternatively, Xenakis’ _Duel_

46 *Paidia*: from Ancient Greek παιδιά (paidía, “childish play, amusement”), from παῖς (paîs, “child”).
47 *Ludus*: from Latin ludus (“game”) and lūdō (“I play”), either from Proto-Indo-European ḫōydos < leyōd- (“to play”) or from Etruscan.
(1959) and Climb! (Kallionpää et al., 2017) exhibit ludic design through their use of an explicit, rule-bound combat to organise compositional outcomes. As I will show, paidia and ludus are central to conceptions of an incongruity between musical creativity and competitive gameplay.

2.1.1.2 Forms of Play

Caillois (2001) also identified four forms of play, marking the beginning of modern efforts towards a taxonomy of playful activity:48

- **Agon** – the play of contest and competition, as in Chess and many sports.
- **Alea** – the play of chance and indeterminate outcomes, as with dice.
- **Mimicry** – the play of mimesis and imagination, as with role-playing.
- **Ilinx** – the play of sensory overload, as with vertigo or hallucinogens.

Of these forms, *agon* and *alea* are the more pertinent to gamified composition. The musical dice games (1.6.1.1) constitute purely *aleatoric* composition games, while *Duel* and *Stratégie* (1.6.1.2) are wholly *agonistic* in design. In general, though, small measures of each are observable in most musically creative games. In *Electroplankton*’s “Hanenbow” (1.6.1.5), *agon* is present in the challenge of adjusting each plankton’s trajectory to strike the intended musical leaf, while *alea* can be found in the discovery of which sounds will emerge as a consequence.49 A non-musician player might also find a playful *mimicry* in accessible composition games through the representation of the self as composer, or of musical concepts as abstract visuals and game mechanics. Designs with an emphasis on visual stimulation or immersive environments – such as the virtual reality musical sandbox *SoundStage* (Olson, 2016) – could also be said to illicit a form of *ilinx*.

Several expanded taxonomies of playfulness have emerged since Caillois, many of which take his work as foundational. The Playful Experience (PLEX) framework, for instance, systematises play into 22 categories that include experiential phenomena as diverse as “humour”, “suffering”, “cruelty”, and “nurture” (Arrasvuori, Boberg, & Korhonen, 2010) – exemplifying the considerable breadth with which play has been

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48 Caillois was adamant that his work was not intended as a taxonomy of play, though it has been widely used as such in game studies and forms the foundation of several expanded taxonomical efforts.

49 Strictly speaking, each plankton’s trajectory has a deterministic sonic result. However, the player cannot precisely model the pitch and timbre outcomes of every plankton’s multiple sonified collisions. From the player’s perspective, then, an *aleatoric* joy emerges from exploring different plant configurations and plankton trajectories to “see what happens”.

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conceived. Here, Caillois’ *agon* provides a sufficiently elegant frame of reference for the types of gameplay interaction presently underexplored in accessible, single-user composition games: the notions of challenge, contest, conflict, and competition.

**2.1.2 A Formal Conception of Games**

The nascent game studies of the early 2000s was characterised by a concerted effort to formalise the essential elements of games. Game scholars, hoping to delineate their area of inquiry, sought a generalisable definition capable of distinguishing formal games and gameplaying from toys and more broadly playful activities. Such distinctions are often drawn along the lines of *paidia* and *ludus* (Deterding et al., 2011), solidifying a discourse that positions exploratory, open-ended forms of interaction in opposition to competitive rule structures, and so external to formal games. Not only has this discourse complicated the conception of musically creative media as “games” (Blickhan, 2016; Collins, 2009), it has informed a prevailing intuition that the aesthetics of competitive gameplay are unsuited to accessible composition experiences.

**2.1.2.1 The Classic Game Model**

Of the many classical game definitions, those devised by Salen and Zimmerman (2003) and Juul (2005) have emerged as the most influential (Aarseth & Calleja, 2015). Both were constructed by consolidating existing perspectives, and so each can be taken as generally representative of a formal model of games. For brevity, I will focus on the definition offered by Salen and Zimmerman: “a game is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome” (p. 80). This posits six constituent elements as summarised in Table 1. The first three conditions – *systems*, *players*, and *artificiality* – can be assumed in most interactive contexts and certainly for all composition games. The remaining elements of *conflict*, *rules*, and *quantifiable outcomes* form the essential conditions typically invoked by those seeking to differentiate games from less formal play activities.50 Together, these conditions constitute the competitive game framework, which I will unpack in greater detail (2.2). For now, it is sufficient to note the connection between this framework and Caillois’ notion of *ludus*, which has encouraged a characterisation of games as *ludic* in opposition to less bounded playful activity as *paidic*.

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50 This reduction reflects many definitions from the twentieth century. For instance, Avedon and Sutton-Smith (1971) define games as: “a contest between powers, confined by rules in order to produce a disequilibrual outcome” (p. 405, emphasis added).
Table 1: Formal elements in Salen & Zimmerman's (2003) definition of “game”.

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>Games are intrinsically systems: “sets of things that affect one another within an environment to form a larger pattern that is different from any of the individual parts” (p. 50).</td>
</tr>
<tr>
<td>Player</td>
<td>Games are actively engaged by participants called players. Players act within a game system to experience the game.</td>
</tr>
<tr>
<td>Artificiality</td>
<td>Games occur in the real world, but are partially insulated from the meanings, rituals, and consequences of everyday life.51</td>
</tr>
<tr>
<td>Conflict</td>
<td>“All games embody a contest of powers” (p. 80), whether between opposing human players or against the game system itself.</td>
</tr>
<tr>
<td>Rules</td>
<td>Rules delimit what players can and cannot do, forming the structure from which the game emerges. Rules can be mediated by either computers or human participants.</td>
</tr>
<tr>
<td>Quantifiable Outcome</td>
<td>Players win, lose, or receive some numerical score at the conclusion of the game. This implies both a clear objective and a framework for evaluating player effort towards the objective, whether human or computer mediated.</td>
</tr>
</tbody>
</table>

2.1.2.2 Gameplay: The Lusory Attitude

An accounting of gameplay itself is equally crucial to formal conceptions of games. To this effect, philosopher Bernard Suits (2005) describes the player attitudes necessary for games to emerge. He defines the playing of a game as “the voluntary attempt to overcome unnecessary obstacles” (p. 34), suggesting that this requires a “lusory attitude” whereby players accept less efficient means of achieving a “prelusory goal” to make possible a game.52 Some have argued that this metaphor fails in the context of digital games, as actions cannot be taken outside of the hardcoded constraints set by the developer (Calleja, 2012). This neglects to acknowledge that: 1) less efficient means are already an implicit design consideration, such as limiting the player’s time, health, or ammunition; 2) that players could impose their own constraints and mini-games, such as only using certain characters; or 3) that fair players agree not to cheat by modifying

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51 This is described by Huizinga (1955) as the “magic circle”, though modern scholars consider hard demarcations between the real- and game-world to be analytically untenable (Consalvo, 2009; Ferreira & Falcão, 2009; Calleja, 2012).

52 An example is prohibiting soccer players from using their hands. While it would be more efficient to simply carry the ball into the opposing goal, the game of “soccer” emerges when participants all agree to submit to the rules prohibiting this.
the game code or purchasing advantages (Consalvo, 2009). Nonetheless, Suits’ (2005) representation of the gameplay attitude has remained influential in game studies and is employed regularly by ludomusical scholars in their ontological negotiations of music games (Fleschner, 2017; Kassabian & Jarman, 2016).

Of further significance to game-based composition is Juul’s (2005) classic game model, which asserts that gameplay requires players to “exert effort in order to influence the [game] outcome” (p. 36). Juul uses this to disqualify systems of purely aleatoric interaction on the basis that chance operations do not afford intentional influence over the game. From this position, the musical dice games (1.6.1.1) would not constitute formal gameplay for the same reason that they do not strictly afford true compositional agency – a lack of player control. This should not discount the use of indeterminacy as a valuable element of composition games (6.4.3), but reinforce the significance of allowing players at least some measure of direct responsibility over the sound output.

2.1.2.3 Games, Tools, and Toys

Formal conceptions of games and gameplaying are a common fulcrum for distinguishing them from tools or toys. The practice of drawing hard taxonomical boundaries is receding from modern game studies (2.1.3), though they remain prominent in discussions of musically creative games and apps. Motivations for this use of classical game perspectives differ: Blickhan (2016) and Fleschner (2016) seek to reframe interactions with apps like Biophilia and Soundrop as gameful (2.3.2), while Dolphin (2014) instead aims to distance his “sound toys” from formal games to emphasise a focus on open sound composition (2.3.4.2). These cases offer critical insight into the aesthetic assumptions surrounding games and musical creativity.

2.1.3 A Wittgensteinian Game Ontology

There has long been contention over the boundaries of “game” as an ontological object, with at least 63 notable definitions proposed (Stenros, 2016). Despite this, the classical project of reaching a generalisable game definition remains unfulfilled, now considered by some to have “created more problems than solutions” (Aarseth & Calleja, 2015). Modern game scholars have increasingly adopted the Wittgensteinian stance that any attempted definition would encircle only a subset of all phenomena described as games (Aarseth & Calleja, 2015; Arjoranta, 2014; Wittgenstein, 1953 [2010]). This does not
suggest that game definitions have no place, but that they should be considered as context-sensitive tools for specific research purposes (Arjoranta, 2019). Wittgenstein is often misinterpreted as claiming that games cannot be formally defined (Arjoranta, 2019), provoking rebuttal from the likes of Suits (2005) and others (Hurka & Tasioulas, 2006) via their own definitions. However, Wittgenstein only writes about games as a useful analogue to systems of language, suggesting that both are best understood as a network of related concepts which he coins “family resemblances”.

2.1.3.1 A Heuristic Approach to Game Elements

Wittgenstein’s (1953 [2010]) notion of family resemblances enables a heuristic approach to game ontology as an alternative to deriving their essential elements. What follows is a framing of game elements as those characteristic of games, rather than necessary for them. For Deterding et al. (2011), being “characteristic” means that an element is: 1) found in most, but not necessarily all, games; 2) readily associated with games; or 3) found to play a significant role in games. These conceptions allow for broader taxonomies of game elements which describe features like leaderboards, achievements, and avatars as potentially gameful (Buckley et al., 2018). In turn, a heuristic approach to game elements can offer a broader understanding of the characteristics of competitive gameplay.

2.1.3.2 Games as Activities

Thus far, I have discussed games only as objects – as the structure of rules, design elements, and technical assets that exists apart from player interaction. In the expanded modern discourse, games are understood not just as formal objects, but as activities (Ferreira & Falcão, 2009; Fritsch, 2014) or processes (Aarseth & Calleja, 2015) that are both socially negotiable and contingent upon the player’s “mental model” of the system (Grip, 2017; Sylvester, 2013). This ontology posits that the “game” emerges in the moment of interaction when the system’s affordances become available to the player (Ferreira & Falcão, 2009), allowing an understanding of gameplay beyond structuralist definitions (Consalvo, 2009). More saliently, an interaction-oriented conception of

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53 According to Deterding et al. (2011), essentialist definitions are problematic for one of two reasons. A strict approach of taking elements unique to games would produce an empty or highly constrained set. Otherwise, a broad approach of taking any element found in games would be boundless.

54 This refers to the notion that games are not played on the screen or board, but in the player’s mind as they mentally model the system’s affordances and plan their interactions (Grip, 2017).
games as activities allows for a more complete investigation of competitive gameplay in compositional contexts.

2.1.3.3 Game Conceptions Applied to this Research

Aarseth and Calleja (2015) describe the difference between games and non-games as discursive, noting that “games are simply those [systems]…referred to, by someone, as games”. While I am inclined towards this heuristic understanding of games, it is not my intention here to espouse or denounce any particular ontology, nor to settle esoteric debates about their appropriate classification. Rather, I have reviewed conceptions of play, games, and gameplaying with the following aims:

1) To lay a theoretical foundation for apprehending the competitive game framework (2.2), including competitive game elements and gameplay; and
2) To contextualise the use of game and play theories by ludomusical scholars (2.3), which illuminates the aesthetic assumptions underlying the avoidance of competitive elements in accessible composition games.

2.2 The Competitive Game Framework

I have suggested that the competitive game framework is related to classical notions of rules, contest, and quantifiable outcomes (2.1.2.1). However, the competitive aspect of games has diverse conceptions and can manifest in a variety of forms. Game contest can be symmetrical or asymmetrical, against players or systems, co-operative or competitive, violent or non-violent (Crawford, 1984), ludic or paidic, and based in any of Caillois’ four forms of play (2.1.1.2). Here I unpack the competitive game framework in greater detail and relate it to the notion of accessible, game-based music creation.

2.2.1 Conceptions of Competitive Gameplay

Salen and Zimmerman (2003) assert that “all games embody a contest of powers” (p. 80), derived from Avedon and Sutton-Smith (1971). They also include in their definition (2.1.2.1) that games require “conflict”, as influenced by computer game designer Chris Crawford’s (1984) suggestion that “conflict is an intrinsic element of all games”. Deterding et al. (2011) similarly characterise games as involving a “competition or strife of actors”. These related terms – contest, conflict, competition, and strife – all signify a common dynamic which emerges from prototypically ludic gameplay: a player “exerting effort” (Juul, 2005) to overcome some manner of
opponent or “unnecessary obstacle” (Suits, 2005). This sense of contest is not undirected. Crucially, it is framed by a goal or outcome for which the player strives, and towards which the game obstacle or opponent impedes progress. It is upon this adversarial interaction that the competitive game framework is founded.

2.2.1.1 Disambiguation: Conflict, Contest, and Competition

To simplify discussion, I take the terms conflict, contest, and competition to be analogous for the purposes of this research, with each referring to the interactive dynamic outlined above (2.2.1). The terms have seen a diverse enough usage in the game studies literature so as to share a semantic intention in the context of gameplay. Following this, it would be equally valid to observe that dynamics of “conflict”, “contest”, or “competition” are underrepresented in gamified composition experiences for single, novice users.

2.2.1.2 Elements of Competitive Gameplay

Competitive gameplay can generally be viewed as emerging from high-level design decisions about the game system, such as having players oppose one another in the first place. Beyond this, however, a number of more specific design features have been framed as contributing to a dynamic of contest in games. Several of these features are identified by Buckley et al. (2018), who consolidate a comprehensive taxonomy of gameful elements from a review of game and gamification literature. The most explicitly competitive of these involve direct violent confrontation, as with “combat” or “boss fights”. A sense of contest also manifests whenever player performance is evaluated, such that players strive to earn “points”, unlock “badges” and “achievements”, or advance on “social graphs” and “leaderboards”. Finally, conflict is apparent within aspects of game progression, where content is withheld until a certain challenge has been met, or where the difficulty of gameplay gradually increases in “levels”. Each of these elements are framed by a goal – whether designed into the system or imposed by the player – that the player struggles, however minimally, to attain. In this way, aspects of violence, player evaluation, and progression inherently predispose gameplay to being experienced as competitive. These aspects and their related elements in Buckley et al. (2018) are summarised in Table 2:
Table 2: Categorisation of competitive game elements identified in Buckley et al. (2018). *Note: the three higher level categorisations are not posited by Buckley et al.

<table>
<thead>
<tr>
<th>Category*</th>
<th>Element</th>
<th>Description in Buckley et al. (2018)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violence</td>
<td>Combat</td>
<td>“fights, battles, duels within games”</td>
</tr>
<tr>
<td></td>
<td>Boss Fights</td>
<td>“final challenges in order to level up”</td>
</tr>
<tr>
<td></td>
<td>Points</td>
<td>“awarded for various deeds in game”</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Badges</td>
<td>“visual representations of rewards or achievements”</td>
</tr>
<tr>
<td></td>
<td>Achievements</td>
<td>“In-game content that is earned by player behaviour, e.g. content for avatar customisation”</td>
</tr>
<tr>
<td></td>
<td>Social Graphs</td>
<td>“Information data sets presented to specific groups or teams of people within a game, e.g. to spur one group on to compete against another”</td>
</tr>
<tr>
<td></td>
<td>Leaderboards</td>
<td>“All player’s positions in a system, usually in relation to the number of points they have been awarded”</td>
</tr>
<tr>
<td>Progression</td>
<td>Content-unlocking</td>
<td>“Content withheld from players until a certain level of ability is reached”</td>
</tr>
<tr>
<td></td>
<td>Levels</td>
<td>“Levels express the number of points the player has, and subsequent levels become more difficult as a player progresses”</td>
</tr>
<tr>
<td></td>
<td>Quests</td>
<td>“Specific tasks which can act as goals and further a narrative thread in a game”.</td>
</tr>
</tbody>
</table>

2.2.1.3 The Competitive Game Framework as a Design Dimension

To avoid ontological debate, I consider the competitive game framework as a design dimension to be approached by particular interactions rather than a hard demarcation between competitive and non-competitive gameplay. This mirrors Wittgensteinian conceptions (2.1.3), and allows for a more robust analysis of gamified composition experiences. For instance, the generative music app Scape (Eno & Chilvers 2012) – introduced prior (1.6.1.6) – exhibits a rudimentary form of game progression whereby players can “unlock” additional sound objects and resources simply by spending time creating music. The core interactions are not themselves competitive, nor physically or mentally challenging. And yet, by requiring players to overcome the arbitrary obstacle of time spent to achieve the goal of greater compositional control, Scape can be described as exhibiting “more” of a competitive game framework than its predecessor Bloom (1.6.1.5), which offers no such progression or explicit goal.
2.2.2 Types of Game Contest

The conception of competitive gameplay that I have outlined (2.2.1) can arise from a variety of game system formats. These differ in the number and nature of competing agents, the symmetry of the contest, the form of play (2.1.1.2) underpinning the competitive mechanic, and the conceptual nature of the “victory condition”. Each of the formats enjoy at least some measure of representation in composition game designs, and so are reviewed here.

2.2.2.1 Player(s)-vs-Player(s)

The prototypical form of game contest is between opposing human players, as represented by board games like Chess and Monopoly, sports like soccer and golf, and multiplayer video games like Fortnite Battle Royale (Epic Games, 2017). The competition in player-versus-player (PvP) games can be symmetrical or asymmetrical with regard to each player’s affordances. In symmetrical contest, all players possess the same properties, strengths, and weaknesses (Crawford, 1984). Xenakis’ game pieces and Gimenes’ (2018) Sound Games 1 & 2 are explicitly musical examples, as the contest is conducted via the players’ musical decisions. Beyond this, any sonification of existing symmetrical games – like Cage’s Reunion (1968) or Parson’s (2010) Music for 32 Chess Pieces – could also be considered symmetrical composition games. In asymmetrical contest, at least one player possesses a unique set of affordances, advantages, and disadvantages unavailable to other players (Crawford, 1984). Though fewer compositional precedents exist, one notable case is Christof Ressi’s game_over_1.0.0. As described in Lüneburg (2018), an expert clarinetist controls a digital game avatar through improvised sonic gestures while a human game master instantiates game obstacles and “enemies” for the performer to overcome.

2.2.2.2 Player(s)-vs-System

Many game systems involve one or more human players competing against the system itself. Some of these are simply computerisations of PvP designs, making games like Chess available to single players via an AI opponent. However, the majority involve the player overcoming a non-symmetrical obstacle or challenge designed into the system, as with the arcade game Space Invaders (Nishikado, 1978). Most player-versus-system
(PvS)\textsuperscript{55} designs are realised as digital games to take advantage of complex automation and information displays, though non-digital designs are also possible. Compositional precedents include the aforementioned *Sounds of Solitaire* (Keatch, 2014), *Climb!* (Kallionpää et al., 2017), and mobile games like *Chiptune Runner* (Evil Indie Games, 2013). The PvS format is the more pertinent to this research as it allows for a single player to engage in competitive, game-based composition. Accordingly, the three original composition games presented in this thesis are player-versus-system designs.

2.2.2.3 Puzzles: Competition as Deducing Solutions

Puzzles are a subset of player-versus-system games that have one or more fixed solutions\textsuperscript{56} as opposed to a dynamically shifting game state (Salen & Zimmerman, 2003). There are limited precedents for puzzle-based composition games, likely owing to the fact that incorporating “correct answers” into a creative system would restrict its compositional novelty and the player’s free exploration. Ghiselin Danckerts’ *Ave maris stella* (1535), for instance, is notated as a chessboard of score fragments which, if navigated correctly, can produce up to twenty four-voice motets as solutions (Westgeest, 1986). This riddle-based interaction is better characterised as uncovering Danckerts’ composed piece than as the creation of music in itself, reflecting Crawford’s (1984) distinction between gameplay as “creating your own solution” and puzzles as “discovering the designer’s solution” (p. 12). The salient implication is that competitive games for interactive composition should not ideally involve a fixed solution.

2.2.2.4 Forms of Play in Competitive Games

All competitive gameplay interaction is intrinsically agonistic, or contest-based. However, interactions within some competitive systems can also simultaneously exhibits traits of Caillois’ other forms of play (2.1.1.2). Agonistic alea is present in chance-based gambling, agonistic mimicry is found in games of deception and misrepresentation, and agonistic ilinx manifests in sensorially demanding sports such as ski jumping; these may be described respectively as competing against probability, against discernment, and against sensory overload. To my knowledge, no composition

\footnotesize
\textsuperscript{55} Note that Massively Multiplayer Online games (MMOs) often refer to this as player-vs-environment (PvE), denoting that players fight large quantities of AI enemies throughout a vast open gameworld.

\textsuperscript{56} Fixed solution implies that a “correct answer” exists prior to the commencement of the game and remains valid throughout. While one might frame the act of gameplay as continuously deducing solutions, non-puzzles games see the available solutions shift with each moment.
games exhibit these forms of competition. As with the scarcity of puzzle-based designs, this has likely occurred to ensure a focus on compositional agency by avoiding superfluous design elements; for instance, the creative potentials and controllability of an agonistic composition game would be severely limited if the player were also required to contend unnecessarily with sensory overload (ilinx). More crucially, though, extending this argument reveals a larger conceptual tension: that any competitive framework could similarly distract from a focus on sound composition (Dolphin, 2014). As I will demonstrate (2.2.4.4, 2.3.4.2), this intuition significantly underscores the rejection of competitive elements in composition games for single, novice users.

2.2.3 The Aesthetics of Competitive Gameplay

Competitive gameplay gives rise to a particular set of experiential aesthetics, which Hunicke, LeBlanc and Zubek (2004) define in the context of game design as “the desirable emotional responses evoked in the player when [they] interact with the game system”. Designers and scholars of musically creative games have relied heavily upon the aesthetics evoked by different forms of gameplay when forming normative judgements about how game-based composition ought to be experienced. Here, I review how these aesthetics emerge through gameplay before introducing the conflicting aesthetic characterisations of creative and competitive gameplay.

2.2.3.1 Mechanics, Dynamics, Aesthetics

Hunicke et al. (2004) developed the MDA framework – mechanics, dynamics, and aesthetics – as a formal approach to understanding and deconstructing game design. Mechanics describe particular game components at the level of assets and algorithms, representing the actions and control mechanisms available to players. These give rise to system dynamics, the run-time behaviour of various mechanics interacting with one another. It is in this sense that I have used language such as “dynamic of contest” thus far: to describe the adversarial dialogues arising between game agents due to the system’s mechanical affordances. Finally, from a game’s dynamics emerges the aesthetic experience of gameplay. To Hunicke et al. (2004), aesthetics represent the

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57 Note that while aspects of alea, mimicry, and ilinx can be present in composition games (2.1.1.2), this is never in a competitive capacity where mimicry, for instance, is how the competition occurs.

58 In games of Poker, for instance, the dynamic of “bluffing” (i.e. lying about one’s hand) is able to emerge from the designed mechanics of card values (hands can win or lose), betting (claims about hands are made), concealing cards (hands cannot be seen), and shuffling cards (hands cannot be predicted).
different types of “fun” or emotional response that gameplay can evoke, including categories like “fantasy”, “fellowship”, and “challenge”. The MDA framework has been influential in studies of games and player experience, with more recent taxonomies like the aforementioned Playful Experience Framework (Arrasvuori et al., 2010) incorporating and expanding upon the eight gameplay aesthetics first offered by Hunicke et al. (2004). The MDA framework also allows Caillois’ four forms of play, as well as the phenomena of paidia and ludus more broadly, to be considered as aesthetics arising from the mechanical elements designed into game systems.

2.2.3.2 The Polarised Aesthetics of Creativity and Competition in Games

Of interest to this research are four particular aesthetic experiences of the 22 identified by Arrasvuori et al. (2010): competition, challenge, discovery, and expression (see Table 3). Competition and challenge are closely linked to ludus through their proclivity for rules and constraints, while discovery and expression are characteristic of paidia due to their less structured, open-ended nature. Table 3 outlines these relationships, providing the PLEX framework’s summary of each aesthetic experience (Arrasvuori et al., 2010) along with examples of how each can manifest:

Table 3: Description and categorisation of discovery, expression, competition, and challenge as gameplay aesthetics. Quotations are from Arrasvuori et al. (2010).

<table>
<thead>
<tr>
<th>Polarity</th>
<th>Aesthetic</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Paidia</strong></td>
<td>Discovery</td>
<td>“Finding something new or unknown”</td>
<td>Discovering a system affordance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Discovering a system outcome</td>
</tr>
<tr>
<td></td>
<td>Expression</td>
<td>“Manifesting oneself creatively”</td>
<td>Designing or constructing</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Personalising or modifying</td>
</tr>
<tr>
<td><strong>Ludus</strong></td>
<td>Competition</td>
<td>“Contest with oneself or an opponent”</td>
<td>Player(s)-versus-player(s)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Player(s)-versus-system</td>
</tr>
<tr>
<td></td>
<td>Challenge</td>
<td>“Testing abilities in a demanding task”</td>
<td>Physical (e.g. dexterity)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mental (e.g. problem-solving)</td>
</tr>
</tbody>
</table>

Through the polarity of paidia and ludus, we can begin to see these groupings of aesthetics as somewhat opposed. Hunicke et al. (2004) demonstrate this conception by juxtaposing two digital game series – Quake (id Software, 1996) and The Sims (Maxis, 2000) – as examples of differing gameplay aesthetics. The Quake games are fast-paced, quintessentially competitive first-person shooters to which Hunicke et al. attribute “challenge” and “competition”. The Sims games, on the other hand, are highly customisable sandboxes for agent-based life-simulations to which Hunicke et al.
attribute “discovery” and “expression”. The authors then continue on to describe challenge as emerging from game dynamics like “time pressure” and “opponent play”, while describing expression as emerging from dynamics that encourage designing, constructing, or personalising game assets. Through this lens, which Arrasvuori et al. (2010) reflect, discovery and expression are presented as the aesthetics of “creative” gameplay, while competition and challenge are framed as the aesthetics of “competitive” gameplay. Critically, this aligns notions of creation and competition with the opposing poles of paidia and ludus respectively.

Neither Hunicke et al. (2004) nor Arrasvuori et al. (2010) are implying with their descriptions that creativity and competition cannot co-exist within a game system. I have previously invoked Minecraft (Mojang, 2011) as a well-loved fusion of creative and competitive elements (2.1.1.1), and Massively Multiplayer Online (MMO) games like The Elder Scrolls Online (ZeniMax Online, 2014) often maintain complex creative systems for customising player appearance, companions, equipment, and housing alongside the game’s core competitive systems. Instead, the polarisation of creativity and competition by the MDA and PLEX frameworks is significant for its suggestion that creative gameplay, ideally, should not evoke the same aesthetic experiences as competitive gameplay. Extending this to musical creativity inspires the normative judgement that game-based composition ought not to feature competitive elements. Unsurprisingly, this intuition has been central to the rejection of the competitive game framework in accessible composition games (2.3.4.1).

2.2.3.3 The Role of Challenge in Games

Having noted that “challenge” is central to the aesthetic experience of competitive gameplay, it is pertinent to review briefly the perceived role of challenge in games. As outlined prior (1.4.3.1), challenge has an oft-studied capacity to engage and immerse players when optimally balanced with player skill (Corcos, 2018; Cox et al., 2012; Csikszentmihalyi, 1990; Ermi & Mäyrä, 2005; Nacke & Lindley, 2010). The positive and intrinsically motivating Flow state (Csikszentmihalyi, 1990) invoked by this desirable or “proper” (Arrasvuori et al., 2010) challenge is itself a significant aspiration of competitive games. Beyond enjoyment, though, appropriately challenging gameplay is also considered to pose a range of extrinsic benefits. Exposure to game challenge has been shown to build persistence and form positive reactions to failure (Anderson, Campbell, & Steinkuehler, 2019), while similarly serving as a valuable framework for
skill development and mastery (Anderson et al., 2019; Shroff et al., 2019). Game challenge also satisfies our desire for competence (Ryan et al., 2006), which self-determination theory (Ryan & Deci, 2000) describes as the basic human need for challenge and feelings of efficacy. In fact, the four game elements most closely associated with competence in a survey conducted by Buckley et al. (2018) were “levels” (progression), “boss fights”, “combat”, and “points” (evaluation) – all central to the competitive game framework (2.2.1.2). Philosophers writing on games (Hurka & Tasioulas, 2006) have even suggested that being “reasonably difficult…in absolute terms”, not just relative to player skill, is essential to the “good” that may be found in them. There is clearly a rich potential in competitive gameplay that may have unforeseen applications within interactive composition – if not for their apparent aesthetic incompatibilities.

2.2.4 Mechanical Difficulties of Musical Creation as Competitive Gameplay

Thus far, I have considered how the paradigmatic aesthetics (2.2.3.2) and formats (2.2.2.3, 2.2.2.4) of competitive gameplay are somewhat opposed to musically creative experiences. However, further design tensions yet emerge at the base mechanics level when considering the role of evaluation within the competitive game framework (2.2.1.2). Here I unpack these mechanical difficulties as a final insight from game studies before reviewing ludomusical scholarship (2.3).

2.2.4.1 Evaluating Musical Performance in Single-Player Games

Single-player competitive games are necessarily player-versus-system designs (2.2.2.2). As such, they have conventionally relied upon system-based evaluations of the player’s effectiveness within the game structure to mediate the contest and assign “victory” or “defeat”. This is no issue in the context of performative music games like the Guitar Hero (Harmonix, 2005) series, which reduce musical performance to quantifiable criteria that can be easily evaluated by a digital game system – for instance, rhythmic accuracy. Players can score points, win or lose, and progress through escalating challenges in what is clearly conceivable as a competitive game framework. It is difficult, however, to conceive of these same mechanics in the context of composition. How might a system fairly “score” the player’s subjective creations while also accounting for the diversity of player musical taste? How should the player “win” – or more critically, “lose” – by the merit of their compositional decisions without
disincentivising the free expression that characterises creative experiences (2.2.3.2)?

Most broadly, how might a system measure creativity when no agreeable psychological framework yet exists? (Said-Metwaly, Kyndt, & Noortgate, 2017)?

2.2.4.2 Evaluating Composition in Single-Player Games

At the mechanics level, a system-based evaluation of composition is not strictly impossible, but rather undesirable. One might, for instance, award points for electing chords that exhibit functional harmony, though this would restrict stylistic exploration and render the game as a test of music-theoretical knowledge rather than of creativity. In the case of Xenakis’ Duel (1959), the use of “payoff matrices” to award points for particular musical pairings (Sluchin & Malt, 2011) greatly constrains the system’s compositional potential – at least, for the players within the system. To avoid this, one might instead link “victory” and game progression to less restrictive criteria, such as creating music for “x” seconds or producing “x” number of sounds, yet these mechanics would so scarcely challenge players as to become arbitrary additions to the system. In these ways, any system-based evaluation of composition will necessarily impose aesthetic constraints that restrict free creation, or will otherwise serve only a limited competitive function. Compounding this tension is the reality that the player’s goal will not always be to compose “good” music, even by their own tastes; enjoyable experiences of discovery and expression (2.2.3.2) are equally found in subversive or experimental goals like “create as much sound as possible”.

2.2.4.3 Solutions to System-Evaluations of Composition

Ludomusical scholars, seeking to frame music-making apps as gameful, have offered both practical and discursive solutions that shift the responsibility of evaluation away from the system. These cases, discussed shortly (2.3.2), can be summarised as either: 1) shifting evaluation to other human judges in a social framework (Fleshner, 2016) at the expense of the single-player format; or 2) framing evaluation as the responsibility of the player’s self-defined aesthetic goals (Blickhan, 2016; Fleshner, 2017) at the expense of a competitive dynamic between the player and system. Alternatively, one might hope to

59 Said-Metwaly et al. (2017) conducted a literature review of 152 papers to compare their approaches to measuring creativity. They found that the appropriate measurement of creativity is an unsettled issue, while the standard instruments purporting to do so suffer from “serious conceptual shortcomings”.

60 Note that Duel (1959) was not intended in the first place as a system wherein players “compose”. As a game piece, Duel is best described as a composition in itself – or at least, a highly constrained possibility space – that is simply performed or manifested through competitive gameplay interactions.
approach system-based evaluations of composition through technological advancement. With the advent of machine learning models like DeepBach (Hadjeres, Pachet, & Nielson, 2017), which generates “highly convincing” four-part Bach chorales, we can conceive of a game system as follows:

1) A single expert musician attempts to compose within a prescribed historical style;
2) They are scored on their similarity to the corpus, such as “88% like Bach”;
3) They win or lose by meeting a dynamically adjusted difficulty threshold, such as “70% similarity”; and
4) They progress to unlock new styles and greater challenges.

This hypothetical design demonstrates that a classically competitive composition game is indeed feasible for single players, though it is entirely inaccessible to novice users in this form. Further, it reinforces that only constrained criteria such as corpus similarity could be evaluated by a system, again precluding more open musical exploration. For these reasons, the most intuitive solution for designing accessible composition games has been to simply reject elements of evaluation and competition.

2.2.4.4 Composition as Core or Peripheral to Competition

On the matter of system mechanics, a further conceptual difficulty arises from tying compositional outcomes to competitive gameplay interactions. If we adopt Wang’s (2016) notion of core and peripheral gamification (1.4.2) to describe the relationship between music creation and the game’s contest, it becomes apparent that compositional processes are often peripheral to the player’s competitive interactions in existing competitive composition games. Systems like Music for 32 Chess Pieces (Parson, 2009) or Sounds of Solitaire (Keatch, 2014), for instance, are sonifications of established game designs where sound is produced as a by-product of actions within the competitive structure. While moves can be made for purely compositional purposes within these frameworks, doing so would often run counter, or at least indifferently, to the goals of the game contest. A design tension thus arises from the co-existence of two potentially conflicting player motivations: creating desirable music, and winning the game. For

61 DeepBach can generate the chorales from scratch or reharmonise a given melody. Demonstrations are available at: https://sites.google.com/site/deepbachexamples/ (retrieved 16 January, 2020).

62 While composition is core to the experience and intention of Music for 32 Chess Pieces, it bears only a peripheral relationship to the underlying competitive structure; players determine each movement in accordance with its strategic value, not by considering its potential sonic output.
designers such as Dolphin (2014), this teleological conflict is reason enough to avoid competitive elements altogether, thereby ensuring that ludic motivations cannot detract from a focus on sound composition (2.3.4.2).

Yet how might we conceive of a system where compositional considerations are core to competitive acts? Where composing is in itself competitive gameplay, not simply its outcome? My intuition is that a competitive compositional dialogue could still emerge between a single player and game system, without incorporating explicit ludic goals, by having the player use gameplay interactions to persistently compete for authorial control over a shared, evolving musical output (2.6.2). I explore this notion through the three original composition games presented herein, which I will first ground in a discussion of music game scholarship (2.3), notable related works (2.5), and musically metacreative perspectives (2.6). For the moment, it is sufficient to note the conflicting player motivations that designers must navigate when introducing a competitive game framework into interactive composition contexts.

2.2.4.5 Ludocompositional Dissonance

Tension between compositional and ludic motivations is a fundamental design challenge for competitive composition games, and a recurring theme in this review (2.3.3.3, 2.3.4.2, 2.5.4). For ease of reference, I use the term ludocompositional dissonance herein to recall this design tension. I derive the term from the related concept of “ludonarrative dissonance” (Hocking, 2007), which denotes opposition between the incentives of a game’s ludic and narrative structures. Ludocompositional dissonance, then, denotes an analogous opposition between compositional and competitive incentives arising from a given gameplay interaction. Austin (2016b) has alluded to this relationship by asking the following:

How does the desire to make music affect gameplay? Does a player follow the stated or implied rules of the game at the expense of the music in order to win, or should a player sacrifice lives, time, and strategic advantages in order to produce better music? (Austin 2016b, p. 122)
2.2.5 Summary: Design Insights from Game Studies

A review of game studies has indicated the following design insights relating to the intersection of interactive composition and competitive gameplay:

- Musical creation shares an affinity with *paidia*, while competition shares an affinity with *ludus* (2.1.1.1).
- The aesthetic experiences ideally evoked by creative and competitive gameplay are characterised as opposing (2.2.3.2).
- Competitive gameplay can restrict compositional novelty and distract from a focus on sound composition (2.2.2.3; 2.2.2.4; 2.2.4.4).
- System-based evaluations of composition impose arbitrary constraints on free musical exploration, or otherwise lack a competitive function (2.2.4.2; 2.2.4.3).

Together, these insights lend credibility to perceptions of an incongruity between musical creativity and competitive game interactions.

2.3 Ludomusical Scholarship

In this section, I ground the insights drawn from game studies (2.2.5) within the burgeoning discourse of ludomusical scholars and music game designers. I first outline existing typologies for digital music games (2.3.1) and examine the use of game theories to apprehend musically creative designs (2.3.2). I then review how scholars and designers have characterised musical activity in games (2.3.3) before addressing a number of design assumptions that have arisen from these efforts (2.3.4). I conclude by distilling these assumptions into two evaluable hypotheses (2.3.5) to be explored by the original works and their respective user evaluations.

2.3.1 Models and Typologies of Music Games

Ludomusicologists have produced a number of definitions and typologies for digital music games during the twenty-first century. Like early game studies (2.1.2), many of these efforts aim to delimit musical games as an ontological category, and have thus sought to distinguish: 1) *music* games from *non-music* games; and 2) musical *games* from musical *non-games*, which are variably described as “tools”, “toys”, or “apps”. The models produced offer useful insight into the aesthetic conceptions of game-based composition present in ludomusical discourse, but also provide a theoretical apparatus.
for evaluating the diverse forms of musical creativity found in existing game systems. I review these perspectives here.

2.3.1.1 Early Music Game Scholarship

Wolf (2001) provides an early definition of music videogames as those “in which gameplay requires players to keep time with a musical rhythm” (p. 130). This limiting scope of performative, rhythm-based interactions reflects the nature of the commercial music games popular at the time of Wolf’s writing, which were near ubiquitously characterised by beat-matching mechanics. Despite the existence of musically creative games like SimTunes (Iwai, 1996) and Mario Paint (Nintendo, 1992), constrained examinations of performative music videogames continued through the early 2000s, with scholars exploring systems like Dance Dance Revolution (Konami, 1998) as pop cultural phenomena (Smith, 2004). This led Williams (2006) to critique Wolf’s narrow focus and the genre at large for its lack of mechanical innovation. To this effect, Williams offers an expanded conception of music games that accounts for creative input on the part of the player, which they believe “certainly should be a part of music games, even if it isn’t yet in most cases” (p. 5).

2.3.1.2 Collins: A Preliminary Taxonomy of Music Games

It is not until Collins’ Game Sound (2008), a seminal text in the ludomusicology canon, that a more systematic taxonomy is established. Collins broadly frames music videogames as those where “music is the primary driving motive or narrative element” (p. 111), introducing a wider conception that extends beyond formal rule structures and system mechanics to consider player intent and motivation. With this conception, Collins identifies three categories of music games: rhythm-action games, creative games, and musician-themed games. Rhythm-action encompasses the performative interactions discussed prior, while musician-themed refers to games like Journey Escape (Data Age, 1982) and Michael Jackson’s Moonwalker (Emerald Software, 1990) which harness the marketing capital of celebrity musicians in designing the game’s narrative and aesthetic. Creative music games, the salient category here, comprise processes of “remixing, production, and composition of original songs” (p.

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63 “Beat-matching” refers to any game that requires players to perform a sequence of inputs in time with musical stimulus; it does require that these inputs occur only on standard bar divisions.

64 Williams (2006) defines music videogames as: “audiovisual games in which the player is actively involved in the creation or playback of music or rhythm” (p. 5).
Notably, this description offers a preliminary accounting of the varying levels of compositional responsibility afforded by digital music games.

2.3.1.3 Austin: A Broad Typology of Music Game Interaction

Austin (2016a) provides an updated but similarly broad perspective in his edited volume on music videogames. He suggests that games are music-based when the “formal elements of the game are musical in nature”. Though his reliance on “formal elements” seems at first more discerning than Collins (2008), Austin’s inclusive typology reveals the breadth with which “musical” is intended. He identifies four types of musical gameplay interaction: matching, mixing, making, and metonymy. Matching encompasses Collins’ use of rhythm-action to describe games like Guitar Hero (Harmonix, 2005), but also includes “pitch-matching” games like SingStar (SCE London Studio, 2007) and “title-/artist-matching” games like SongPop (FreshPlanet, 2012). Metonymy denotes gameplay in which the subject matter alludes to music or musical culture, but is not “expressly musical” (Austin, 2016a) itself; this extends Collins’ musician-themed to include games like Music Inc. (UK Music, 2014), a strategy-based mobile game simulating the life of a start-up music producer.

Of primary interest is Austin’s separation of making and mixing interaction, which Collins (2008) had encapsulated under creative music games. Mixing involves the re-organising of “pre-packaged” sound assets at the higher level of loops or complete layers, such as an entire guitar track. It is found in games like DropMix (Harmonix, 2017), where players arrange chip-embedded cards atop a custom electronic game board to combine and remix existing commercial music in real-time. In contrast, making interactions afford a more complete creative agency to manipulate granular musical resources, such as pitch, rhythm, or timbre, and is found in games like Electroplankton (Iwai, 2005) and Chiptune Runner (Evil Indie Games, 2013). Within the context of musically creative game systems, mixing and making present a useful polarity for evaluating the degree of compositional control, or “authorial responsibility”, afforded to the player. Interactions can be placed on a continuum between: 1) extreme mixing, a

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65 With “title-matching”, Austin (2016a) is referring to quiz games where players have to correctly guess the title or artist of a musical excerpt. This gameplay still involves active critical listening; conversely, a trivia game about artist facts would instead be classed as metonymy, as it is simply “about” music.
66 DropMix uses a smartphone for audio playback and information display via a companion app. A demonstration is available at: https://www.youtube.com/watch?v=HW_jvcmp7BI (retrieved 18 January, 2020).
minimally compositional interaction limited to surface-level manipulations such as track volume; and 2) extreme making, a maximally compositional interaction where the player determines the intricate pitched, durational, and timbral details of all sonic events produced. This heuristic schema resembles that of paidia and ludus (2.1.1.1), along with design dimensions such as instrument-based versus composition-based interaction (Herber, 2008) that will be discussed shortly (2.3.1.5).

2.3.1.4 Kassabian and Jarman: A Narrow Definition and Formal Ludology

The broad conceptions of Collins (2008) and Austin (2016a) – by far the more common approach in music game scholarship – posit no essential conditions for musicality within gameplay. In contrast, Kassabian and Jarman (2016) define music games more narrowly as those where “the majority of gameplay…and if applicable, winning and losing, [is] predicated on the ability to make good sound and/or musical choices” (p. 124). Kassabian and Jarman use this to disqualify games like Otocky (Iwai, 1987) and Rez (Mizuguchi, 2001). Both are highly musicalised arcade-style shooters affording minor creative agency, yet their gameplay merely “results” in music production; it does not require that any musical decisions be made to succeed, such as timing shots to musical stimulus. In this way, musical decision-making becomes a valuable heuristic for distinguishing core and peripheral relationships between compositional processes and competitive gameplay (2.2.4.4). It offers a frame of reference for evaluating why competitive actions in systems like Sounds of Solitaire (Keatch, 2014), despite enabling the wilful and directed production of music, seem only to generate sound as a peripheral by-product: because the competitive act of moving pegs to win the game does not strictly require a musical decision. By extension, a core integration of composition into competitive gameplay would ideally require that movements within the competitive structure be themselves compositional decisions.

Kassabian and Jarman (2016) also posit a more formal ludology for distinguishing music games from other musical media like “tools”, “toys” and “apps”. Drawing on


68 A gameplay demonstration of Rez is available at: https://www.youtube.com/watch?v=wZu6AVzcd9o (retrieved 19 January, 2020).

69 To reiterate, movements can of course be made for purely compositional purposes. However, this will often run counter to the formal game objectives unless the optimal game strategy and desired compositional input happen to align.
Suits (2005), musical tools are distinguished from games due to their lack of “unnecessary obstacles”; mobile instruments like MorphWiz (Wizdom Music LLC, 2010), for instance, prioritise usability as a design feature and so fundamentally eschew unnecessary challenges to operation. They then differentiate musical games from apps and toys using the notions of competitive evaluation, “prelusory goals”, and games as “virtual worlds” (p. 129). While music games involve striving towards an outcome and being measured accordingly, musical apps and toys offer less-structured explorations of audiovisual possibilities that preclude prelusory goals beyond “enjoyment” or “make pleasant sounds” (p. 129). Kassabian and Jarman ultimately rest their distinction on a built conception of exploratory musical experiences as paidic, and thus opposed to the disciplinary, mastery-oriented play of formal ludic games. I unpack these associations during a more detailed review of how scholars have characterised musical activity within game contexts (2.3.3).

2.3.1.5 Herber: Digital Music Games as Composition-Instruments

Herber (2008) contributes the “composition-instrument” as a conceptual framework for describing the musical potentials of digital games and other interactive media. It describes a blend of instrumental and compositional interaction found in games like Electroplankton (Iwai, 2005), where system output is not so direct and predictable as to resemble playing an instrument, nor so obscured from the player’s interactions so as to lose the novelty of exploring input-output relationships. Herber suggests that a composition-instrument equilibrium is found when interactions manifest as “perturbations” or “ripples” within a generative system; when emergent patterns of sound are asynchronously set in motion by players, to be discovered by them, while retaining a discernible causality to their actions. This conception is particularly salient for novice users: it allows for systems to generate complex, novel outcomes from simple gameplay inputs while still framing the output as the player’s responsibility. In this way, the composition-instrument framework is a valuable heuristic for the design of accessible, single-player composition games.

70 With “virtual worlds”, Kassabian and Jarman aim to reserve “game” for interactions within truly artificial gameworlds, which are entered, as distinct from utilitarian interactions with virtual instruments and other “tools”, which are used.
71 In Herber (2008), “asynchrony” denotes that the complete effect of input upon output is not immediately apparent when interacting with composition-instruments.
72 To elaborate, novice players will struggle to produce complete musical textures if sound does not evolve beyond immediate instrumental inputs, yet will be deprived of authorial control if the sonic output is too reliant on the system’s generative idiosyncrasies.
Implicit within Herber’s (2008) framework is a polarity between instrument-based and composition-based interaction. This conceptual distinction has been applied to interactive music systems at least as early as Rowe (1992), and bears metacreative implications that I will discuss further in (2.6.1.2). For the moment, the instrument-composition distinction should be noted as another useful design dimension for describing and comparing musical games: as with paidia-ludus (2.1.1.1) or mixing-making (2.3.1.3), player interactions may be instrument-based, composition-based, or any blend between the two.

2.3.2 Ludological Approaches to Music Creation Apps

Apps and games for music making (Austin, 2016a) are frequently subject to ontological negotiations, being historically difficult to characterise as formal “games” due to their lack of ludic elements (2.1.2). Here I review how ludomusical scholars have utilised game theories to reinterpret musically creative apps as gameful, both through practical recontextualisation (2.3.2.1) and discursive reframing (2.3.2.2). I relate each effort to the notion of competitive compositional gameplay to preface a discussion of the underlying aesthetic assumptions (2.3.3; 2.3.4).

2.3.2.1 Practical Recontextualisation: Fleshner on Soundrop

Fleshner (2016) details a hypothetical recontextualisation of the music-making app Soundrop (Develoe LLC, 2010) as a socially competitive classroom game. Interaction with Soundrop involves drawing “sound bars” to manipulate the trajectory of an endless stream of falling balls, which create complex pitched and rhythmic patterns as they cascade through the player-designed structure.73 Fleshner proposes that multiple students be given iPads running Soundrop, and that one player be momentarily appointed as “judge”. The judge devises a set of rules, such as “only 4 sound bars allowed”, or an arbitrary aesthetic descriptor, such as “green” or “fluffy”, to guide player compositions for that round. Players then submit their creations anonymously for critique by the judge, at which point a “winner” is crowned and a new round may commence. The game concludes once each player has acted as judge, leaving the player with the most rounds won as the game’s victor.

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73 A demonstration is available at: https://www.youtube.com/watch?v=63FyqOMpORI (retrieved 19 January, 2020).
Fleshner’s recontextualisation of Soundrop makes several contributions. It establishes a competitive framework where players can win or lose by the socially evaluated merits of their musical creativity, at least ostensibly. It also extends the scope of creative access afforded by the app; beyond enabling composition itself, novice players also gain partial access to the design of musically creative systems when they conceive the parameters from which several compositions emerge. In the context of this research, Fleshner’s design also makes several compromises. Most immediately, the multi-player format in part sacrifices the portability and availability so central to the promise of mobile musical apps (1.6.2.1). Further, as a competitive system, players may not consider the evaluative process to be “fair” or “meaningful” due to: 1) the lack of transparent criteria for judgement; and 2) its dependence on a sole adjudicative agent with both subjective biases and a personal stake in the contest. This returns to the thorny issue of evaluating musical creativity (2.2.4), which discursive renegotiations of music-making apps have instead sought to circumvent entirely.

2.3.2.2 Discursive Reframing: Blickhan on Biophilia

Blickhan (2016) offers a ludological interpretation of interacting with the app-album Biophilia (Björk, 2011), which was introduced prior (1.6.1.6). Blickhan’s analysis involves identifying the gameful qualities of interactions with Biophilia via a reinterpretation of Juul’s (2005) classic game model. She posits that Juul’s quantifiable outcomes (2005, p. 36) can exist as a “variety of musical and visual results from exploration within the apps” (p. 137), the emotional recompense for which is dependent upon the “user’s interpretation of their own engagement” (p. 137). This reframes evaluation, along with the defining and mediation of goals, as the responsibility of the player. Blickhan also attributes gamefulness to the fact that user choices can influence “visual and auditory elements” (p. 133), presenting an exceptionally broad conception that applies to most interactive media.

Fleshner (2017) espouses a similar treatment of creative music apps, taking Soundrop and Seaquence (Okaynokay, 2017) as case studies. He too repositions goals and evaluation as the responsibility of the player, but instead draws on a renegotiation

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74 For instance, it is in the judge’s best interest to award points to the player with the least rounds won, rather than to the round’s best composition, to increase the odds of personal victory. This exemplifies the motivational conflicts that can arise when blending creative interactions with competitive goals (2.2.4.4).

75 This refers to Juul’s criterion of “emotional attachment” (2005, p. 36) to the outcomes of gameplay as a key element of formal games.
Fleshner argues that winning and losing in the context of musical creation is predicated upon the player’s ability to make musical choices that satisfy the self-imposed obstacle of their aesthetic expectations for each play session. While this framing of gameplay as musical decision-making recalls Kassabian and Jarman (2016), Fleshner’s shared adoption of Suits’ (2005) theory results in an entirely contrasting conception of gameful interaction so broad as to describe all of composition itself. It is revealing that neither Blickhan (2016) nor Fleshner (2017), despite their liberal interpretations of ludic goals and evaluation, attempt a comparable negotiation of musically creative apps as displaying a competitive dialogue between player and system. I offer one such interpretation further in (2.5.1).

2.3.3 Ludomusical Mappings: Performance as Ludus, Composition as Paidia

Conceptions of musical creation as aesthetically opposed to competitive gameplay are acutely evident in the ways that ludomusical scholars have mapped paidia and ludus to musical activity, both within and without gaming contexts. In particular, their characterisation of composition as paidic reveals implicit judgements about the ideal nature of musically creative experiences, reflecting the more broadly polarised aesthetics of creativity and competition apparent within game studies (2.2.3.2).

2.3.3.1 Austin: Performance and Composition

Beyond providing a typology of musical gameplay (2.3.1.3), Austin (2016a) also considers how paidia and ludus align with performance, improvisation, and composition. He describes ludus as the “strictly organised play of performing music by rote…or the mastery of a rhythm game…achieved by executing the requisite movements to perfection” (p. 5). This relates performance in music games to the aesthetics of challenge and competition (Arrasvuori et al., 2010). In contrast, Austin identifies paidia as “present both in improvisatory musical practices…and in playing music games that give players the freedom to create music through gameplay” (p. 5). Although Austin does not go as far as exploring paidia and ludus within his four types of musical gameplay (2.3.1.3), he presents a clear characterisation of compositional interactions as polarised from the competitive play of performance-based games. To be clear, though, Austin does not argue that ludus is strictly incompatible with musical creation; he simply positions the two as contrasting aesthetic experiences.
2.3.3.2 Kassabian and Jarman: Music as Liberatory and Disciplinary

Kassabian and Jarman (2016) mirror Austin’s (2016a) characterisations of musical activity, but do not wield the specific terminology of paidia and ludus. Instead, they draw on cultural perceptions of music itself as engendering both “liberatory” and “disciplinary” experiences: that is, music as both a “path to freedom, salvation, and self-expression” (p. 123) and a “hardship…a demanding task master” (p. 123). This characterisation functions as an analogue of the paidia-ludus polarity, but takes music rather than play as its starting point: the qualities of paidic play resemble those of “liberatory” musical experience, while those of ludic play resemble “disciplinary” engagements. Through a review of music-making media, Kassabian and Jarman use this framework to make a more explicit distinction between music “games” as disciplinary and music “non-games” (i.e. “apps”, “tools”, or “toys”) as liberatory musical experiences. They describe performative games like Guitar Hero (Harmonix, 2005) as tasks to be achieved, to be repeated until the rule structure is mastered, while suggesting that apps and toys instead foster “experimentation” and the “joyful, ecstatic, creative aspect of musical experience” (p. 130). This again shows a characterisation of creation as paidic and performance as ludic, though Kassabian and Jarman go further. Having established their conceptions of liberatory (paidic, creative) and disciplinary (ludic, performative) musical experience, they conclude that “music in virtual worlds seems only to be able to appear – or perhaps sound – as one or the other, but not both” (p. 130). While I do not take this as a normative claim in itself, Kassabian and Jarman also present the express judgement that competitive aesthetics are unsuited to novice music creation, as addressed shortly (2.3.4.1). For now, their conclusion is a notable demonstration that single-player systems have rarely sought to consolidate competitive dynamics with musical creation.

2.3.3.3 Dissenting Characterisations: Musical Games as Paidoludic

Naturally, some scholars and designers dissent from these characterisations of paidia and ludus in music games as either polarised (Austin, 2016a) or, in the extreme, mutually exclusive (Kassabian & Jarman, 2016). Jacobus (2017) coins the portmanteau “paidoludic” to describe a synthesis of player expression (paidia) and rule-bound

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76 In this context, “virtual worlds” is simply referring to musical activity in any digital media context, be it a digital music game or the use of mobile instruments in live performance.

77 This should not be taken to imply that the works referenced in 2.3.3 are in direct dialogue; they are concurrent isolated analyses that do not reference or respond to one another.
competition (ludus) in games like Beat Hazard: Ultra (Cold Beam Games, 2011). The competitive mechanics involve manoeuvring a spaceship to defeat enemies and avoid debris, but the length and intensity of each game session is determined by the player’s choice of soundtrack from their personal music library. For Jacobus, this gameplay is simultaneously ludic, in its competitive nature and defined win-loss conditions, and paidic, in the player’s free manipulation of challenge and their agency to determine the musical aesthetic for each game session.

Reflecting this from a practitioner perspective, Wang (2016) describes how the intentional synthesis of paidia and ludus allows him to meet the design aims of his prolific portfolio of mobile music apps, which include the likes of Ocarina (Smule, 2008) and Magic Fiddle (Smule, 2010). His apps aim to lower novice inhibitions towards music-making through the open-ended and expressive play of paidia, while also motivating engagement through the ludic elements of points, progress, goals, and learning challenges. Addressing this, Wang suggests that his apps engender “both paidia (playing) as well as ludus (gaming), embodying the free expression of the former as well as the latter’s rule-based structure to [motivate] short- and long-term engagement” (p. 186). Although Wang’s characterisations of paidia and ludus do not substantially diverge from others, he marks a rare departure by considering their fusion as not only viable, but desirable in the context of accessible music-making experiences. Nonetheless, Wang does not obscure the inherent challenge of balancing “goals [and] rules” with “open-ended musical expression and exploration” (p. 182), reinforcing that a tension between ludic and creative goals is likely to emerge from any meeting of composition and competitive game design (2.2.4.4).

2.3.4 Musical Creativity as Antithetical to Competitive Gameplay

Thus far, I have examined the mechanical and aesthetic tensions that arise from the union of interactive composition with competitive game design. However, I have yet to address their most express manifestation: assertions that musical creativity is in fact incompatible with competitive gameplay. Here I review this assumption, addressing both theoretical and designer precedents along with their relation to the key research concept of accessible composition for single players.

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78 Choosing faster songs increases the pace of gameplay, while choosing longer songs requires the player to survive for longer.
2.3.4.1 Aesthetic Opposition to Competitive Musical Creation

It is perhaps appropriate to begin with a reviewer’s response to *Chase*, one of the original games developed during this research to explore competitive, game-based composition. In response to a submission reporting on the original works (Studley, Drummond, & Scott, 2019), the anonymous reviewer commented that the competitive mechanics of *Chase* “will induce a fear/flight-type of response, which is not something we associate with any type of art or creativity”. Notably, this frames the stress and pressure invited by *Chase*’s combat-based gameplay as aesthetically unsuited to creativity at large, let alone composition. Kassabian and Jarman (2016) reflect this sentiment, though with specific reference to accessible music-making. After introducing apps like *Balls* (iotic, 2009) and *Bloom* (Eno & Chilvers, 2008) as exemplars of exploratory music creation through simple and “unintimidating” interactions, they suggest that such apps “provide amusement and pleasure in ways that the pressure of competition and points present in games never could” (p. 129). This again frames the competitive “strife” (Deterding et al., 2011) implicit to ludic contest as incompatible with music creation, yet also positions aesthetics of challenge and pressure as counter to accessible design.

2.3.4.2 Dolphin on Sound Toys, Access, and Rejecting Competitive Design

Dolphin (2014) posits a similar conception during his discussion of “sound toys”. He first describes sound toys as an inclusive platform for providing “access to composition through symbolic representation of often complex underlying systems” (p. 45) before assigning this label to systems like *Electroplankton, Bloom, Biophilia*, and *Soundrop*. Dolphin then asserts that such designs avoid an “intentionally competitive framework” to encourage a “playful experience” (p. 46) that facilitates casual, exploratory engagements. This reflects Kassabian and Jarman’s (2016) aesthetic opposition to aspects of competition in accessible music-making, yet Dolphin also makes explicit a mechanical opposition. He argues that sound toys’ avoidance of competitive elements is equally significant to ensuring that interaction remains “primarily concerned with sound” (p. 46), rather than with ludic motivations such as “winning”. Having developed

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79 *Chase* involves running from a hostile agent who perpetually pursues the player and depletes their “health” when approaching too closely (see Section 4.2). The video demonstration provided to the reviewer is available at: https://youtu.be/TjjKulzusUc (retrieved 22 January, 2020).

80 Dolphin (2014, p. 46) uses this phrase to denote deliberate design elements like “winners”, “violence”, “rigid rules”, “specific objectives”, “rewards” for objectives, “competition” and “scoring.”
and discussed several sound toys of his own (Dolphin, 2009b, 2009c), Dolphin’s insights can be taken as a designer perspective to balance Wang’s (2016) optimism for fusing paidic and ludic elements. It is notable, then, that both Wang and Dolphin, despite their contrasting positions, highlight the same *ludocompositional dissonance* that looms over the prospect of composing within competitive game structures (2.2.4.4; 2.3.3.3). In this way, Dolphin exemplifies both the *aesthetic* and *mechanical* (Hunicke et al., 2004) oppositions to competitive musical creation.

### 2.3.4.3 Creativity, Musical Creativity, and Single-Player Competition

Before closing the discussion of ludomusical discourse, I would clarify that the perspectives reviewed here (2.3) should not be taken to suggest that competitive gameplay is devoid of creativity itself. To play any competitive game from Chess to *Fortnite Battle Royale* (Epic Games, 2017) requires that players create their own solutions to each dynamic scenario (Crawford, 1984), and Wang (2016) argues that “effective” game design encourages players to “make creative use of game rules to overcome a set of challenges” (p. 182). Excepting the *Chase* reviewer (2.3.4.1), the design issues arise specifically with *musical* creativity. And yet, given the abundance of competitive designs for multiple users and formal performance settings (1.6.1; 1.6.3), this clearly does not characterise all gamified composition. It can be concluded, then, that the assumptions drawn by ludomusical scholars are directed specifically towards single-user contexts, and become most explicit when concerning use by musical novices.

### 2.3.5 Summary: Design Assumptions Underlying Competitive Composition Games

Having reviewed ludomusical perspectives, the insights drawn from game studies (2.2.5) can now be distilled into two evaluable design assumptions that underpin the rejection of competitive elements in accessible, single-player composition games:

A1) The presence of competitive *mechanics*, such as points, goals, or win-loss conditions, detracts from a focus on compositional interactions.

A2) The *aesthetic* experience of competitive gameplay, such as challenge, conflict, or pressure, is unconducive to musical creation.

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81 Notably, scholars like Dolphin, Austin, and Kassabian and Jarman do not address the many competitive designs evident in the wider practice of game-based composition, whether formal game pieces like *Duel* and *Climb!* (Kallionpää et al., 2017) or accessible designs like *Music for 32 Chess Pieces* (Parson, 2009).
These claims, representing an aggregate of literature perspectives, begin to answer my first research question: *What are the aesthetic assumptions and design challenges underpinning interactive composition in competitive game settings?* The first (A1) speaks to the design challenge of introducing ludic incentives into a *core* compositional experience without either: a) creating a *ludocompositional dissonance*, or b) framing composition as merely *peripheral* to the competitive game (2.2.4.4). The second (A2) is instead a normative judgement regarding the ideal aesthetic experience of musical creation and the emotional responses that it should or should not invoke.

2.3.5.1 Reflecting on the Research Gap

There is a lack of practical research interrogating A1 and A2, and so limited empirical work investigating the player experience of composing within competitive game settings. It is this gap that I aim to address through my original composition games and their evaluation via mixed-methods user studies. Together, they explore how competitive game environments influence the compositional experience and the extent to which A1 and A2 are reflected in player perceptions. Of course, to develop game systems capable of this inquiry first requires navigating the design challenges posed by A1 and A2. This leads to the second research question explored in this thesis: How can musical creativity and competitive gameplay be reconciled in a digital game while maintaining a focus on accessible sound composition?

### 2.4 Empirical Research on Competition and Creativity

There is a rich history of empirical research exploring the relationship between competition and creativity beyond gameplay contexts. While not of primary concern to this research, it provides a pertinent psychological grounding for the aesthetic intuition shared by ludomusical scholars that competitive environments are unconducive to musically creative experiences. In this section, I briefly introduce the live issue of measuring creativity (2.4.1) before outlining notable work regarding the influence of competition on non-musical creativity (2.4.2). I conclude by considering research on the relationship between competition and creativity in non-game musical settings (2.4.3).
2.4.1 Measuring Creativity

Creativity is a deeply multifaceted concept. It is usually formulated in the broad terms of producing novel, valuable, surprising, or interesting outcomes (Canaan et al., 2018), but has been variably used to describe cognitive processes, personalities, artefacts, and even environments (Said-Metwaly et al., 2017). Given this exceptional scope, it is no surprise that the measurement of creativity remains a live issue. Evaluations of creativity are necessarily localised to a given time and place (Sternberg, 2019), with criteria dependent on what is being assessed and by whom (Martine, Cooren, & Bartels, 2019). Approaches like the Consensual Assessment Technique (Amabile, 1982b), where creativity is measured via the consensus of expert judges from a relevant field, have thus been popular as a way to disentangle evaluations from the validity of any particular theory of creativity (Baer & McKool, 2009) while still accounting for domain-specific interests. Nonetheless, Said-Metwaly et al. (2017) demonstrate through a review of 152 papers that the appropriate measurement of creativity remains an unsettled issue, noting further that existing approaches suffer from “serious conceptual shortcomings” (p. 238). The challenge of measuring creativity contextualises the difficulty of designing competitive games around system-based evaluations of player musical creativity (2.2.4).

2.4.2 The Effects of Competition on Creativity

There is a long-running debate within psychological inquiry as to the effects of competition on creative output and experience (Eisenberg & Thompson, 2011). While some note competition as crucial for creative innovation within capitalist economic paradigms (Clydesdale, 2006), the prevailing psychological perspective has suggested that competition, as a proxy for extrinsic motivation, tends to inhibit or constrain an individual’s creativity (Amabile, 1982a; Brown & Gaynor, 1967; Deci et al., 1981; Hennesey & Amabile, 2010; McGlynn, Gibbs, & Roberts, 1982). Other work has also suggested that cooperation is a superior arrangement to competition for engendering creativity (Kohn, 1986). Although there are methodological issues in translating these findings directly to game-based musical creation, they have broadly canonised

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82 For instance, much of this work compares student performance in a simple task, such as creating paper collages, between a control group and an experiment group with an induced competitive condition, such as a reward for the best work. The creativity of each participant’s output is evaluated by a panel of expert judges as per the Consensual Assessment Technique (Amabile, 1982b). This approach translates poorly to more complex, domain-specific areas like musical composition.
competition as unconducive to creativity and are reflected all the same in the aesthetic judgements of ludomusical scholars and music game designers (2.3.4.1; 2.3.4.2). The characterisation of extrinsic motivation as detrimental to creativity (Amabile, 1982a) also provides a useful psychological grounding for the challenge of ludocompositional dissonance. Discrete ludic goals provide motivational incentives that are extrinsic to compositional decision-making, and so may detract from a compositional focus as Dolphin (2014) has suggested (2.3.4.2). However, replacing explicit ludic goals with a co-creative dialogue that is intrinsically agonistic may provide a path forward for designing competitive composition games for single players, as my original works explore (3.2.1).

It is not a settled issue that competition has a simple negative correlation with creativity (Leeuwen & Baas, 2017). Early psychological research found that creativity, framed as “ideational flexibility”, was enhanced when competing for monetary reward (Raina, 1968). Studies in workplace management have found that competitive co-workers can stimulate creativity, but only in certain personalities (Cummings & Oldham, 1997). Others find that low and high levels of intergroup competition can promote creativity and idea generation, but less so with intermediate levels between these extremes (Baer et al., 2010). More recently, Gross (2019) finds that moderate competition can promote creativity within market contexts, though heavy competition increases the likelihood of disengagement. Again, these investigations are not clearly applicable to musical composition nor competitive gaming as intended here; they are concerned with product innovation rather than artistic practice, and with social or economic contest rather than the recreational experience of engaging with competitive digital games. Nonetheless, the diversity of their conclusions indicates a more complex relationship between creativity and competition than is broadly assumed.

2.4.3 The Effects of Competition on Musical Creativity

There is limited empirical work investigating the influence of competition on specifically musical creativity, though the few notable cases speak further to their complex relationship. Clydesdale (2006) analysed biographical texts on the history and creative processes of The Beatles, concluding that competitive forces, both internal

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83 I use “discrete” to denote non-compositional goals within the ludic structure, such as “escape the maze” or “defeat the boss”, that are isolated from realising a desired musical outcome.

84 The two texts analysed were a documentary, The Making of Sergeant Pepper (1992), and an autobiographical book, The Beatles Anthology (2000).
and external to the group, significantly enhanced their musical creativity and output. Where Clydesdale’s case study provides novel anecdotal evidence contra the psychological canon of competition as detrimental to creativity, Eisenberg and Thompson (2011) offer a more rigorous investigation via a conventional experimental design. They explore how competition conditions affect the creativity of live improvisations by sixteen experienced pianists, testing also for levels of stress and intrinsic motivation. Competition was induced by informing random participants that their improvisations would be recorded and judged by musical experts, with monetary prizes and social recognition awarded to the most creative works.\footnote{Ten experts then ranked all improvisations according to the Consensual Assessment Technique (Amabile, 1982b) and all participants completed a questionnaire to measure stress and motivation. Eisenberg and Thompson found that improvisations were judged as more creative under the competitive condition, noting further that competing participants were more stressed but also more intrinsically motivated.}

2.4.3.1 Implications for Competitive, Game-based Composition

Eisenberg and Thompson (2011) demonstrate that competitive settings can support musical creation, even when provoking aesthetic experiences that ludomusical scholars have framed as undesirable for creativity (2.3.4.1). The findings also indicate that competition can be introduced into creative settings without compromising the creator’s intrinsic motivation, and may even encourage it. To concede, instrumental improvisations by expert performers are a poor analogue for novice players using symbolic gameplay interactions to co-compose with a game system; particularly given that part of the ludomusical opposition to competitive aesthetics relates specifically to facilitating an accessible experience for non-experts (2.3.4.1; 2.3.4.2). Still, in lieu of empirical research on the player experience of composing in competitive game settings, even these limited few investigations suggest a more complex relationship between musical creativity and competition than is reflected in ludomusical discourse. I take this to invite further exploration of the compositional potentials of competitive game environments.

\footnote{The control group was also recorded, though participants improvised without the pretense of competing for extrinsic reward.}
2.5 Competition in Notable Composition Games

I now explore a series of notable works pertinent to the aims of this research. This is not an exhaustive accounting of all playful music-making systems, and an overview of works relating to game-based interactive composition has been given prior (1.6). Instead, I review select cases using the theoretical perspectives discussed thus far to elucidate the design challenges of fusing compositional interactions with competitive gameplay. I explore interpretations of competitive game notions like “unnecessary obstacles” (Suits, 2005) and progression (2.2.1.2) within the works, along with polarities such as paidia-vs-ludus (2.1.1.1), mixing-vs-making (2.3.1.3), and core-vs-peripheral gamification (2.2.4.4). The insights revealed significantly inform the original works presented herein.

2.5.1 Creative Constraints as Competition: Unnecessary Obstacles in Soundrop and Electroplankton

In Fleschner’s (2017) ludic reframing of Soundrop (2.3.2.2), he describes the player’s aesthetic goals for their music-making session as an “unnecessary obstacle” (Suits, 2005) – as arbitrary and negotiable, but submitted to by the player for the joy and challenge of overcoming it. However, this obstacle can also be found in varying degrees at the system mechanics level. The falling musical balls in Soundrop are not manually deployed by the player in an instrumental fashion. They fall in a ceaseless stream at a fixed rate, with the player’s only intervention being to draw sound bars to redirect their flow. The foremost purpose of this fixed drop rate is as a metric constraint for the musical novice; it ensures that the aggregate musical outcome of the many sonified bounces exhibits a consistent metronomic pulse that most would find agreeable. Yet beyond providing access, the relentless flow of balls also presents an unnecessary obstacle for the player to negotiate in their search for sonic outcomes. The designer might have allowed players to drop balls at their own discretion from multiple points at once, but instead gives the constraint of a single, fixed origin point with a static drop rate. From this interaction emerges a rudimentary form of competition against the system in pursuit of compositional goals. Critically, this interpretation of a

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86 This would be infeasible due to the thousands of examples found on mobile app stores, let alone the many precedents in the wider practice of interactive composition.

87 This resembles the arbitrary condition of not using one’s hands in games of soccer, or of using golf clubs instead of simply carrying the ball to the hole, as per Suits (2005) original intention.

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compositional contest does not require explicit ludic goals – which *Soundrop* accordingly lacks.

2.5.1.1 Constraints and Obstacles as *Core* or *Peripheral*

It would be of little practical use to reframe *every* musical constraint as one of Suits’ unnecessary obstacles. Instead, we might consider whether a creative constraint is *core* or *peripheral* to the primary gameplay mechanics. When balls bounce in *Soundrop*, the resulting sound event is constrained to the pentatonic scale and a single marimba-esque timbre. Were the player allowed to change these harmonic and timbral constraints, the operational challenge of gameplay – of placing sound bars to produce a desired musical result – would not differ so substantially as if the player were allowed to freely drop balls from any location or angle, or even just manipulate the rate of their flow.\(^{88}\) In this way, the temporal constraints emerging from the unmanipulable ball dropping\(^{89}\) exhibit a *core* relationship to *Soundrop*’s gameplay mechanics, while the harmonic and timbral constraints are comparatively *peripheral*: they pose less of an unnecessary obstacle to gameplay, and so less of a compositional contest. The implication is that a creative constraint should make an operational difference to the gameplay mechanics to be considered a competitive obstacle.

2.5.1.2 Constraints and Obstacles as *Paidic* or *Ludic*

Much of these conclusions also apply to the mini-game “Hanenbow” from *Electroplankton*, which bears a close resemblance to the interaction metaphor in *Soundrop*. The player still manipulates the trajectory of objects (plankton) to collide with movable geometry (leaves), which produces single, pitched tones.\(^{90}\) A key difference, though, is that the player can alter the rate at which the plankton are launched, or even launch them manually with individual button presses. Hanenbow thus employs the same compositional obstacle as *Soundrop* – bouncing projectiles to create musical patterns – but through mechanics that are substantially less restrictive. This suggests that creative constraints can also be characterised as either *paidic* or *ludic*: Hanenbow’s open control embodies the free expression and unstructured exploration of

\(^{88}\) To elaborate, the player’s core interactions would not overly be affected if the sound bars instead produced piano tones, or notes from the mixolydian mode, when struck by balls.

\(^{89}\) These constraints include a regular pulse and a repetitious texture.

\(^{90}\) A video demonstration is available at: https://www.youtube.com/watch?v=tFoK8BTXM4&t=1m34s (retrieved 20 November, 2020).
paidia, while Soundrop’s restrictive conditions for ball flow more closely approach the rule-bound contest of ludus. Through this lens, we can interpret compositional interactions in Soundrop as being more competitive than in Electroplankton’s Hanenbow. And yet, for this same reason, Soundrop also affords markedly less compositional control. This illuminates a critical design tension underpinning competitive, game-based composition: that creative control and competitive gameplay have a somewhat inverse relationship.\footnote{By “inverse relationship”, I mean that to approach either greater compositional control or more competitive gameplay comes at the detriment of the other. Restrictive game obstacles lower the player’s creative control, yet making it less restrictive would generally move away from ludic contest.}

### 2.5.2 Design Polarities in Biophilia

*Biophilia* (Björk, 2011) affords a diversity of musical interactions between its nine unique modes. “Thunderbolt” and “Mutual Core” are simple playful instruments, “Moon” and “Solstice” are abstract musical sequencers, and “Dark Matter” offers a series of aural puzzles based on matching (Austin, 2016a) chromatic pitches. Of primary interest here are the modes “Sacrifice” and “Crystalline”, which respectively embody the opposing poles of making versus mixing interaction (2.3.1.3), of compositional control versus competitive design, and of explicit versus abstract musical representation. Their juxtaposition articulates several of the design dimensions pertinent to competitive, game-based composition.

#### 2.5.2.1 Making versus Mixing

Interaction with *Sacrifice* is paradigmatically making-based. It is devoid of conventional game iconography or interface elements, instead resembling an abstract notation editor (Figure 2). Players can add sonic events from a library of 26 short samples, delete individual events from their musical score, playback their composition, and save the score for later use. Polyphony cannot be achieved as samples are played in a linear sequence, and the player cannot manipulate the timbre of each, yet the granularity of creative control\footnote{For instance, the library of twenty-six samples includes one octave of the complete Aeolian mode commencing on “A”.} in *Sacrifice* still makes possible a diversity of original compositions. *Crystalline*, in contrast, epitomises mixing-based interactions. The player pilots a small crystal craft through a series of tunnels by tilting their iPad, occasionally reaching a choice between multiple diverging tunnels (Figure 3). The player’s choice of tunnel at
these intersections determines the macrostructural assembly for the realtime playback of a piece composed by Björk, with color-coded entrances denoting different song sections. In this way, *Crystalline* is better characterised as affording a live remixing and rearranging of Björk’s music than as the composition of original music.

**Figure 2**: Interface for “Sacrifice” from Björk's *Biophilia*, displaying the Aeolian mode commencing on “A” as a hybrid of standard notation and the Latin alphabet.

**Figure 3**: Divergent tunnels representing potential musical arrangements in “Crystalline” from Björk's *Biophilia*.
2.5.2.2 Control versus Competition

Importantly, Crystalline exhibits competitive mechanics and gameplay metaphors absent from Sacrifice. Players face the game obstacle of successfully piloting their craft to enact a desired musical outcome. They are also tasked with collecting specific patterns of crystals distributed throughout the tunnels to unlock new musical segments, providing a form of competitive progression (2.2.1.2) via earnable “achievements” (Buckley et al., 2018). The player cannot lose in the prototypical sense of a “game over”, but can fail to achieve their self-defined musical objectives by missing crystals or tunnel entrances. Crystalline, despite affording less creative control, is thus decisively more ludic and competitive than Sacrifice. In fact, the high degree of control found in Sacrifice can be directly attributed to its paidic lack of restrictions, obstacles, and other competitive measures. The player does not need to earn sonic resources, nor deploy them using gameful interactions like piloting craft or aiming projectiles; they are simply given the complete sandbox of musical materials from the onset to be freely explored without pressure or constraint. As with the juxtaposition of Electroplankton with Soundrop, this again suggests that competitive game design runs counter to compositional control.

2.5.2.3 Explicit versus Abstract Musical Representations

Of further note is the contrasting visual representations of musical content between the two modes. Like Soundrop and Electroplankton, Crystalline relies on symbolic visuals and simulated physics to create an abstract representation of sonic outcomes. In Sacrifice, however, the 26 individual samples are more explicitly represented as notational symbols upon a musical score. The symbols are based on a musicalised calligraphy of the Latin alphabet; while the sonic meaning of non-musical letters must still be decoded by the player, the letters A through G denote their respective pitches and are even visualised as a direct analogue of standard notation (Figure 2). Compared to Crystalline’s simple gameplay metaphor of “tilt to fly”, the control interface for Sacrifice is a complex grid of buttons resembling a Launchpad (Figure 4), bringing the interaction experience closer to the use of a creative tool than the playing of game.

93 D’Errico (2016), in a dissertation on interface aesthetics for sound production, describes the use of simulated physics and symbolic visuals as inherently gameful in itself.
94 For example, the letter “W” represents a bass hit, and “K” represents a vocal sample.
Crucially, designs like *Crystalline, Electroplankton,* and *Soundrop* can only construct their layer of playful abstraction because they have substantially fewer musical controls to abstract in the first place. For instance, directly mapping *Sacrifice*’s samples to the mechanics of *Crystalline* would require that each intersection offer 26 available choices, or would otherwise necessitate the addition of new control parameters entirely. Even then, the base metaphor of piloting a craft cannot match the temporal freedom and rhythmic control of simply pushing buttons at one’s discretion. This suggests that as music-making games aspire to greater compositional control, their visual representations necessarily become less abstracted from the underlying musical processes for the sake of usability.

2.5.2.4 Summary: A Network of Design Dimensions

Of all the nine modes in *Biophilia,* *Sacrifice* provides the greatest compositional control. It is revealing, then, that *Sacrifice* also has the most complex interface, shows the least abstraction of musical concepts, and is the furthest removed from the mechanics, metaphors, and iconography of competitive gameplay. Inversely, *Crystalline* is the mode that most closely approaches competitive game design, but in turn offers the least creative control and most clearly epitomises music-mixing interactions over music-making. This interplay reveals that the many polarities of competitive, game-based composition are not isolated from one another, but rather interact as a complex network of variably conflicting design dimensions. The challenge for designers, then, is finding a balance point within this network that satisfies their design goals in spite of the inevitable compromises.
2.5.3 Compositional Game Progression in Scape and Fract OSC

Game progression, whereby players are awarded new content or mechanical affordances for satisfying given tasks (2.2.1.2), is often central to the player motivations and competitive dynamics of player-vs-system designs. We have seen an example in Biophilia’s “Crystalline”, where players can unlock new song sections for their remixing repertoire by collecting patterns of crystals. However, progression in this instance is somewhat peripheral to the musically creative interactions: although the player is crucially motivated by the promise of earning new compositional resources, they do not progress by acts of composition themselves. The implementations of compositional progression in Scape (Eno & Chilvers, 2012) and Fract OSC (Phosfiend Systems, 2014) offer further insight on this relationship.

2.5.3.1 Progression through Non-Competitive Composition in Scape

As introduced prior (2.2.1.3), Scape features a rudimentary form of game progression whereby players can earn additional sound objects via the simple metric of time spent creating music. Each unlockable sound object offers new timbral and textural possibilities through their unique generative behaviours,\(^{95}\) presenting a clear compositional incentive as similar to Crystalline’s progression. Distinguishing Scape, though, is that composition is core to progression: it is achieved through acts of musical creation, not through peripheral ludic tasks, such as collecting crystals, that are delimited from musical decision-making (Kassabian & Jarman, 2016). Critically, the condition for progression in Scape is also distinctly non-competitive, in that players progress equally from any and all interactions within a given time frame. To reimagine Scape’s musicalised progression as competitive would require that certain creative decisions be given greater ludic value than others so as to award faster progression. This again returns to the fundamental issue of restricting creative exploration by imposing arbitrary evaluations of player composition (2.2.4.2). The implication is that compositional progression, perhaps necessarily, gravitates towards being either: a) non-competitive, but core to music creation; or b) competitive, but peripheral to music creation.

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\(^{95}\) Individual objects, called “elements”, each follow a generative rule, such as “play if all other elements are silent”, or “play more sparsely in the evening”. Players can also unlock new “moods”: broader frameworks determining the timbral and harmonic treatment of all elements within the soundscape.
2.5.3.2 Progression through Musicalised Puzzles in *Fract OSC*

*Fract OSC* (Phosfiend Systems, 2014) is a highly musicalised environmental puzzle game. Following the tradition of *Myst* (Cyan, 1993), the player is given limited explicit direction and so must explore and interact with the abstract gameworld to determine how to progress. With every puzzle the player completes, they are awarded new components for a loop-based, polyphonic synthesiser which they gradually construct throughout the game. The synthesiser comprises a “lead”, “bass”, and “pad” module, for each of which the player unlocks a basic step sequencer, various modulation controls, and finally a more complex “pattern sequencer” for storing multiple loops. Players can return to their synthesiser at any time to check their progress or create music using the modules and control parameters currently unlocked. *Fract OSC* culminates in a final extended puzzle which rewards the player with the synthesiser’s full range of features. Like *Crystalline*, then, the player progresses through a series of competitive game obstacles – in this case, visual puzzles – to earn additional sonic resources to be used for interactive composition.

The true novelty of *Fract OSC*, however, is that each visual puzzle is itself a functional step sequencer. In this way, all puzzles can also double as variably constrained creative sandboxes. Some have a single fixed solution: for instance, requiring players to reposition nodes on a three-dimensional step sequencer to satisfy a strictly prescribed configuration. Others are more forgiving hybrids of music-making and music-matching (Austin, 2016a), where players must complete a pitch or rhythmic sequence based on visual or audio cues within the environment, but are permitted small creative liberties. In both cases, the player can momentarily ignore the ludic objective to freely influence the sequencer’s live playback in exploratory acts of composition. However, this invokes a *ludocompositional dissonance* (2.2.4.5) in which the player’s composing is external to the puzzle and so not competitive, while their submission to the puzzle precludes free musical creativity.

For this reason, the most interesting puzzles in *Fract OSC* are those which allow for multiple compositional solutions. In the final zone, the player must “compose” a safe

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96 These modulation controls range from abstract multi-parameter controls, such as “grit” or “shimmy”, to more specific functions like high pass filters, low frequency oscillators, and envelope manipulation.
97 A demonstration is available at: https://www.youtube.com/watch?v=YN1x0E2EZMU&t=4m0s (retrieved 29 January, 2020).
98 A demonstration is available at: https://www.youtube.com/watch?v=YN1x0E2EZMU&t=12m48s (retrieved 29 January, 2020).
path along a series of step sequencer bridges while weaving in between restricted notes.\textsuperscript{99} Though trivial as a ludic challenge, the puzzle’s novelty emerges from tasking players with devising the most musically creative solution – albeit by their own standards – to navigating the otherwise simple game obstacle. This interaction is not immune to \textit{ludocompositional dissonance}, as the most efficient ludic solution remains to simply charge forward without listening to the resulting music. Nonetheless, it demonstrates that elements of competitive game progression can themselves engender musically creative interactions, so long as a range of compositional outcomes are permissible as solutions.\textsuperscript{100}

\subsection*{2.5.4 \textit{Ludocompositional Dissonance in Chiptune Runner and Pop Tones}}

The works discussed thus far (2.5) can only be considered to exhibit competitive gameplay through quite liberal interpretations. \textit{Chiptune Runner} (Evil Indie Games, 2013) and \textit{Pop Tones} (Hoeberechts, Shantz, & Katchabaw, 2014) present rare cases of accessible, single-player composition games that posit a more defined competitive game framework. In turn, however, their approaches to implementing competitive mechanics also provoke the most explicit \textit{ludocompositional dissonance} (2.2.4.5), revealing a need for new design strategies beyond imposing system-defined ludic objectives.

\subsubsection*{2.5.4.1 \textit{Ludocompositional Dissonance in Chiptune Runner}}

\textit{Chiptune Runner} is a musically creative mobile game structured as a series of two-dimensional platforming levels. The player adds or removes nodes from a multi-instrument step sequencer, which forms the level’s architecture, to guide an automated running avatar safely past a series of violent obstacles.\textsuperscript{101} The avatar also serves as a “playhead” for performing the sequencer data, allowing players to compose by editing steps ahead of the avatar. \textit{Chiptune Runner} builds upon this basic interaction using several classic competitive elements: players can lose lives, collect stars for higher scores, engage in “boss fights” (Buckley et al., 2018),\textsuperscript{102} and progress to higher tiers of difficulty. Engaging with any of these features, however, gives rise to a

\begin{itemize}
  \item \textsuperscript{99} A demonstration is available at: https://www.youtube.com/watch?v=WYAfi66otMNc&t=1m33s (retrieved 29 January, 2020).
  \item \textsuperscript{100} This reflects the prior discussion (2.2.2.3) of why puzzle designs with single, fixed-solutions are ill-suited to musically creative applications.
  \item \textsuperscript{101} A tutorial demonstrating these mechanics is available at: https://www.youtube.com/watch?v=czrTBn8jUWY&t=28s (retrieved 30 January, 2020).
  \item \textsuperscript{102} A demonstration is available at: https://www.youtube.com/watch?v=czrTBn8jUWY&t=11m18s (retrieved 30 January, 2020).
\end{itemize}
**ludocompositional dissonance**: the player is incentivised to relinquish their free musical creation, at least partially, to focus instead on drawing paths that best achieve their present ludic goal, such as avoiding obstacles or collecting items.

This does not suggest that competitive interactions with *Chiptune Runner* preclude musical creativity. As with the bridge puzzles in *Fract OSC*, there are multiple compositional solutions to each ludic situation, and players could adopt the challenge of discovering the most novel sonic outcome that still achieves their current competitive purpose. Yet this is precisely the tension: with so many *system-defined* objectives for the player to contest with, any simultaneous attempt at compositional expression becomes an additional challenge which the ludic structure actively disincentivises. *Chiptune Runner* has a “god mode” which alleviates this tension by disabling player death, yet interaction then returns to the non-competitive musical creation of *paidic* designs like *Scape* and *Bloom* (Eno & Chilvers, 2008). The implication is that competitive gameplay, so long as it is implemented via system-based ludic objectives, seems bound to work against composition – and vice versa.

2.5.4.2 Ludocompositional Dissonance in *Pop Tones*

*Pop Tones* (Hoeberechts et al., 2014) exemplifies this same tension, though is a notable counterpoint to *Chiptune Runner* in its compositional design. *Pop Tones* was developed as an academic exercise to test the researcher’s *Algorithmic Music Evolution Engine* (AMEE) in a music game context. AMEE itself is a generative music system designed to adapt its musical parameters to one of ten emotional adjectives as a high-level control. *Pop Tones* harnesses this functionality in a “match-3 style game” (p. 435) where players catch colour-coded balls as they float down the screen (Figure 5). Each ball type represents a different emotional music state, and matching three of a kind both fills their respective “emotion bar” (p. 435) and influences AMEE’s real-time music generation to reflect the matched emotion. The level is completed when the bar for each emotion is filled, but the player loses if they miss too many balls or if their stack of unmatched balls reaches the top of the screen.

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103 Even micro-objectives like “collect this star” or “avoid that bomb” can be approached through a variety of physical paths, and so can be satisfied while still producing a diversity of musical results.

104 Music generation in AMEE comprises five separate modules for generating a structure, harmonic progression, motif, mode, and meter. The results for each module can be passed to an “emotion mapper” (p. 429) for adjustments at any stage, making it suitable for real-time adaptive environments like games.

105 The ten supported emotions are: happy, sad, triumphant, defeated, excited, serene, scared, ominous, angry, and crazy (Hoeberechts et al., 2014).
Figure 5: Greyscale screenshot of Pop Tones during gameplay. Hoeberechts et al. (2014), The Oxford Handbook of Interactive Audio, Figure 25.4, p. 436. Reproduced with permission of the Licensor through PLSclear.

*Pop Tones* affords high-level compositional interventions where players can broadly influence musical “mood” via tempo and tonality, contrasting the granular control of *Chiptune Runner*’s music-making interactions to more closely resemble music-mixing. It also harnesses abstract visual representations of musical content, such as the “emotion balls” (Figure 5), rather than gamifying established musical interfaces like step sequencers. And yet, despite opposing many of the design dimensions in *Chiptune Runner*, Pop Tones remains subject to the same *ludocompositional dissonance* due to its reliance on system-based ludic objectives. Excepting moments of serendipitous alignment, the pursuit of creative objectives, such as “make happy music”, is inherently disposed to detract from competitive objectives, such as “fill the sad meter”, and vice versa.

2.5.4.3 *Pop Tones* as Novel Compositional Strategy

Amongst other single-player systems, *Pop Tones* is unique for offering a rare form of compositional “strategy”. The tempo of music generation determines the rate at which balls appear and descend, and hence the game’s difficulty. Having decoded this relationship, the player can direct the music towards particular emotional states to

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106 To be clear: *Pop Tones* is characterised by music-mixing and *abstract* musical representations, while *Chiptune Runner* is characterised by music-making and *explicit* musical representations.
either: a) slow the tempo and make the game easier, or b) hasten the tempo for an additional challenge, or to renew their stock of balls for compositional purposes. Players can modify tempo and game speed in *Chiptune Runner* by running over “power-ups”, though this is a purely ludic action. In *Pop Tones*, this intervention requires a *musical* decision (Kassabian & Jarman, 2016) – an aesthetic inference about musical representations of emotion – and so constitutes a form of compositional strategy. There is a latent competitive potential in this interaction, whereby ludic outcomes may be sought and obstacles overcome through strategic compositional decisions. Nonetheless, it remains overshadowed by the *ludocompositional dissonance* of imposing system-based objectives in the first place.

### 2.5.4.4 Addressing Ludocompositional Dissonance

At its core, *ludocompositional dissonance* relates back to Kassabian and Jarman’s (2016) suggestion that the two experiences of *paidic* creation and *ludic* competition cannot co-exist in virtual musical worlds (2.3.3.2). As the games reviewed here demonstrate, however, it is not the case that single game systems are incapable of affording both experiences individually; much of the joy of engaging with *Fract OSC* or *Chiptune Runner* is found in the tumultuous flickering\(^{107}\) between free musical exploration and competitive gameplay. Rather, it seems that the two are separate mindsets unable to easily co-inhabit any one moment of interaction, so long as system-based objectives are present to conflict with compositional motivations. For this reason, reconciling musical creativity and competitive gameplay is likely to require new strategies beyond implementing conventional ludic goals.

### 2.5.5 The Game System as Compositional Opponent

The works reviewed here (2.5) illuminate a complex network of design tensions challenging the prospect of competitive, game-based composition. This contextualises the rejection of competitive elements in single-player composition games (1.6.4.1) and lends credence to the related aesthetic and mechanical assumptions present in the ludomusical discourse (2.3.5). I am unconvinced, however, that tensions like *ludocompositional dissonance* are the inevitable result of joining composition with *any* competitive dynamic, and not simply a by-product of the specific *types* of contest

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\(^{107}\) Wang (2016) uses this term to describe an alternating player focus between expressive playfulness (*paidia*) and rule-based submission (*ludus*) in his instrumental mobile apps.
currently employed by the rare few cases of competitive music-making games. There is an approach to compositional contest which, to my knowledge, remains unexplored in accessible composition games: one that is contingent not on ludic goals, but on the system composing in contest with the player as their co-creative opponent. This conception, which I explore through my creative works, may be understood through the emerging field of musical metacreation.

2.6 Musical Metacreation and Competitive Composition

Musical metacreation (MuMe) is a subfield of computational creativity\(^{108}\) focused on endowing machines with the ability to achieve creative musical tasks (Pasquier et al., 2016). MuMe encompasses both purely automated systems requiring no human intervention and interactive systems for human-computer co-creation, with objectives ranging from offline composition to live accompaniment and improvisation. Theories of MuMe are critical to apprehending the game system as a compositional opponent (2.5.5), which I posit as a potential solution to my second research question: How can musical creativity and competitive gameplay be reconciled in a digital game while maintaining a focus on accessible sound composition? I conclude this chapter by reviewing these perspectives to frame a point of departure for the creative research presented herein.

2.6.1 A Taxonomy of Musical Metacreation

A wide variety of system behaviours and outputs may be deemed musically creative. Given the conceptual difficulties of evaluating creativity in general (2.4.1), MuMe writings have emphasised that attributions of musical creativity are necessarily a function of how systems are perceived by unbiased observers (Bodily & Ventura, 2018). Eigenfeldt et al. (2013) propose a taxonomy which distinguishes MuMe systems by their perceived level of autonomy – the system’s control over the final musical result. Although Eigenfeldt et al. are addressing the relationship between the system and its “designer/composer” (p. 43), adapting their taxonomy to address a player’s dialogue with a music-making game system provides a useful account of why the games reviewed thus far (2.5) do not strongly constitute a compositional “opponent”.

\(^{108}\) Computational creativity is often defined as the “philosophy, science and engineering of computational systems which, by taking on particular responsibilities, exhibit behaviours that unbiased observers would deem to be creative” (Colton & Wiggins, 2012, p. 21). Bodily and Ventura (2018) directly adopt this in defining musical metacreation, with the simple amendment of “musical behaviour”.

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2.6.1.1 System Autonomy in Music-Making Games

Eigenfeldt et al. (2013) identify seven levels of musical metacreation, from least (1) to most (7) autonomous, which can be repurposed to describe the player experience of interacting with a musical game system (Table 4). Player perceptions of system autonomy are highly dependent on their comprehension of input-output relationships; even wholly deterministic mappings may be seen to exhibit metacreativity if they are too complex for the player to accurately model. As such, composition games will generally satisfy at least the first two conditions, independence and compositionality, when considering that musically novice players necessarily entrust many sonic parameters to the system’s control. Salient here, though, is the distinction between generativity (level 3) and proactivity (level 4). None of the works discussed prior (2.5) initiate musical gestures independently of player input. When the player idles in Electroplankton or Soundrop (2.5.1), for instance, the system’s musical state perpetuates in stasis until the player alters the game environment. Though capable of generating complex gestures in response to gameplay inputs (i.e. generativity), these games are merely “reactive” (Eigenfeldt et al., 2013) and so do not exhibit proactivity.

Of course, these classifications generate borderline cases which necessarily hinge upon perception. In Chiptune Runner (2.5.4.1), the sequencer begins playing music without any initial player input,\(^{109}\) contrasting systems like Soundrop where sound is only produced once the player draws “sound bars”. The initial sequencer data is pre-configured for each game level until first edited by the player, and so it is unclear whether players would perceive this fixed content as a proactive musical initiative of the system given that it does not vary between game sessions. At any rate, there are no accessible, single-player composition games which clearly exhibit proactive musical gestures, and certainly none which independently adapt (level 5) their musical behaviour over the game session. I consider these higher metacreative behaviours – that is, proactivity (4) and above – to make possible a compositional contest between player and game system as co-creative opponents (2.6.2).

\(^{109}\) That is, beyond commencing the game session itself.
Table 4: Summary of Eigenfeldt et al. (2013) taxonomy of MuMe system autonomy, adapted for composition games.

<table>
<thead>
<tr>
<th>Autonomy</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (least)</td>
<td>Independence</td>
<td>Any process beyond the player’s control which affects musical output, however marginally.</td>
</tr>
<tr>
<td>2</td>
<td>Compositionality</td>
<td>Processes beyond the player’s control which affect multiple musical gestures.</td>
</tr>
<tr>
<td>3</td>
<td>Generativity</td>
<td>Game system generates musical gestures, but only in reaction to player inputs.</td>
</tr>
<tr>
<td>4</td>
<td>Proactivity</td>
<td>Game system initiates its own musical gestures.</td>
</tr>
<tr>
<td>5</td>
<td>Adaptability</td>
<td>Game system changes its musical behaviour over time, deciding when and how independently of player inputs.</td>
</tr>
<tr>
<td>6</td>
<td>Versatility</td>
<td>Game system determines its own musical content without pre-defined stylistic constraints.</td>
</tr>
<tr>
<td>7 (most)</td>
<td>Volition</td>
<td>Game system is capable of deciding whether it wants to create music, and of making its own aesthetic judgements.</td>
</tr>
</tbody>
</table>

2.6.1.2 Metacreative Perspectives in Rowe’s Player Paradigm

Composition games are interactive music systems, making Rowe’s (1992) classification dimensions useful for apprehending notions of a metacreative game contest. Most pertinent is his distinction between the instrument and player paradigms: instrument systems represent predictable, controlled, and direct responses (Drummond, 2009), such that use by a single player resembles a “solo” performance (Rowe, 1992), while player systems behave with a sense of independence and autonomy (Drummond, 2009) where the output more resembles a “duet” (Rowe, 1992). Through this lens, designs like Soundrop and Electroplankton seem to align with the instrument paradigm due to their deterministic output and lack of proactive musical behaviour. Others blur the distinction by more closely approaching proactivity, as in Chiptune Runner, or by affording less predictable, high-level control, as in Pop Tones. Conceiving the game system as a co-creative opponent more explicitly invokes the player paradigm, yet also expands it: the system is not merely a musical collaborator assisting the novice user with reactive generation, but an opposing “player” proactive in the competitive composition game.

110 Though outside of Rowe’s (1992) framework, Electroplankton and Soundrop are more accurately described as “sound toys” (2.3.4.2) or “composition-instruments” (2.3.1.5).
2.6.2 MuMe as Competitive Gameplay

To present a system as an opposing compositional force necessitates higher metacreative behaviours: it is hardly an opponent if not proactive in competing, and only a poor opponent if incapable of adapting its strategy. Existing composition games lack these behaviours, and so relate to the novice player as a creative assistant rather than a rival “player”. If a game system initiates its own compositional gestures, players can make strategic interventions to contest the system’s authorship and realign the musical output with their own creative goals. This makes possible a form of game competition which is not dependent on peripheral ludic objectives (2.5.4), nor on abstract interpretations of “unnecessary obstacles” (2.5.1). The aesthetic experiences of competition and challenge (2.2.3.2) still emerge, but with compositional interactions at the core of the player-vs-system contest. Critically, this circumvents issues like ludocompositional dissonance, and so begins to alleviate the mechanical concerns of ludomusical scholars (see “A1”; 2.3.5). For this reason, designing game systems as proactive compositional opponents shows promise for a more holistic union of musical creativity and competitive gameplay.

Several challenges still remain. For one, this approach is unlikely to reconcile the polarised aesthetic experiences of competing and creating (2.2.3.2) for those who view them as inherently incompatible (see “A2”; 2.3.5). Metacreative behaviours can also pose a mechanical challenge to the player’s creative control, which is generally reduced as a system grows more autonomous.\(^1\) It seems, then, that even musical metacreation can manifest as paidic or ludic in game contexts: a minimally autonomous system which offers free paidic creation may preclude a dynamic of contest, while a proactive system which challenges the player’s creativity as a ludic opponent may restrict their musical control. This recalls the inverse relationship between creative control and competitive game elements (2.5.1.2, 2.5.2.2), suggesting that the pursuit of any competitive dynamic – even without ludic goals – must be carefully balanced with the player’s compositional affordances. Clearly, reframing game systems as a metacreative opponent does not resolve all of the latent tensions arising between competition and musical creativity. Nonetheless, the approach remains unexplored in single-user

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\(^1\) Eigenfeldt et al. (2013), for instance, describe how mappings which deny a sense of control (or perceived control) can be seen to exhibit a significant level of metacreation (p. 44).
composition games, and so we lack the practical insights and player perspectives to appropriately assess its potential for offering new co-creative experiences.

2.6.3 MuMe and Games at Large

There is a burgeoning interest in applying MuMe systems to the automatic generation of conventional game music; that is, music which supports emotional affect (Ekman, 2014), immersion into a gameworld (van Elferen, 2016), the auditory display of gameplay information (Ng & Nesbitt, 2013), or narrative discourse (Summers, 2016). A great diversity of systems have been developed for these aims (Brown, 2012a; Gillespie & Bown, 2017; Herremans & Chew, 2017; Hutchings & McCormack, 2019; Prechtl, 2016; Scirea et al., 2017). However, there has been comparatively little exploration of MuMe systems as games themselves – particularly for single users. Since the inception of the international workshop on MuMe (est. 2012), only two papers have addressed this: one a discussion of Sound Games 1 & 2 (Gimenes, 2018) as game pieces for multiple players (1.6.1.7), and the other my own submission (Studley et al., 2019). This comes despite the range of metacreative strategies with potentials for novel music game design, such as Markov models, generative grammars, artificial-life algorithms such as Boids and cellular automata, evolutionary approaches, and neural networks (Duarte, 2020).

Many MuMe-based projects have provided close precedents. Thor Magnusson’s The Predators (Magnusson, 2007) is an artificial life (A-Life) instrument based on predator-prey interactions; potentially gameful components like environmental obstacles and death were excluded for simplicity (p. 336), yet their inclusion in Aneesh Vartakavi’s comparable geneSynth project shows the potential for A-life properties in composition game scenarios. Closely related are musical experiments with Conway’s Game of Life (Ogawa & Kuhara, 2009), which notably includes glitchDS as an accessible, single-user music sequencer for the Nintendo DS gaming platform. Recent

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112 Note that the only other MuMe papers to focus on games – Brown (2012b) and Gillespie and Bown (2017) – are related to generating conventional videogame music, or “background music”.
113 The Predators is part of the “ixiQuarks” collection, a series of instruments and effects developed using the audio programming language SuperCollider to explore musical interaction in screen-based environments (Magnusson, 2007).
114 A demonstration is available at: https://cycling74.com/projects/genesynth (retrieved 6 February, 2020).
115 A description of glitchDS features and control schemes, along with a download link and video demonstration, are available at: https://www.gamebrew.org/wiki/GlitchDS (retrieved 6 February, 2020).
developments in Musebots,116 a crowning MuMe project, show an expansion from their original function as strictly autonomous ensembles towards human intervention and live collaboration (Brown et al., 2018), paving the way for their potential use in game contexts and even as compositional opponents. Most directly, Pop Tones (Hoeberechts et al., 2014) demonstrates a music-game application for the growing interest in generating emotionally affective music (Scirea et al., 2017).

Clearly there are gameful potentials within interactive MuMe systems. And yet, we lack any practical explorations of human-computer co-creation as a competitive game between player and system. I take this as the point of departure for my creative research. Just as metacreative perspectives offer new opportunities for competitive composition games, so too may game design lead to novel forms of interactive and accessible musical metacreation.

2.7 Chapter Summary

This chapter has reviewed the theoretical and practical contexts of designing competitive composition games for single novice players. I have distilled the aesthetic assumptions, design dimensions, and mechanical challenges surrounding this notion through a survey of literature perspectives (2.1-2.4) and related game systems (2.5). Taking musical metacreation as a theoretical lens (2.6), I then outlined a novel approach to competitive composition which remains unexplored in the current landscape: a reframing of the game system as the player’s co-creative opponent. The design insights emerging from this review are summarised following.

2.7.1 Design Assumptions

A review of ludomusical discourse (2.3) reveals two design assumptions that underpin the rejection of competitive elements in accessible, single-player composition games:

A1) The presence of competitive mechanics, such as points, goals, or win-loss conditions, detracts from a focus on compositional interactions.

A2) The aesthetic experience of competitive gameplay, such as challenge, conflict, or pressure, is unconducive to musical creation.

116 Project details, including the Musebot Specification and audio examples, can be found at: http://musicalmetacreation.org/musebots/ (retrieved 6 February, 2020).
The few empirical investigations into the influence of competition on musical creativity do not reflect this purely antagonistic relationship (2.4.3), suggesting a more complex interplay between the two than is presented in ludomusical discourse. My creative works test these assumptions in a design context to explore how they are reflected within player perspectives.

2.7.2 Design Dimensions

A close examination of related works (2.5) has revealed a network of interrelated design dimensions pertinent to the discussion and development of competitive composition games. Drawing on perspectives from game studies (2.1-2.2), ludomusicology (2.3), and musical metacreation (2.6), the dimensions should not be taken as hard dichotomies but as polarised continuums for comparing and conceptualising composition games:

- **Paidia vs. ludus** (Caillois, 2001); describing the competitiveness of compositional interactions (2.1.1.1; 2.2.3.2; 2.3.3; 2.5.1.2; 2.6.2).
- **Mixing vs. making** (Austin, 2016a); describing the granularity of player musical control (2.3.1.3; 2.5.2.1).
- **Core vs. peripheral** (Wang, 2016); describing how competitive gameplay relates to compositional processes (2.2.4.4; 2.3.1.4; 2.5.1.1; 2.5.3.1).
- **Instrument vs. composition** (Herber, 2008); or alternatively, Rowe’s (1992) “instrument” and “player” paradigms (2.3.1.5; 2.6.1.2).
- **Abstract vs. explicit** musical representations; (2.5.2.3; 2.5.4.2).
- **Metacreative autonomy** (Eigenfeldt et al., 2013); describing the system’s control over musical output and creative behaviour (2.6.1; 2.6.2).

2.7.3 Design Challenges

The review of related works (2.5) also highlights a series of design challenges and conceptual tensions to be navigated in developing game systems for competitive composition. Most of these emerge from seemingly inherent conflicts with providing creative control in gameful or metacreative environments:

- **Ludocompositional dissonance**; a tension between ludic and compositional incentives during interaction (2.2.4.4; 2.3.3.3; 2.3.4.2; 2.5.4; 2.6.2).
- **Creative control vs. competition**; where more competitive designs can detract from the player’s creative control (2.5.1.2; 2.5.2.2; 2.5.2.4).
• Creative control vs. autonomy; where more autonomous systems command increasing control over the shared musical result (2.6.2).
• Creative control vs. abstraction; where systems with deeper creative control are incentivised towards explicit musical interfaces for the sake of usability (2.5.2.3; 2.5.2.4).

2.7.4 Point of Departure

There are few existing precedents for competitive single-player composition games, which principally include Fract OSC (2.5.3.2), Chiptune Runner (2.5.4.1), and Pop Tones (2.5.4.2). In these designs, contest emerges primarily from the player’s overcoming of peripheral ludic obstacles; the player composes in the interstitial moments between competitive gameplay, not as competitive gameplay itself. I have outlined an alternative approach – the game system as a proactive compositional opponent (2.5.5; 2.6.2) – which is presently unexplored in composition games or musical metacreation at large. There is also a lack of empirical work investigating the player experience of composing within competitive game settings, and so limited practical insights with which to reflect on the design assumptions and tensions reviewed here. I explore these novel contexts through the development of three original composition games and their subsequent user evaluation, as outlined in Chapter 3.
Chapter 3: Methodology

This chapter details my methodological approach to the research questions outlined prior (1.2.1). I begin with an overview of the methodology and its epistemological roots to explicate the role of the creative works and two user studies within the research design (3.1). I then discuss the specific conceptual and technical strategies employed by the creative works (3.2) before outlining the collection and analytical methods for the user studies (3.3). I conclude by delimiting the scope of the research (3.4).

3.1 Overview

My research design can be summarised as an iterative, mixed method inquiry driven by creative practice. It relies on a pragmatic methodology which draws variably upon traditions of practice-based research (Candy, 2006; Skains, 2018), Constructivist Grounded Theory (Charmaz, 2000, 2006), generic qualitative induction (Liu, 2016; Thomas, 2006), and quantitative analysis as appropriate to each of the diverse research aims. Figure 6 provides an overview of the research design, which is summarised below:

1) **Contextual Research** – A review of literature perspectives provides a theoretical starting point by revealing the design assumptions, dimensions, and challenges underpinning competitive, game-based composition (2.7).

2) **Practice and Evaluation: Phase One** – Literature insights inform the development of an initial phase of creative works (*EvoMusic* and *Chase*) which are evaluated in a comparative, mixed methods user study. This generates design insights from a *practitioner* perspective and experiential insights from a *player* perspective.

3) **Practice and Evaluation: Phase Two** – the Phase One insights inform, and are tested through, the development of an additional creative work (*Idea*) and its evaluation in a second comparative user study. New questions are incorporated to investigate any novel themes arising from the Phase One findings.

4) **Knowledge Construction** – Data from both studies are used to construct an understanding of the player experience of composing through competitive gameplay interactions. The degree to which the player experience reflects...
literature conceptions (2.7), as well as the design insights generated through practice, is assessed. The potential for competitive games as a platform for interactive composition is evaluated, and design recommendations are drawn.

3.1.1 Approaching the Research Questions

With this design, I explore competitive, game-based composition through three key perspectives as knowledge sources: literature, practitioner, and player. Each perspective primarily aligns with one of the three research questions, though all address each question at least indirectly. These associations are outlined below:

Q1) *What are the aesthetic assumptions and design challenges underpinning interactive composition in competitive game settings?* – I address this primarily through a review of related works and literature, the findings of which are summarised prior (2.7). My practice illuminates new challenges and design dimensions unexamined in the literature, while the player perceptions revealed through the user studies allow for a critical reflection on scholarly conceptions. My conclusions are informed by consolidating all three perspectives.

Q2) *How can musical creativity and competitive gameplay be reconciled in a digital game while maintaining a focus on accessible sound composition?* – I predominantly address this with the knowledge gained through practice, for which the original games and their explication herein are primary “evidence” (Nelson, 2013). Player perspectives are used to support evaluation of the games’ value as both interactive systems and research. Literature perspectives provide a conceptual starting point for the works by highlighting an unexplored approach to compositionally competitive gameplay (2.5.5; 2.6.2; 3.2.1).

Q3) *How do competitive game settings shape player perceptions of musical control, creativity, and ownership?* – This intends to capture the player experience of composing with(in) and against the game systems, and is addressed primarily through the two mixed methods user studies. My practice manifests the artefacts by which player insights can be generated. Literature perspectives inform the selection of pertinent thematic categories to be explored in the user studies, as discussed further in (3.3.1.2).

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117 My use of “literature” in this section refers not only to the conceptions presented by scholarly texts, but to the insights gleaned from a review of related games, systems, and media in Chapters 1 and 2.
Figure 6: Visualisation of my research design. Bold arrows illustrate the primary line of inquiry as it occurred sequentially throughout my program. Dotted arrows indicate other insights significant to informing subsequent steps.
To synthesise literature, player, and practitioner perspectives towards the construction of new knowledge – and so address the research questions – requires a pragmatic, hybridised methodology sensitive to the idiosyncrasies of each.

3.1.2 Developing a Pragmatic, Hybrid Methodology

This research at its core is practice-based. My development of original composition games is both a key method of inquiry (Nelson, 2013, p. 9) and an outcome of the research process (Hamilton & Jaaniste, 2009). Skains (2018) describes the role of creative acts in practice-based research as “experiments” designed to answer directed research questions (p. 86). This resembles Sullivan’s (2009) notion of theoretical practice-led research as exploring specific research issues and problems. Applying these perspectives here, the original games primarily address my first and second research questions (1.2.1): they interrogate the assumptions (2.7.1) and challenges (2.7.3) underpinning competitive composition games within a practical design context (Q1), and also explore a novel approach (3.2.1) to reconciling musical creativity and competitive gameplay (Q2). Nonetheless, an understanding of competitive, game-based composition cannot be reached from a practitioner perspective alone. Candy (2006) stresses the importance of user-centred methods in evaluating interactive arts research (p. 18), both to reflect an authentic participatory context and to provide opportunities for the learned insights to inform future practice. Given also that my games aim to be accessible to musical novices, it is crucial to capture the player experience of composing with(in) and against them.

Several quantitative instruments have been used to measure gameplay experience, ranging from Likert-style questionnaires (Brockmyer et al., 2009; IJsselsteijn et al., 2007) to psychophysiological methods (Kivikangas et al., 2011). However, my works are a complex intersection of aims beyond the conventional gameplay experience, aspiring at once to be gameful, compositional, accessible, competitive, and metacreative. Capturing rich player perspectives in this novel space requires a multi-

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118 For the purposes of this research, I do not consider it useful to differentiate between the branches of “practice-related” (Skains, 2018) research drawn by Candy (2006) and others, such as practice-based, practice-led, and practice-as-research. My creative works contribute to a larger hybrid methodology, and so cross many of these boundaries otherwise useful for delineating solely practice-driven research.

119 Theoretical practice-research is one of four areas outlined by Sullivan (2009). The others include conceptual research (attempting to understand the artefact), dialectical research (exploring meaning-making in art), and contextual research (prompting social change).

120 This includes measures like skin conductance, heart rate variability, or facial muscle tension. The data is collected during gameplay, in real-time, and is correlated with concepts like emotional arousal.
faceted approach, particularly given the lack of existing empirical evaluation, and so I have seen fit to develop a pragmatic, hybrid methodology. Firstly, I take a mixed methods approach (Creswell, 2009) to exploring player experience (3.3): quantitative instruments provide a high-level comparison and evaluation of the works, whilst qualitative inductive methods capture rich player insights and allow new themes to emerge. Secondly, I deem it crucial that this evaluative process be integrated alongside my practice within a larger cyclical design that allows the insights gleaned from each to guide the other. To address this, I adapt principles from Constructivist Grounded Theory (Charmaz, 2000, 2006) as heuristics to guide the research design.

3.1.3 Adapting Principles of Constructivist Grounded Theory as Heuristics for Research Design

Grounded Theory (GT), first articulated by Glaser and Strauss (1967), is a family of principles and methods for generating new theory from data (Birks & Mills, 2015). It is a flexible, exploratory methodology most appropriate when little is known about a phenomenon (Tie, Birks, & Francis, 2019), stressing the primacy of grounded observation over theoretical preconceptions (Bryant & Charmaz, 2007). GT approaches are widely applied in musical research domains, including music therapy (O’Callaghan, 2012), education (Callaghan, 2002), ethnography (Boele, 2013), and even the evaluation of a music industry classroom game (Herzig, 2019). While distinct schools of GT have formed, a core set of essential procedures is shared. I do not adhere strictly to these procedures, nor is there scope in this program for the due diligence of constructing a systematic “grounded theory” alongside the time-consuming development of three digital games. Indeed, my works and their evaluation herein are equally as concerned with exploring existing theoretical preconceptions (2.7.1) as with building new theory. I merely adapt useful principles from the school of Constructivist Grounded Theory (CGT) to organise a pragmatic methodology capable of reconciling literature, practitioner, and player perspectives.

Of immediate interest in CGT is the constructivist epistemology. To explore the player experience of competitive, game-based composition through my creative work positions me inevitably as an invested practitioner, and so I cannot as researcher satisfy

121 Grounded Theory scholars generally note three methodological variants: the positivist Glaserian school, Strauss and Corbin’s school, and the Constructivist school developed by Charmaz.
the positivist paradigm of a distanced, unbiased observer. Through the user studies, I construct a “plausible account” (Charmaz, 2006, p. 132) of the player experience, itself constructed by each participant.\textsuperscript{122} This account can then be used to reflect on literature assumptions (2.7.1) and guide future design, but neither presumes objectivity nor seeks to “prove”, for instance, that musical creativity and competitive gameplay can be reconciled. Of further use is the iterative design underpinning CGT, particularly as it concerns the principle of “theoretical sampling” (Birks & Mills, 2015). I have adapted this process for my creative practice so that it may be integrated into a cyclical, mixed methods investigation. Where CGT researchers strategically sample additional participants\textsuperscript{123} to confirm or disconfirm emerging theories, I instead allow any novel themes from the phase one study to inform the design of an additional game capable of exploring them further in phase two.

Another heuristic can be drawn from the role of literature and extant theory in CGT (Ramalho et al., 2015). Where traditional GT suggests delaying the literature review to avoid contaminating data,\textsuperscript{124} CGT introduces a theoretically agnostic use of literature as a pragmatic measure for informed analysis (Lempert, 2007; Thornberg, 2012). This is critical to accounting for literature perspectives (2.7), which crucially inform the creative works, within the exploratory methodology. It allows me to recognise existing preconceptions about competitive composition (2.7.1) and subject them to scrutiny (Charmaz, 2008, p. 402) via participant experience, but to remain sensitive to new themes arising from player perceptions and so explore them in further works. Related to this is GT’s strong emphasis on interacting with data (Corbin, 2016), which refers originally to techniques like extensive memo writing and constant comparative analysis. Adopting an iterative design allows for a comparable interaction through practice. User data is explored through additional games which then generate further user data, interacting all the while with literature and practitioner perspectives in analysis.

To be clear, the individual user studies do not adhere to CGT methods; as discussed further in (3.3.3.2), the qualitative portion of data collection and analysis more closely

\textsuperscript{122} Player experience, as communicated by the user study participants, is contingent upon their experience with, and implicit values for, at least the following: games, music, competition, challenge, composition, and creativity.

\textsuperscript{123} Note that Grounded Theory methods are not restricted to interviews or surveys with human participants. As per Glaser’s dictum that “all is data” (Glaser, 1998), the source can include literature, government reports, videos, music, or any other artefacts (Tie et al. 2019).

\textsuperscript{124} That is, to discourage researchers from “forcing the data into pre-existing concepts which distort or do not fit with data” (Thornberg, 2012, p. 244).
resembles the generic qualitative induction model (Liu, 2016; Thomas, 2006). I simply adapt the exploratory and iterative principles of CGT to guide the overall research design. In this way, Figure 6 can also be taken to represent a liberal application of CGT principles to a practice-based investigation.

3.2 Creative Works

This research has produced three original composition games: EvoMusic, Chase, and Idea (Figure 7). Here, I outline the conceptual approaches (3.2.1) and system design (3.2.3) shared by the works, their distinct methodological roles (3.2.2), and my approach to evaluating them as research and as systems for interactive composition (3.2.4). Their individual mechanics and compositional strategies are detailed in Chapters 4 and 6.

![Figure 7: Screen captures of my original composition games: EvoMusic (left), Chase (middle), Idea (right).](image)

3.2.1 Conceptual Approach

EvoMusic, Chase, and Idea are each conceived as compositional contests between a single player and game system. The player and system do not produce discrete compositions to be separately ranked, but compete for creative control over a single, shared musical output unfolding in real-time. Enabling this interaction is that the state of the gameworld influences the parameters of live music generation. A novice player can exert creative control by interacting with the gameworld to affect sonic change, while the game’s internal logic is designed such that the music generation moves inexorably towards a broad aesthetic outcome over the course of a game session. The player strategically contests or embraces the designed musical trajectory in a persistent effort to align the generated musical output with their own aesthetic goals, which variably collide or comply with the system’s proactive (Eigenfeldt et al., 2013) compositional gestures. In this way, the games act as both collaborator and opponent.

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125 That is, in the manner of human composers vying for a prize or commission.
126 This “aesthetic outcome” might include harmonic cacophony, textural density, or silence.
inviting a novel dialogue between player and system that is at once musically competitive and co-creative.

My decision to frame the competitive dialogue as a contest for creative control\textsuperscript{127} is informed by two key insights from the literature review (Chapter 2). Firstly, the design challenges (2.7.3) underpinning competitive composition seem largely to arise from the tension of affording musical control within agonistic contexts. By positioning control as the site of competition, I aim to gamify this tension itself and so explore its potential to support new compositional experiences. Second, and related, is the issue of positioning competition as core to the player’s compositional processes (2.2.4.4). I consider competing for creative control as one solution to this, for which my logic follows:

1. Composition will be peripheral to the competitive interaction so long as self-contained ludic goals are present (e.g. defeat all enemies to win).
2. To have a core relationship, any concurring ludic and compositional incentives should ideally be aligned, such that compositional decisions are themselves moves within the competitive system.
3. For this to occur, the ludic goal would need to be musical. However, it should not be an aesthetic prescription, such as compose “happy” music, as this imposes arbitrary constraints on free expression and raises the issue of system-based evaluations of success (2.2.4.1-2.2.4.3).
4. Competing for musical control is thus an appropriate ludic objective as it is compatible with any player-defined aesthetic goal\textsuperscript{128} and does not require a system-based evaluation. The contest also does not necessitate peripheral ludic objectives, such as avoiding death, and so is less inherently prone to issues like ludocompositional dissonance (2.2.4.5).

\textbf{3.2.2 Methodological Approach}

Despite sharing a common conceptual approach (3.2.1), the two phases of original works serve distinct methodological roles. Phase One (EvoMusic, Chase) may be characterised as a preliminary exploration of competitive composition games, while Phase Two (Idea) acts as a refinement and synthesis of the insights revealed.

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\textsuperscript{127} A metaphor guiding this conception has been a “tug-of-war” between the player and system for authorial agency, with each straining to “pull” the musical output towards their own aesthetic goals.

\textsuperscript{128} That is, the player must strive to approach and subsequently preserve their desired musical output no matter its aesthetic nature.
3.2.2.1 Phase One: *EvoMusic* and *Chase* as Contrasting Implementations

*EvoMusic* and *Chase* were designed as contrasting implementations of a player-versus-system contest for compositional control. The games are intentionally aligned with opposing poles of the design dimensions outlined prior (2.7.2); for instance, *EvoMusic* affords highly granular control and is comparatively *paidic*, while *Chase* offers only broad control but is more distinctly *ludic*. My intention with this approach is two-fold. Firstly, given the network of interrelated polarities orbiting the notion of competitive composition (2.7.2), the development of contrasting implementations enables a wider charting of the potential design space. From a practitioner perspective, this allows me to explore the unique affordances and challenges of each approach and so inform design recommendations. Secondly, juxtaposing *EvoMusic* and *Chase* in a comparative user study allows for one approach to be highlighted as the more successful, or at the least offers richer insight into player values and perceptions than an isolated evaluation of each system could afford.

3.2.2.2 Phase Two: *Idea* as Synthesis

*Idea* was developed as a synthesis of the most successful features of *EvoMusic* and *Chase*, as informed by the findings of the first user study and my own practitioner insights gleaned through the design process. Where Phase One offers a preliminary exploration of competitive compositional gameplay, my aim with *Idea* is to refine my approach by using player experience to mediate the extremes of *EvoMusic* and *Chase* in pursuit of an appropriate balance for each design dimension (2.7.2). Beyond this, and with equal significance, *Idea* is designed to explore any novel themes or insights revealed by the first user study. To support these aims, the second user study juxtaposes *Idea* with the more successful game from the preliminary study (*EvoMusic*).

3.2.3 Overview of System Design

In all three works, the total composition game as experienced by the player comprises separate game and music systems which communicate on a single computer device (Figure 8). The game system is the central brain, acting as the portal through which the player interprets and interacts with their composition. It handles the game’s logic, information display, and crucially directs the music generation system to respond to the player’s actions as control inputs. The game systems were developed in *Unity*: a
flexible, object-oriented 3D game engine which allows for the easy mapping of sonic parameters to physics and gameworld data\textsuperscript{129} (Unity Technologies, version 2017.3.1).

The music system, though obscured from the player, is responsible for the generation and playback of musical content in response to in-game actions. Conceptually, it reflects the sonic outcome of the ongoing “combat” between the player’s compositional interventions and the game’s own musical gestures. MIDI data is first generated using basic stochastic strategies, such as first order markov chains and generative grammars, which determine the pitch, velocity, duration and timing of sonic events. The MIDI data is then passed through software instruments and audio effects plug-ins for playback. In *EvoMusic* and *Chase*, timbre is chosen directly by the player using a pre-game settings menu (Chapter 4); in *Idea*, timbre is manipulated during live gameplay by the player and several in-game agents (Chapter 6). In all games, the sonic output can be captured as a WAV file so that players can preserve permanent artefacts of their creativity.

Soundscape elements do not explicitly factor into composition, save for a subtle and persistently looping environmental ambience which the player cannot influence and is not captured in the WAV recording. The music systems were developed in the *Max* programming environment (Cycling ’74, version 8.0.1).

Interoperability between *Max* and *Unity* is achieved through Open Sound Control\textsuperscript{130} (OSC), a communication protocol useful for networking multimedia devices with audio processing environments. I use a C# script from Thomas Frederick’s *UnityOSC* project\textsuperscript{131} to send OSC Messages between *Unity* and *Max* over the device’s local network (Figure 9), with each message containing gameworld data as float or string values. This communication is bidirectional: whilst the game state determines the parameters for music generation and playback within *Max*, *Unity* also responds visually to each of *Max*’s individually generated sonic events to assist with information display.\textsuperscript{132}

\textsuperscript{129} Unity maintains a plethora of data on the behaviour of each “object” within the gameworld. This includes parameters like object position, rotation, scale, velocity, quantity, behavioural state, and more – all of which can be used to trigger musical processes as a control input.

\textsuperscript{130} The OSC specification, developed by Matt Wright, is available at: http://opensoundcontrol.org/spec-1.0 (retrieved 24 February, 2020).

\textsuperscript{131} Frederick’s *UnityOSC* scripts, example projects, and a brief written tutorial can be obtained at: http://thomasfredericks.github.io/UnityOSC/ (retrieved 24 February, 2020).

\textsuperscript{132} This ranges from simply “flashing” a game object whenever it produces a sonic event (in *EvoMusic*) to displaying the pitch and duration content of editable melodic motifs (in *Idea*).
3.2.3.1 On the Choice of Software and Platform

In their developmental forms, the original games require that two standalone applications run simultaneously on a single device. This is due to the lack of a compiler for converting *Max* patches into native C# code, which would enable *Unity* to run both the music and game systems from a single packaged application. Although users do not need to install *Unity* or *Max* to run the game and music systems, this format is not ideal for disseminating the works. Others have adopted a *Max-Unity* design for interactive composition media, the most salient being Dolphin’s early sound toys *SpiralSet*
(Dolphin, 2009c) and MagNular (Dolphin, 2009b), though these also require separate sound and game engines communicating over a local network (Dolphin, 2009a).

Solutions are available within alternative audio programming languages. Chunity, a plug-in for Unity which enables integration of the ChucK audio programming language (Wang, 2008), has been used by tertiary students to design interactive audiovisual games (Atherton & Wang, 2018). Pure Data patches can be embedded into Unity using the open source Heavy compiler, whilst procedural instruments developed in Csound can be exported as plug-ins for the FMOD audio middleware and then packaged within a Unity-built application. The decision to use Max is purely pragmatic. Firstly, my existing familiarity with the language dramatically reduced the time required for experimentation and development. Secondly, the games’ reliance on two concurrent applications does not detract from their interaction experience nor evaluation in a user study context, as each game appears as a single application to the participant.

The motivations for developing the games on the PC platform, and for interaction with a mouse and keyboard, are similarly pragmatic. My approach to competitive, game-based composition (3.2.1) is equally applicable to other control interfaces, such as Xbox controllers or Wii Remotes, other platforms, such as mobile devices or virtual reality, and other contexts entirely, such as interactive installations. While each is sure to harbour undiscovered potentials and affordances, developing and testing the games on the one device (PC) enables a streamlined workflow focused on an exploration of the research concepts rather than matters of technological implementation. This also circumvents the issue of compiling the Max and Unity applications for mobile devices, which would otherwise serve as highly appropriate platform for the games with regard to accessibility (1.6.2.1). Again, I am foremost concerned with exploring the conceptual

134 The ChucK programming language and documentation can be found at: https://chuck.cs.princeton.edu/ (retrieved 24 February, 2020).
135 Pure Data is an open source analogue to Max. Documentation and download links are available at: https://puredata.info/ (retrieved 24 February, 2020).
136 Originally developed by the now defunct Enzien Audio, the Heavy compiler converts Pure Data patches to C source code. See: https://github.com/enzienaudio/hvcc (retrieved 24 February, 2020).
137 Csound is an audio programming language emphasising backwards compatibility and platform compatibility. See: https://csound.com/ (retrieved 24 February, 2020).
challenges and potentials of competitive composition games; a comparison of alternative platforms is beyond the scope of this research.

3.2.3.2 On the Choice of Music Generation Strategies

The music generation in *EvoMusic*, *Chase*, and *Idea* employs a combination of rule-based and stochastic strategies. While the player influences the parameters for this generation, at least one aspect of each sonic event – be it pitch, velocity, or timing – is determined by algorithmic processes such as first order markov chains (Brooks Jr. et al., 1957) and generative grammars (Lerdhal & Jackendoff, 1983). These strategies can be criticised for producing simplistic output as compared to contemporary evolutionary or machine learning techniques (Hunt, Mitchell, & Nash, 2017). However, stochastic and rule-based strategies are also highly suited to real-time interaction: they are computationally inexpensive, easily mapped to in-game actions in a way that is discernible to players, and take no perceptible time to compute musical gestures in response to player input. This responsiveness and transparency is crucial to facilitating the sense that players can exert strategic compositional interventions in contest with the game system. Stochastic and rule-based strategies are thus appropriate for modelling the intended co-creative dialogue as a preliminary exploration of its potentials for interactive composition. As with technological platforms, I consider the applications of alternative generation strategies – such as artificial life algorithms, evolutionary approaches, or neural networks – to be beyond the scope of this research.

3.2.4 Evaluating the Works as Systems and Research

The comparative user studies are the primary method for evaluating the creative works. Foremost, the studies address a methodological concern: how can I be confident that the games do in fact explore competitive composition, and so are capable of reflecting the potential for interactive composition at large? I take the games to satisfy this role if: 1) participants report aesthetic experiences related to both creativity and competition (2.2.3.2); and 2) participants identify the intended competitive co-creative dialogue outlined prior (3.2.1). From there, the user evaluations can reflect on more specific research themes informed by the literature review, such as the effect of competitive design on creative control, whilst also evaluating the games more generally as interactive systems – for instance, with regard to usability.
I also evaluate the works from a practitioner perspective to support the findings of the user studies. Beyond a personal reflection on their successes and challenges, I position each work along the design dimensions identified for competitive composition games (2.7.2). Classifying the works in this way contextualises the player insights generated by each, thereby grounding any design recommendations\(^{139}\) and helping to communicate their value as evidence of a research inquiry. A similar approach is used by Yee-King (2016), who evaluates a computationally creative synthesiser\(^{140}\) by both surveying the user experience and situating his design within ontologies of creative systems to communicate its novel characteristics. In the broader context of evaluating MuMe systems, my approach encompasses both *self-evaluation* and *external validation* strategies (Bodily & Ventura, 2018). The specific evaluation methods employed in the user studies are detailed further in (3.3.2; 3.3.3).

### 3.3 User Studies

I have conducted two mixed methods user studies for this research: a comparative evaluation of *EvoMusic* and *Chase* (n=24), and a revised comparative evaluation of *EvoMusic* and *Idea* (n=6). Here, I outline the methodological considerations informing the studies (3.3.1), the study design itself (3.3.2), and my analytical methods (3.3.3). The results of each user study are discussed in Chapters 5 and 7 respectively.

#### 3.3.1 Methodological Considerations

**3.3.1.1 The Significance of Evaluating Player Experience**

Formal evaluations of musical HCI\(^{141}\) systems generally address two areas: user *experience* and musical *output*.\(^{142}\) Evaluations of user *experience* can include questionnaires or interviews, psychophysiological measures such as skin conductance (Prechtl, 2016), or the analysis of user interface telemetry (Tubb & Dixon, 2014). Evaluations of musical *output* range from direct audio analysis (Yee-King, 2016) to validations of musicality or stylistic authenticity; these can rely on either computational

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\(^{139}\) Classifying the works allows interested parties to note which player experiences and responses were evoked by particular design characteristics, and so inform future design decisions.

\(^{140}\) Yee-King’s system (*Evosynth*) is a virtual modular synthesiser based on interactive genetic algorithms. Users audition different sound synthesis patches and select their favourite for breeding, after which a new generation of patches is evolved, and so on. The system focuses on timbral exploration.

\(^{141}\) “Human-Computer Interaction”.

\(^{142}\) Prechtl (2016), considering game contexts specifically, divides these as “player-oriented” and “music-oriented” approaches (p. 60).
metrics (Murray & Ventura, 2012) or human-based approaches, such as musical turing tests (Pearce & Wiggins, 2001). In MuMe contexts, it is also common to evaluate system behaviour, whether through quantifiable measures of system autonomy (Bown & Martin, 2012) or subjective assessments of the system’s perceived musical creativity. Otherwise, formal evaluations of MuMe systems have focused predominantly on musical output (Murray & Ventura, 2012; Teixeira & Pinto, 2017; Yu et al., 2016) with only few recent exceptions (Bray, Carey, & Bown, 2019).

Of these three evaluation areas – user experience, musical output, and system behaviour – I consider player experience to be the most valuable to an exploration of competitive, game-based composition. Whatever the player’s aesthetic judgement of the musical output, and however autonomous or creative they deem the system’s behaviour, the player’s experience of composing within the games reveals their implicit criteria for musical creation, for competitive gameplay, and more. These are vital to reflecting on literature conceptions of competitive music-making (2.7.1), and so to apprehending the potentials of competitive gameplay as a platform for interactive composition. For this reason, I have designed the user studies as mixed methods surveys to be completed immediately after interaction with the games (3.3.2). This most closely resembles the approach of Eisenberg and Thompson (2011), who use questionnaires to capture the affective experience of improvising under competitive conditions to better understand their interrelationship (2.4.3). I do not collect user interface telemetry, nor conduct psychophysiological measures, and the surveys do not inquire explicitly about qualities of the musical output. While these areas are of clear interest to competitive composition games, I have chosen to constrain this preliminary investigation to the perceived influence of competitive gameplay upon the core compositional experience.

3.3.1.2 Presupposed Themes for the User Studies

It is crucial that the user studies include opportunities to capture novel and unexpected player insights in the form of open qualitative responses. However, the studies are also designed to explore a number of conceptual themes which, as informed by my review of literature and related works (Chapter 2), I have presupposed as being pertinent to

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143 Stowell et al. (2009) warn that standard metrics like “task completion rate” do not clearly apply to musically creative interactions in the first place (p. 960).
apprehending competitive, game-based composition. These themes guide a significant portion of the user study questions and are detailed below:

- **Control** – the player’s ability to direct the musical output towards a desired outcome. I take this as crucial to player perceptions for two reasons: 1) many of the tensions between musical creativity and competitive gameplay seem to revolve around compositional control (2.7.3); and 2) my games position musical control as the site of competition between the player and system (3.2.1).

- **Balance** – this is related to control, but refers specifically to the perceived balance of control between the player and system. The games aim to facilitate a co-creative dialogue that is uniquely competitive, and so the human-computer relationship becomes a salient lens for exploring control. As a metacreative consideration, this also touches upon perceptions of system autonomy.

- **Creativity** – the degree to which the player’s interactions are perceived as musically creative, to which the games aid musical creativity, or to which it evokes aesthetic experiences related to creativity, such as discovery or expression (2.2.3.2). At their core, the games intend to provide novice access to interactive composition, and so perceptions of creativity are paramount.

- **Ownership** – the degree to which the player feels intellectually responsible for the musical output, or that they have “authored” it. My interest in perceptions of ownership is informed by the many “compositional forces” (Dolphin, 2014, p. 48) influencing the musical output, including the designer, player, and system itself. This is closely linked to perceptions of control and balance, and is also related to system autonomy as a metacreative consideration.

- **Competition** – the degree to which the player feels they are competing against the game system, or to which they characterise the gameplay experience as competitive more generally. An account of how players value the use of agonistic elements in musically creative experiences is central to this research, and provides a vital reflection on literature conceptions.

- **Challenge** – the degree to which the game is perceived as physically or intellectually challenging, as distinct from usability. Challenge is intimately tied to competition as an aesthetic of ludic experiences (2.2.3.2), yet also offers insight into accessibility. It is thus key to capture players’ perceived and preferred levels of challenge while gaming and composing.
• **Usability** – the perceived ease of using, and of learning to use a system. Usability is valuable to any game or interactive system, but is particularly pertinent to these works as a measure of accessibility.

Whilst I view each of these themes as useful to constructing an understanding of competitive composition games, I am foremost concerned with how the competitive gameplay environment influences perceptions of the core compositional experience; that is, of musical control, creativity, and ownership. This informs my third research question and the predominant focus of the user studies: How do competitive game settings shape player perceptions of musical control, creativity, and ownership?

### 3.3.2 User Study Design

The user studies were conducted as single supervised sessions for each participant. After providing written consent, participants were asked to play one game for approximately twenty minutes before completing a survey reflecting on their experience; this process was then repeated for the second game. The order in which they played the games was assigned randomly as a control, and participants responded to an identical set of questions for both games. The broad aims of the research were introduced via a participant information statement, but no specific details about the games or survey questions were given to avoid influencing participant responses (Stowell et al., 2009). Participants were recruited anonymously from the undergraduate student cohort at the University of Newcastle, Australia under a human ethics protocol approved by the Human Research Ethics Committee (HREC). The only demographic data collected from participants were indications of their existing musical knowledge and proficiency with digital games for the purpose of contextualising responses. The recruitment process itself did not filter for musical or gaming experience to allow for a broad representation of potential users; that is, to capture the perceptions of musicians, gamers, musician-gamers, and novices to both.

In evaluating each game, participants first completed ten Likert-scale questions derived from the System Usability Scale (Brooke, 1996), a standardised instrument for subjective assessments of system usability (Bangor, Kortum, & Miller, 2008) which has been specifically recommended for evaluating accessible music game systems (Chung

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144 The protocol is entitled “Evaluating game-based applications for real-time interactive music composition” (H-2018-0510), approved by the Human Research Ethics Committee on 20 February, 2019.
The scale yields a score between zero and one hundred, providing a high-level overview for direct comparison between games. Participants then responded to six core questions (see Table 5) concerning their perceptions of musical control, creativity, compositional contest, and ownership within the games. These questions are hybridised, entailing both a five-point Likert-scale rating and a short, open-ended justification to enable broad comparison within each theme whilst also allowing for latent qualitative trends to emerge. Next, participants were given the opportunity to indicate which features they most enjoyed along with any aspects they would like to improve in free-form responses. The survey concludes with a direct, open-ended comparison between the two games being evaluated: *EvoMusic* and *Chase* in the first study, or *EvoMusic* and *Idea* in the second. Participants were able to specify a preferred game, articulate their reasoning at length, or reflect freely on any further insights they deem appropriate. A complete list of survey questions is available in Appendix A.

Table 5: Summary of Questions 1-6 for Section 3 of the user studies. The themes are discussed in section 3.3.1.2. *Note: Likert-scale responses to question 1 are: 1 = Game had total control, 2 = Game had most control, 3 = Balance between the game and I, 4 = I had most control, 5 = I had total control.*

<table>
<thead>
<tr>
<th>№</th>
<th>Theme</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Balance*</td>
<td>How would you describe your level of creative control over the music in the game?</td>
</tr>
<tr>
<td>2</td>
<td>Control</td>
<td>It was easy to direct the music towards a result that I desired in the game.</td>
</tr>
<tr>
<td>3</td>
<td>Challenge</td>
<td>I felt a sense of challenge while creating music in the game.</td>
</tr>
<tr>
<td>4</td>
<td>Creativity</td>
<td>I found that the game helped me to be musically creative.</td>
</tr>
<tr>
<td>5</td>
<td>Competition</td>
<td>I felt that I had to compete against the game for creative control of the music.</td>
</tr>
<tr>
<td>6</td>
<td>Ownership</td>
<td>I felt a sense of ownership over the music created during my time playing the game.</td>
</tr>
</tbody>
</table>

Two additional hybridised questions were introduced into the second user study (Appendix A, Section 3, Questions 7 & 8). These were incorporated to further investigate unexpected participant insights relating to their implicit values and ontological criteria for “games”. I discuss this at length in Chapter 5 (5.2.3.1; 5.2.3.3; 5.3.1).
3.3.2.1 Concurrent Triangulation Design

The survey design is based on the “concurrent triangulation” (Creswell, 2009) approach to mixed methods data collection and analysis (see Figure 10). It allows for the concurrent collection of equally weighted quantitative and qualitative data to construct a broader understanding of player perceptions than would be afforded by either method alone (p. 205). This is a pragmatic measure: qualitative responses are vital to capturing rich insights about the player experience and their implicit aesthetic values, whilst the use of standard quantitative instruments allows for high-level comparisons both between the games and to established benchmarks (Bangor, Kortum, & Miller, 2009). The two data sources can then be compared to strengthen conclusions or contextualise the results.145

![Figure 10: Overview of my implementation of “concurrent triangulation” mixed methods design.](image)

For instance, any convergences or divergences between the quantitative and qualitative data (Creswell 2009, p. 213) can be used to reinterpret the findings, or even evaluate the methodological appropriateness of either approach.

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145 For instance, any convergences or divergences between the quantitative and qualitative data (Creswell 2009, p. 213) can be used to reinterpret the findings, or even evaluate the methodological appropriateness of either approach.
3.3.3 Analytical Methods

3.3.3.1 Quantitative Data

Data collected from the System Usability Survey (SUS herein) were used to produce mean scores for each game. The scores were compared to a global SUS benchmark of approximately seventy for “good” usability (Bangor et al., 2009) and a paired-samples t-test was conducted to test for significance\(^{146}\) between the games. Likert-scale responses to the six hybrid questions were numbered from one to five (Strongly Disagree = 1, Strongly Agree = 5) and used to calculate a mean response. Paired-samples t-tests were conducted for each question (see Table 5) to test for significance between games within the primary themes, such as musical control (3.3.1.2). I expect the use of parametric tests on the ordinal Likert-scale data to yield acceptably close representations of player responses, even if statistical assumptions like normal distribution are violated (Norman, 2010). Nonetheless, I have compared the frequency distribution of participant responses to capture divergence in player perceptions\(^{147}\) (Sullivan & Artino, 2013). In addition, each Likert response is also contextualised by the participant’s subsequent qualitative justification and their broader qualitative responses throughout the survey.

3.3.3.2 Qualitative Data

The qualitative data were categorised by participant, by question, and by conceptual theme to facilitate cross-examination and construct a detailed representation of player perceptions. The two free-form responses (Appendix A, Section 4) and the final extended comparison were used to identify underlying player values, such as the extent to which they prioritise challenge in games. Finally, the participants’ preferred game was used to contextualise all other survey data. For instance, a participant might rate Chase as a more usable system and more enjoyable game, but still ultimately prefer EvoMusic as a compositional experience. This ensures that any conclusions built from participant responses are interpreted in relation to their explicitly stated preference. These methods are derived from the generic inductive approach to qualitative analysis (Liu, 2016; Thomas, 2006), allowing an exploratory accounting of player experience via

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\(^{146}\) As per convention, I interpret significance as a confidence interval of 95% (\(\alpha = 0.05\)).

\(^{147}\) If responses are clustered at high and low extremes, then descriptive statistics such as mean and standard deviation will not fairly characterise the divided player perceptions (Sullivan & Artino, 2013).
description of the most prevalent and influential themes – whether presupposed (3.3.1.2) or emerging through the open-form responses. The methodological flexibility of this approach, as opposed to more defined traditions for qualitative theory construction, makes possible its integration into the mixed methods design (3.3.3.3).

3.3.3.3 Mixing Quantitative and Qualitative Data

Qualitative themes, both presupposed and emergent, were quantified by their frequency within participant responses; an approach Creswell (2009) describes as “integration”. This aids in the identification and analysis of the “most important themes” (Thomas, 2006) expressed by participants as per the generic inductive model. Salient qualitative quotes were also compared to each apparent quantitative finding – including those from the SUS responses – to support, disconfirm, or otherwise contextualise the results (Creswell, 2009). This addresses concerns for the use of Likert-scale metrics in the evaluation of musical HCI systems (Stowell et al., 2009) by reconciling the conclusions with rich qualitative insights using the player’s own language. In turn, the quantitative results allow for critical reflection on potential themes emerging during analysis of the qualitative responses. Together, the two data sources enable a detailed comparative evaluation of the games which makes possible a comprehensive accounting of the player experience of composing through competitive gameplay interactions.

3.4 Limitations and Delimitations

Digital games are an intensely multimodal medium, regarded by some ludomusicologists as the contemporary expression of the Gesamtkunstwerk (Greenfield-Casas, 2017; Moseley, 2016). This research does not investigate every arena of digital game design. I do not explore with any rigour the visuality of composition games, be it matters of interface design or visual aesthetics, nor do I consider issues such as auditory information display (Ng & Nesbitt, 2013) – which is sure to bear interesting challenges for compositional media. Similarly, neither the works nor user studies compare the potentials of alternative platforms such as mobile gaming.

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148 Creswell (2009) outlines three approaches to mixing quantitative and qualitative data: integrating, connecting, and embedding (pp. 207-8).
149 A German term used in aesthetics to describe a “total artwork” – one that synthesises many or all art forms, or strives to do so. The use of this term to describe digital games can refer to the multiple sensory modalities engaged (e.g. visual, auditory, haptic; see Moseley, 2016), or to the many artistic forms encompassed (e.g. ludic, musical, narrative, operatic, cinematic; see Greenfield-Casas, 2017).
or virtual reality (3.2.3.1), nor do they investigate the full diversity of music generation strategies available to digital composition games (3.2.3.2). Regarding the user studies, I do not specifically address established models of game engagement (Brockmyer et al., 2009), nor have I sought to capture broader phenomena now considered canonical to the gameplay experience, such as “Flow” (Csikszentmihályi, 1990; Sweetser & Wyeth, 2005). Finally, despite my overarching aim for the games to be accessible to musical novices (Error! Reference source not found.), I do not here explore the applications of digital composition games within educational (Chung & Wu, 2017) nor serious game (Abt, 1970) contexts.

In my view, understanding the player experience of composing within competitive game environments necessarily precedes these lines of inquiry. As such, this research first explores if there are potentials at all in competitive gameplay as a platform for musically accessible, single-user composition. The constrained scope of the original works and user studies appropriately models the intended interaction, and so enables a preliminary accounting of how competitive gameplay influences the perceived compositional experience – in particular, the player’s sense of musical control, creativity, and ownership. It is through such an accounting that we can take seriously the evaluation of competitive composition games as a novel design space. That we can reflect empirically on their potentials in light of the literature’s theoretical assumptions (2.7), and so come to a more grounded understanding. It is my aim with this research to provide an informed position from which future research and practice can explore the affordances of alternative interfaces, platforms, metacreative strategies, and contexts for competitive, game-based composition.

3.5 Chapter Summary

In this chapter, I have developed an exploratory, pragmatic methodology for addressing the research questions. I have outlined an iterative, mixed methods design (Figure 6) capable of reconciling literature, practitioner, and player perspectives in constructing an account of competitive composition games (3.1). I have discussed the conceptual (3.2.1) and technical (3.2.3) implementation of three creative works as adversarial metacreative games, outlined their varied methodological roles (3.2.2), and discussed my approach to their evaluation as systems and practice-research (3.2.4). I have also detailed the design (3.3.2) and analytic methods (3.3.3) employed in two comparative user studies.
conducted to evaluate the works and investigate how competitive gameplay influences the player’s compositional experience.

The remaining chapters follow the sequential implementation of my research design (Figure 6). Chapter 4 details the design of *EvoMusic* and *Chase* as an initial charting of the design space. Chapter 5 reports on a user study comparing these works and discusses salient implications for Phase Two. Chapter 6 outlines *Idea* as an exploration of novel themes from the first study, reflecting also on the dimensions and challenges revealed throughout the creative works’ development. Finally, Chapter 7 presents the results of a comparative study between *Idea* and *EvoMusic*, proposes recommendations for the nascent design space, and consolidates all findings to construct an understanding of the potentials of competitive, game-based composition.
Chapter 4: Creative Works – Phase One

This chapter presents *EvoMusic* and *Chase* as the first phase of creative research. I detail the gameplay mechanics, music system design, and competitive framework of each (4.1; 4.2) before comparing the games as contrasting implementations of competitive co-creation (4.3). I conclude with a discussion of practitioner insights generated through the development process, relating each to the design dimensions and challenges revealed through the literature review (4.4). Some contents of this chapter align with a number of papers published during this research (Studley et al., 2019; Studley, Drummond, et al., 2018; Studley et al., 2020), which each discuss the design of *EvoMusic* and *Chase* for varying purposes.\(^\text{150}\) A prototype concept for *EvoMusic* was also outlined as a demonstrative case in an earlier paper on the ontology of musically creative games (Studley, Vella, et al., 2018).

### 4.1 EvoMusic

#### 4.1.1 Overview

*EvoMusic* is a two-dimensional clicking game inspired by principles of mitosis and evolution. The player acts as a sonic gardener, curating the growth of an evolving population of musical “cells”. Each cell is assigned a discrete sonic event at an atomic scale – a single pitched tone, a lone percussion layer, or a short sound effect – which they intermittently produce while drifting around the game space (Figure 11). These events are organised by the music system into a metrically constrained musical output, which the novice player influences by removing or protecting particular sounds at the discretion of their own aesthetic goals. Each cell grows over time, eventually dividing into two new cells: one child inherits the sonic event of the parent, while the other is assigned a new event through a range of stochastic processes (4.1.3). This provides the novice user with a continually renewing stock of musical events to interact with, but also allows players to preserve any favoured sonic features as a means of shaping compositional identity over the course of gameplay. Crucially, the population’s growth

\(^{150}\) Studley, Drummond, et al. (2018) focuses on system design and implementation, Studley et al. (2019) discusses the works as metacreative systems, and Studley et al. (2020) presents the results of a comparative user study evaluating the games (see Chapter 5).
is inexorable, and so the player must persistently contest an inherent pull towards cacophony by “pruning” excess or unwanted sonic events. There is no objective means for the player to win or lose, nor a defined “end point” for the game session and thus composition. The player simply strives to attain, and then defend, a desired musical state against the system’s persistent dynamic of growth and complexification for as long as they desire. A video demonstration of interaction with EvoMusic is provided in the accompanying media (see “Creative Works”, p. xv).

4.1.2 Compositional Gameplay Mechanics

There are six “types” of cell in EvoMusic. A cell’s type determines the class of sonic event that may be assigned to it once instantiated (Table 6). Each play session is preceded by a pre-game settings menu (Figure 12) where the player configures: 1) the cell types used in-game; 2) the speed of cell growth, analogous to game “difficulty”; and 3) the initial tempo, metric, and harmonic constraints for the session. The game then commences with the player’s selection of a single starting cell, which grows and divides into two new cells, and so forth in an exponentially growing population. The player shapes this growth – and so the resulting musical output – by clicking on individual cells with a variety of tools or “abilities”. They can “lock” cells to temporarily halt growth and preserve favoured sonic content, “mutate” cells to hasten growth and
promote sonic variety,\textsuperscript{151} or outright “destroy” cells to remove unwanted sonic content as a staple of gameplay. To aid this interaction, cells flash when producing their assigned event so that the player can quickly decode the sonic identity of each cell to enact desired compositional interventions, such as removing an unwanted sound.

\textbf{Table 6:} Summary of the cell types in \textit{EvoMusic} and their sonic characteristics. \textit{Monophonic} cell types only allow one cell to produce its event at any given time. \textit{Polyphonic} cell types allow multiple cells to sound their event simultaneously.

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Appearance</th>
<th>Sonic Event Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melody</td>
<td>Yellow sphere</td>
<td>Short, pitched tones with sharp attack. Mid-to-high register. Monophonic.</td>
</tr>
<tr>
<td>Harmony</td>
<td>Pink sphere</td>
<td>Long, pitched tones with gradual attack and long sustain. Mid register. Polyphonic.</td>
</tr>
<tr>
<td>Bass</td>
<td>Red sphere</td>
<td>Low-register, pitched tones of varying duration. Monophonic.</td>
</tr>
<tr>
<td>Percussion</td>
<td>Green sphere</td>
<td>Stochastic rhythms on a single percussive layer for each cell, such as snares, woodblocks, or hi-hats. Polyphonic.</td>
</tr>
<tr>
<td>SFX</td>
<td>Blue sphere</td>
<td>Miscellaneous sound effects such as whistles, glass breaking, or beeping. Monophonic.</td>
</tr>
<tr>
<td>Destructive</td>
<td>Black cube</td>
<td>Cascading synthesiser with several short, dissonant tones. Polyphonic.</td>
</tr>
</tbody>
</table>

\textbf{Figure 12:} Pre-game settings menu in \textit{EvoMusic}.

\textsuperscript{151} When a cell is “mutated” by the player, its next division produces one child of different cell “type” with a different class of sonic event.
This design enables two distinct modes of compositional interaction. In the first, the player makes high-level, macro-musical decisions by using the pre-game settings menu to define the composition’s starting point and broad musical parameters. Here, the player acts as a gardener, planting the initial seed and defining the space in which it may grow. In the second, the player makes granular, micro-musical decisions by interacting with individual sonic events during live gameplay. Here, the player acts as a winnower, culling the populace in search of a desired musical crop. Only in this second mode, during live gameplay, is a competitive dynamic apparent between the player and system – the specific mechanisms for which are discussed further in (4.1.4). With regard to a compositional artefact, the player can record a WAV file from any point within the game session. They can also “save” the live state of gameplay, which creates a snapshot of the current cell population and their sonic events to be later resumed. Beyond providing traditional “saved game” functionality,\(^ {152}\) this allows players to preserve a favoured musical state as a constrained possibility space for dynamic re-listening.

**4.1.3 Music System Design**

Whenever a new cell is created, the music system (*Max*) assigns it an unused sonic event of the appropriate class; if the event is pitched, this obeys the player’s pre-defined harmonic constraint up until a certain population size (4.1.4). The *urn* object\(^ {153}\) is used to determine the specific content of each new event, such as its pitch or percussive timbre, as a simple random process. *Max* then treats the pool of currently active events as the parameters for music generation, performing them with stochastically determined order, timing, velocity, and duration. As such, the player’s gameplay interactions influence this pool of possible sonic resources rather than dictating their performance directly, recalling Herber’s (2008) notion of interacting through asynchronous “perturbations” as opposed to directly instrumental gestures (2.3.1.5).

*Max* maintains a separate, MIDI-based system for each cell class which organises the real-time performance of their currently active events. These systems differ to suit the musical needs of each class, so for brevity I will describe the “bass” cell (see Table 6)

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\(^{152}\) Most digital games allow players to “save” the progress of their game session to resume at a later time. However, this functionality is also commonly used to provide a “safe point” from which to experiment or fail. In the context of *EvoMusic*, players can revert to favourable musical states if they lose control of the piece or attempt a compositional intervention with which they are dissatisfied.

\(^{153}\) The *urn* object in *Max* outputs random, non-duplicate integers within a range. This functionality can be used to select from the unused sonic events (i.e. not currently assigned to any cell) at random.
system to exemplify the stochastic processes employed. A rhythmic treatment for each new bar is first generated. As visualised in Figure 14, this is organised by a basic generative grammar for which the stochastic weightings are determined by either first order markov chains\(^{154}\) or the size of the cell population, where a larger population encourages rhythmic density. Pitches are then stochastically assigned to the generated rhythm from the pool of active “bass” events. A velocity for each note is determined using the \textit{drunk} object,\(^{155}\) at which point the completed MIDI data is passed through software instruments and audio effect plug-ins for playback. The specific plug-ins used are determined by the player’s choice of a preset timbre for each cell class using an in-game settings menu (Figure 13). Every class system is centrally timed by Max’s metronome, following a tempo and metre chosen by the player prior to each game session (Figure 12). The player can also allow the tempo and metre to shift stochastically over time through the settings menu (Figure 13). In this case, metre transitions are determined by a predefined first order markov chain, whilst tempo moves gradually using the \textit{drunk} object (see footnote 155) at random time intervals.

\textbf{Figure 13}: Main Settings menu in \textit{EvoMusic}.

\(^{154}\) Note that the markov chain transition weightings were not calculated through analysis of musical input; I programmed these manually without any deliberate reference to a particular style or aesthetic.

\(^{155}\) The \textit{drunk} object in Max outputs random integers within a specified step range of the previous output with each successive generation. The intended metaphor is a “drunken” walk, moving gradually but inconsistently within a larger defined range.
Figure 14: Visualisation of the grammar used to generate rhythms for performing “Bass” cell events (left), with summaries of the stochastic process used at each decision level (right). Note: other metres are used in EvoMusic, but 3/4 metre allows the simplest visual representation.
4.1.4 Competitive Framework

The competitive framework in *EvoMusic* is multi-faceted. At its core is that the player persistently strives to realise and maintain a desired musical state amidst the system’s own musical interventions via population growth, and so a contest of compositional control emerges (3.2.1). However, population growth is also tied to an increasing chance that new sonic events will not conform to the player’s initially chosen harmonic constraints. The system thus exhibits an innate pull towards cacophony and textural complexity as the population bifurcates, providing an inexorable aesthetic trajectory for the player to compete against using in-game abilities – that is, by “destroying” unwanted cells, “locking” favourable cells, and so on. There are no hard-coded conditions by which the player may lose to this growth, nor any final means of victory against it. Instead, by responding promptly to new sonic events, the player can keep the population to a manageable size while pursuing a desired musical outcome or otherwise exploring the parameter space. The difficulty of this mechanic can be adjusted prior to gameplay (Figure 12) by altering the speed of cell growth, allowing more time to digest and respond to musical changes.

*EvoMusic* also incorporates more traditionally competitive game elements to support the core compositional contest described above. For one, each cell division risks the creation of “destructive” cells (see Table 6), which destroy “non-locked” cells upon collision and may disrupt the music if the player fails to promptly remove them. Additionally, all actions taken by the player consume “energy”, displayed as a vertical bar to the right of the interface (see Figure 11), which is only replenished by generating further music. I have included this “resource-management” (Costikyan, 2002) as a balancing mechanic to preserve the compositional contest. By preventing the player from freely creating or destroying cells ad infinitum, they are unable to entirely negate or overpower the system’s designed musical trajectory. This better cultivates the perception of an equal, gamified dialogue between the player and system as compositional forces, yet also enables a form of compositional strategy where players must prioritise interactions with cells that will best affect their aesthetic goals.

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156 For instance, there is no “game over” if the player fails to keep the cell population under a prescribed limit.
157 For comparison, *Soundrop* (2010) allows players to add or remove sound bars at leisure, as does *Pulsate* (2012) with its sound pulses.
4.1.4.1 Access, Competition, and Core Composition

A key aim of _EvoMusic_’s design is to engender compositional interactions that are both accessible to musical novices and closely integrated with the core competitive dynamic. For this reason, the relationship between player and system cannot be purely antagonistic, particularly as it concerns musical _control_. Rather, the game must facilitate a co-creative dialogue that resides at all times, and with each interaction, in a liminal space between collaboration and competition. _EvoMusic_ achieves this through the dual role of the population growth mechanic. As discussed, the music’s ceaseless growth lies at the heart of the player’s compositional contest with the game system. However, it is by this same mechanism that the novice player receives a continually renewing stock of sonic events to preserve, discard, and explore at their discretion. The system thus provides the musical resources and organisational constraints\(^\text{158}\) that allow non-experts to compose through gameful interactions, yet also challenges the player to actively maintain their creations in a co-creative contest. It is this holistic relationship that makes possible the positioning of accessible composition as _core_ (2.2.4.4) to the competitive game framework.

Several other elements in _EvoMusic_ contribute to this relationship. Most immediately, the absence of any defined win-loss conditions is designed to circumvent _ludocompositional dissonance_ and so ensure the primacy of compositional interaction. Further, the more traditional competitive elements that risk evoking this tension, such as the “destructive” cells, are both assigned sonic consequences and strategically linked to other elements in the compositional contest. Destructive cells not only destroy other potentially favourable musical events, but disrupt the sonic space with harsh, chromatic synthesiser cascades. Conversely, destructive cells are also an effective means of culling the musical populace if the player is running low on “energy”, and so can be used to enact compositional interventions. Finally, each cell division can result in a natural “mutation” in which one child cell spawns as a different cell type. The sonic variety promoted by this mechanic, as with the other elements discussed, will variably aid or oppose the player’s immediate musical intentions; mutation works against those who have attained a desired musical state, but in favour of players still exploring the

\(^{158}\) I use this in reference to the role of _Max_ in organising the timing, duration, and pitch of each individual sonic event within a metrically constrained framework, such that the musical output presents as generally agreeable to most novice players.
possibility space. By imbuing each of these mechanics with both accessible and competitive functions, the game system can shift freely and fluidly between the roles of compositional ally and opponent.

4.2 Chase

4.2.1 Overview

*Chase* is a first-person running game designed as a departure from *EvoMusic* in both its compositional control and treatment of the competitive game framework. The player is perpetually pursued by a red humanoid agent, the “Red Man” (Figure 15), over a three-dimensional gameworld comprising four interconnected environments. The Red Man’s present environment and proximity to the player influence the high-level parameters of stochastically generated music being produced in real-time throughout the game session (4.2.2). Having decoded these sonic relationships, the player strategically navigates the gameworld to manipulate the Red Man’s position and exert a broad compositional control. Like *EvoMusic’s* population growth, the Red Man’s pursuit of the player is relentless: the generated music rapidly approaches textural saturation unless the player strives to maintain a distance appropriate to affecting their desired musical state. Unique to *Chase*, however, is that the player can “lose” the game session if caught too often (4.2.4), presenting a more explicit ludic motivation than is realised within *EvoMusic*. A video demonstration of interaction with *Chase* is provided in the accompanying media (see “Creative Works”, p. xv).
4.2.2 Compositional Gameplay Mechanics

From the moment *Chase* begins, the Red Man launches a relentless pursuit of the player. With this in mind, the player’s primary compositional interaction involves strategically manipulating the Red Man’s position to influence high-level parameters of stochastically generated music. Tempo, velocity, and rhythmic density increase as the Red Man approaches – an easily decoded, one-to-many mapping broadly representative of musical “intensity”. Metric and harmonic constraints for generation also shift as the Red Man enters different environments (Table 7). Importantly, in-game movement is designed such that players can always gradually distance themselves from the Red Man should they strive to. Between this slight mechanical advantage, the Red Man’s dogged pursuit, and the readily deciphered sonic relationships in *Chase*, a novice player can experiment along simple musical dimensions by deftly navigating the game environment to redirect the Red Man.

The player loses “health” whenever they are caught by the Red Man, eventually leading to their death and loss of the game. New musical layers accumulate as this occurs, but also recede if the player restores health by collecting heart-shaped tokens distributed throughout the gameworld (Figure 16). The result is a risk-reward dynamic where the music grows more timbrally and texturally interesting in proportion to the danger of defeat (4.2.4). Several design elements aid the player in this engagement.
They receive a numerical indication of the Red Man’s proximity (Figure 15) and can enable a “rear-view mirror” display if desired. The generated music also pans in accordance with the Red Man’s position, serving a dual purpose as both an additional creative parameter and an auditory aid for locating the Red Man. Finally, the player begins at quite a distance from the Red Man upon entering the gameworld, affording a free selection of initial compositional “strategies” where the player might: 1) flee immediately in search of a different musical environment; 2) idle in anticipation of a particular musical texture before fleeing to maintain it; or 3) approach the Red Man willingly to explore new timbral combinations at the cost of increased danger.

**Table 7:** Summary of the musical treatment of environments in Chase. Note: harmonic treatments are followed by a scale degree formula and its equivalent as semitones from a given tonal centre.

<table>
<thead>
<tr>
<th>Environment</th>
<th>Metre</th>
<th>Harmonic Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>4/4</td>
<td>Major: 1-2-3-4-5-6-7; [0 2 4 5 7 9 11]</td>
</tr>
<tr>
<td>City</td>
<td>4/4</td>
<td>Harmonic Minor: 1-2-b3-4-5-b6-7; [0 2 3 5 7 8 11]</td>
</tr>
<tr>
<td>Snow</td>
<td>3/4</td>
<td>Lydian-Dominant: 1-2-3-#4-5-6-b7; [0 2 4 6 7 9 10]</td>
</tr>
<tr>
<td>Desert</td>
<td>3/4</td>
<td>Phrygian-Dominant: 1-b2-3-4-5-b6-b7; [0 1 4 5 7 8 10]</td>
</tr>
</tbody>
</table>

**Figure 16:** A collectible heart-token in Chase for replenishing player health.

Like EvoMusic, Chase affords compositional intervention through both pre-game parameter configuration and live gameplay interaction, of which only the latter supports
a dynamic of competitive co-creation (4.2.4). However, while *EvoMusic* divides high-
and low-level control between its pre-game settings and core gameplay respectively
(4.1.2), the only compositional decision enacted outside of *Chase*’s live gameplay is an
initial choice of which instruments will be used for the playback of generated music.
The sound world of *Chase* is rather constrained: rhythmic treatment is benign and
quantised, harmonic treatment is strictly confined to each environment’s mode (see
Table 7), and the timbral palette is comprised of familiar sonic identities enshrined in
the Western musical tradition, such as piano and orchestral strings. This polite sonic
treatment compounds with the easily apprehended game controls\(^{159}\) to ensure that *Chase*
presents as both compositionally and mechanically accessible. A WAV recording can
be captured from any point during gameplay, though the player cannot save the live
state of gameplay in the manner of *EvoMusic*.

4.2.3 Music System Design

In *Chase*, the music system has much greater responsibility over moment-to-moment,
note-level decisions. The player interacts with only high-level musical characteristics
using simplified, one-to-many mappings, as visualised in Figure 17. *Max* then generates
and performs musical content within these broad constraints. Each instrumental layer in
*Chase* is an individual sub-system which stochastically determines the pitch, velocity,
and duration for sonic events as MIDI data, to be passed through software instruments
and effects plug-ins for audio playback. A global chord system coordinates any pitched
content generated within these sub-systems, as follows:

1) Each beat has a probability of initiating a global chord transition, with individual
beat weightings dependent on the current metre.

2) Once initiated, a pre-defined first order markov chain decides the next global
chord within the harmonic constraint. A unique transition matrix is used for each
of the four available harmonic frameworks; for example, the weightings used for
the “Forest” environment are shown in Table 8.

3) Instrumental sub-systems obey the current global chord when generating pitched
content to ensure harmonic cohesion.

\(^{159}\) The control scheme used in *Chase* adheres to established conventions in first-person keyboard and
mouse games, such as using the WASD keys to move, Space to jump, and Shift to sprint. This allows
players to harness any existing proficiency with the platform for heightened compositional control.
Figure 17: Visualisation of the control mappings in Chase. Green represents live gameplay interaction, Yellow represents pre-game configuration, and Blue represents musical outcome.
Table 8: Markov transition table for Major key chord transitions in Chase. Values are rounded to 2 decimal places.

<table>
<thead>
<tr>
<th>From</th>
<th>I</th>
<th>ii</th>
<th>iii</th>
<th>IV</th>
<th>V</th>
<th>vi</th>
<th>vii°</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>-</td>
<td>0.09</td>
<td>0.04</td>
<td>0.31</td>
<td>0.39</td>
<td>0.16</td>
<td>-</td>
</tr>
<tr>
<td>ii</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.09</td>
<td>0.3</td>
<td>0.42</td>
<td>0.15</td>
</tr>
<tr>
<td>iii</td>
<td>0.04</td>
<td>0.11</td>
<td>-</td>
<td>0.52</td>
<td>-</td>
<td>0.33</td>
<td>-</td>
</tr>
<tr>
<td>IV</td>
<td>0.41</td>
<td>0.18</td>
<td>0.06</td>
<td>-</td>
<td>0.35</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>V</td>
<td>0.71</td>
<td>0.04</td>
<td>-</td>
<td>0.18</td>
<td>-</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>vi</td>
<td>0.19</td>
<td>0.19</td>
<td>0.19</td>
<td>0.19</td>
<td>0.19</td>
<td>-</td>
<td>0.03</td>
</tr>
<tr>
<td>vii°</td>
<td>0.8</td>
<td>-</td>
<td>0.12</td>
<td>-</td>
<td>-</td>
<td>0.08</td>
<td>-</td>
</tr>
</tbody>
</table>

The specific approach to note generation differs between sub-systems, but all involve simple rule-based and stochastic strategies. For instance, bass layers first generate a rhythm using a combination of generative grammars and first order markov chains similar to EvoMusic (Figure 14). Pre-defined weightings then determine which inversion of the current global chord should be performed for each rhythm using a velocity generated from a stochastic range that shifts higher as the Red Man approaches (Figure 17). Not all sub-systems are active simultaneously; only those currently activated by the player’s falling health value produce music, and an instrument can only be activated if chosen by the player in the pre-game menu. The immediacy of some mappings in Chase, such as the tempo rising with the Red Man’s proximity, frame the player’s interactions as markedly more “instrumental” than EvoMusic in Herber’s (2008) terms (2.3.1.5). However, due to the lack of granular control over individual pitch choice or articulation, these interactions more closely resemble “conducting” a performance of the player’s high-level harmonic, metric, and timbral decisions.

4.2.4 Competitive Framework

At its core, the compositional contest in Chase is conceptually similar to EvoMusic. The Red Man’s unrelenting pursuit of the player pulls the music inexorably towards textural saturation, which the player must variably resist or embrace to explore sonic outcomes. However, Chase also presents a more explicit ludic incentive via its objective “loss” condition: the depletion of player health. Naturally, this invites a greater risk of ludocompositional dissonance by introducing non-musical incentives for escaping the Red Man, such as avoiding “game over”, for which EvoMusic has no direct analogue. The player might flee the Red Man or seek out health-pickups (Figure 16) for
motivations unrelated to the musical outcomes of these interactions\textsuperscript{160} – or worse, in conflict with their desired musical outcome.\textsuperscript{161} A desire to alleviate this informed several design decisions in Chase. Firstly, there is no comparably objective means of “victory” to further detract from compositional motivations, nor is there any mechanism for defeating the Red Man; the player simply creates music for as long as they desire. Secondly, as with the destructive cells in EvoMusic (4.1.4.1), any mechanic used to satisfy the ludic goal of avoiding death has both an explicit musical function and a clear role within the core compositional contest for creative control. These measures enable Chase to explore a contrasting implementation of the competitive framework – one that harnesses an explicit ludic objective – without jeopardising the intended co-creative dialogue.

Chase also makes use of a balancing mechanic to ensure that the player does not command complete control over the system’s musical output in the manner of a tool. The player is afforded three modes of movement: walking, sprinting, and jumping. Outrunning the Red Man is crucial to the player’s compositional interventions, yet only sprinting and jumping are able to achieve this; at walking speed, players will inevitably be caught. Sprinting and jumping slowly consume “stamina”, displayed as a green bar to the top right of the interface (Figure 15), which if depleted restrains the player to a walk. Only while walking does stamina begin to recuperate, in turn risking capture and a ceding of control to the game’s natural musical trajectory of increasing rhythmic and textural saturation. As such, players must carefully manage the stamina resource to enact their compositional goals, providing a comparable balancing mechanism to the energy bar in EvoMusic (4.1.4). Rather than offering uncontested musical control, Chase and EvoMusic use ludic elements to gamify creative control itself, thus preserving the system’s role as a proactive collaborator and opponent (3.2.1).

\textsuperscript{160} An example would be picking up health to reduce the risk of defeat, rather than for want of fewer instrumental layers, which recede as the player regains health.

\textsuperscript{161} For instance, a player who desires the maximum instrumental layers and textural intensity, which requires being close to the Red Man and having low health, will also be incentivised to flee from the Red Man to avoid losing the game, thus lowering the musical intensity.
4.3 EvoMusic and Chase as Contrasting Implementations of Competitive Composition Games

4.3.1 Overview

As outlined prior (3.2.2.1), EvoMusic and Chase are designed as contrasting implementations of competitive, game-based composition. While both systems embody the central notion of a proactive co-creative opponent (3.2.1), they explore opposing poles of the design dimensions suggested by the literature review (2.7.2) to approach a preliminary charting of the design space. Their relationship can be summarised as follows: EvoMusic allows for deeper and more diverse musical control than Chase, but Chase more closely approaches a traditional competitive game framework. Here, I position the games along each design dimension to unpack their contrasting approaches in detail (4.3.2). A visual summary is provided in section 4.3.3.

4.3.2 Design Dimensions in EvoMusic and Chase

4.3.2.1 Paidia versus Ludus

EvoMusic and Chase exhibit a common ludic tendency by virtue of the system’s role as a variably antagonistic compositional force. Players use their gameplay interactions in an effort to maintain authorial control amidst the system’s own compositional gestures, engendering a basic premise of ludus as contest. Both games also employ mechanics and iconography related to resource-management,162 a prototypical component of many competitive designs (Costikyan, 2002). However, the presence of a defined “loss” condition in Chase, and its resultant extramusical incentives, invokes a more explicit rendering of ludus akin to traditional competitive game structures. Further to this, the contest in Chase is predicated on a more literal “combat” where the player may be figuratively “harmed” and “killed” by the Red Man; the destructive cells in EvoMusic, the closest analogue, are not so direct. As such, EvoMusic can be considered as comparatively paidic when juxtaposed with Chase’s more explicit game framework.

4.3.2.2 Mixing versus Making

EvoMusic affords atomised command over musical content at a granular level, such that players can selectively nurture or suppress individual sonic events. The larger co-

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162 EvoMusic features an “energy” bar (4.1.4), whilst Chase utilises a health and stamina bar (4.2.4).
creative system resembles a gamified genetic strategy with the player’s musical tastes serving as a fitness function. In *Chase*, the player harnesses only a single in-game control input – movement through the environment – to influence multiple high-level musical characteristics including rhythmic density, the harmonic framework, and general intensity as represented by tempo, velocity, and ensemble size. Given that *EvoMusic* also allows for these high-level compositional decisions via pre-game parameter configuration, *Chase* cedes far less responsibility over the final musical outcome to the player. Whilst both games exhibit compositionality, the deeper control and increased authorial responsibility afforded by *EvoMusic* more explicitly characterises music making interactions (2.3.1.3). Comparatively, *Chase* approaches musical mixing interactions (2.3.1.3) through its lack of low-level intervention.

4.3.2.3 Core versus Peripheral

I have endeavoured with both designs to ensure that the player’s competitive gameplay interactions are closely integrated with their compositional decision-making, and vice versa. Nonetheless, the possibility of “losing” in *Chase* presents extramusical incentives that risk a reframing of compositional decisions as peripheral to satisfying the ludic objective of evading capture in each moment of interaction. This is not without purpose: along with enabling a more explicit expression of *ludus*, the use of a defined loss condition in *Chase* but not in *EvoMusic* allows for a comparison of how the player’s compositional experience is influenced by the introduction of purely ludic incentives. To this end, *EvoMusic* better characterises a core integration of compositional and competitive interactions.

4.3.2.4 Instrument versus Composition

Neither *EvoMusic* nor *Chase* offer the predictability or expressive range that underpins paradigmatically instrument-based interaction. Still, *Chase* may be characterised as more instrumental than *EvoMusic* due to the player’s comparatively immediate and somewhat performative control over parameters such as tempo and velocity. In *EvoMusic*, the player’s interactions with the cell population influence the musical output asynchronously: gameplay choices are “perturbations” within the system, the sonic results of which only become fully apparent over time as the population grows.

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163 Sonic events selected as favourable by the player are preserved to produce similar events and grow to prominence within the composition. Unfavourable sounds do not survive the player’s selection.
and the pool of musical events are stochastically organised into an ongoing performance. In *Chase*, the single input of player movement dictates the tempo, velocity, and metre of the system’s stochastic performance with immediately discernible results, thus influencing the musical output synchronously as akin to a “conductor”. In Herber’s (2008) terms (2.3.1.5), then, *EvoMusic* more closely approaches prototypical *composition* than the comparatively *instrument*-based interaction of *Chase*.

4.3.2.5 Abstract versus Explicit Representation

*EvoMusic* employs quite an explicit visual representation of sonic content and behaviour. Each atomic sound resource is embodied as an individual object that perambulates the game space, colour-coded by musical type to allow an immediate visual overview of the composition’s textural constitution. Objects flash whenever their musical event is performed to make clear their sonic identity. This is also accompanied by a brief graphical overlay representing the event’s duration in standard notational iconography, such as a quaver. Comparatively, the visual interface for *Chase* is heavily abstracted from its resultant musical output. The Red Man’s in-game proximity represents near all musical characteristics under the player’s influence, and no conventional musical iconography is used. Instrumental layers are only visually linked to the player’s depleting health bar, which offers no indication as to the level of activity within each layer as allowed by *EvoMusic*’s colour-coded cells. *Chase* focuses instead on game iconography, such as the use of “hearts” for health-pickups, to reinforce its intentionally ludic character in contrast to *EvoMusic*.

4.3.2.6 Metacreative Autonomy

Both games initiate their own musical gestures, but only *EvoMusic* displays a change in its musical behaviour over time. Although the musical output of *Chase* is ever shifting, the system’s inherent musical trajectory remains static over the course of a game session: it only strives to “intensify”. In contrast, *EvoMusic* exhibits two behavioural states which the system initiates at its own probabilistic discretion: 1) “grow”, the default state whereby the cell population bifurcates to approach musical complexity; and 2) “consume”, prompted by the unpredictable creation of a destructive cell which rapidly destroys other cells and so begins to simplify and replace the musical output. With reference to the Eigenfeldt et al. (2013) taxonomy of metacreative autonomy (2.6.1.1), *Chase* thus represents *proactivity* (level 4) while *EvoMusic* exhibits
adaptability (level 5). Alternatively, one might consider Chase as somewhat more autonomous than EvoMusic, as the music system in Chase assumes far greater responsibility for the low-level organisation of sonic content. This presents a difference in degree, rather than kind, of autonomy: while only EvoMusic exhibits adaptability, Chase can be perhaps be characterised as more proactive than EvoMusic.

4.3.3 Visual Summary: EvoMusic and Chase

The following (Figure 18) is a visualisation of how EvoMusic and Chase, and so the contrasting approaches they embody, are positioned along the design dimensions pertinent to competitive composition games. Their spatial placement does not adhere to any scale; it is simply a visual reference for summarising the contrast between the two designs. A similar visualisation incorporating the third original composition game, Idea, is provided in section 6.3.3.

Figure 18: Visual comparison of design dimensions in EvoMusic and Chase; E (blue) = EvoMusic, C (red) = Chase.
4.4 Practitioner Insights: Phase One

I conclude this chapter with a discussion of the preliminary design insights gained through my development of *EvoMusic* and *Chase*. While I elaborate on these themes following a discussion of *Idea’s* design (6.4.1), they are introduced here as a preface and point of comparison to the player perspectives revealed in the first user study (Chapter 5).

4.4.1 On the Tension between Competitive Gameplay and Composition

At all stages of developing the games, from early conceptualisation to implementation and play-testing, I have contended with palpable tensions between the design aims of competitive gameplay and interactive composition. These are well captured by Figure 18, which shows that *Chase*, as the more explicitly ludic design (4.3.2.1), also seems likely to offer the less desirable compositional experience: *EvoMusic* affords deeper control (4.3.2.2), achieves a better representation of *compositional interaction* (4.3.2.4), and exhibits a closer integration of compositional processes into the core competitive gameplay loop (4.3.2.3). This is distinct from the *aesthetic* disparities expressed by Kassabian and Jarman and others (2.3.4.1). There are serious *mechanical* challenges to reconciling competitive and compositional interaction within a holistic single-player experience. These tensions, first suggested by my review of related media (2.5), were made explicit through my design process.

4.4.1.1 Ludocompositional Dissonance: Modes of Interaction and their Expectations

In playing *Chase*, I find that the danger of losing encourages a division of the experience into two discrete modes of interaction – competing and composing – which, though oscillating freely throughout the session, are never quite synthesised as “competitive composition”. I find both modes enjoyable, but experience them nonetheless as separate mindsets informing distinct decision-making processes. This relationship is no surprise, reflecting the challenge of *ludocompositional dissonance* (2.2.4.5) that I have discussed at length herein. Comparatively, I find *EvoMusic* to more readily fuse competitive and compositional motivations due to its lack of extramusical objectives diverting my attention. Each compositional act is a competitive move and vice versa, and so I view interaction with *EvoMusic* as more conducive to expressing musical creativity. Crucially, though, I also find *EvoMusic* to be less enjoyable than *Chase* from a pure gameplay perspective, owing in no small part to the absence of a
defined ludic obstacle to motivate my engagement. Whilst this likely stems from my own tastes in competitive gameplay, it suggests nonetheless that avoiding extramusical ludic incentives to ensure a focus on composition – as Dolphin (2014) has described (2.3.4.2) – could also detract from the system’s value as a “game”. I do not bring such expectations to my interactions with non-competitive designs such as Soundrop and Electroplankton. It is perhaps the case, then, that by exhibiting a competitive dynamic at all, a composition game would inherently invite comparison to more traditional ludic designs and so be caught between conflicting expectations for gameful and compositional experiences that are not easily satisfied without undermining the other.

4.4.1.2 Control, Contest, Autonomy, and Access

From a design standpoint, I also find significant tensions in balancing matters of musical control and accessibility within the context of competitive gameplay. Providing convincing control metaphors is already a key challenge for designers of interactive music systems (Drummond, 2009). Typically, those designed for musical novices need also constrain their output for the user’s benefit whilst still maintaining illusions of satisfactory control (Jordà, 2003) and compositional novelty.164 Blaine and Forlines (2002), for instance, describe forfeiting a level of musical expressivity to focus on accessible game interaction and sonic cohesion. Complicating these aims in my own works is a further aspiration for the system to act as a proactive, co-creative opponent; as with the conflicting modes of competitive and compositional interaction, approaching one aim seems often to undermine another. What results is a looming tension between the design goals of control, accessibility, competition, and system autonomy, navigating which requires a series of challenging compromises at the mechanical level.

Foremost, a clear difficulty of my approach to compositional contest – competing for creative control (3.2.1) – is that any mechanics for making the system more competitive tend also to impede the player’s influence over the musical output. One solution might be to ensure a complexity of deep control inputs for several musical parameters, yet this invites the issue of remaining accessible to musical novices (Blaine & Forlines, 2002; Jordà, 2003). No matter the compromise chosen, affording the player greater command over the musical output in turn incentivises a less autonomous, and so less

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164 That is, a novice should be able to influence the system in predictable ways to enact a desired outcome, yet also explore and experiment within the system to discover novel outcomes beyond their expertise that they could not normally model or create.
compositionally competitive system. Further, attempts to circumvent these tensions by instead deriving contest from an extramusical ludic objective, as I have done with Chase, seem only to evoke a separate mechanical tension between the player’s ludic and compositional motivations (4.4.1.1). A serious challenge, then, is to facilitate an engaging competitive dialogue that is not simply peripheral to compositional decisions while also offering accessible, yet creatively satisfying, musical control. My first two games make diverging compromises in this regard. Chase greatly sacrifices depth of control to focus on accessible interaction and conventional competitive gameplay. EvoMusic more readily balances control and competition, but is harder to use and understand as a result, even if still musically accessible by most standards. My aim is to realise two contrasting approaches which, through their comparative evaluation (Chapter 5), can explore how players value and prioritise musical control, system usability, and competitive gameplay in such environments. It is my hope that participant insights will offer some guidance as to an appropriate balance for future designs.

4.4.2 On the Temporal Incentives of Composing via Competitive Gameplay

I have always found the best competitive gameplay experiences to possess a unique temporality; a sensation of thinking and acting faster than real-time, perhaps born from the “rush” of challenge or an absorption into the Flow state (1.4.3.1; 2.2.3.3). Crucial to this experience is system responsiveness; an immediacy and accuracy of information display which Salen and Zimmerman (2003) encapsulate as the core game design principle of discernibility. Exhibiting discernible input-output relationships is a common goal of interactive music systems, though I have found the context of competitive gameplay to invite particular temporal incentives when devising the system’s compositional affordances. More so than in non-competitive settings, players require timely feedback on the sonic outcome of their actions so that they may promptly respond to the system’s competing musical gestures: in EvoMusic, for instance, players need to quickly identify and delete unfavourable cells before they grow to dominate the composition. This incentivises the use of shorter musical gestures that take less to time to listen to, model, and subsequently act upon. The use of more gradually unfolding gestures and perturbations, though not strictly precluded by the temporal demands of competitive gameplay, are in turn disincentivised. From this, a new tension arises by which competitive gameplay seems inherently predisposed to instrument-based, rather than composition-based, interactions.
Of course, a designer might facilitate musical responses of greater duration by increasing the time between actions to slow the “pace” of competition. In games like Chess, which has enjoyed several sonifications (1.6.1.2; 1.6.1.7), the contest is predicated upon far-reaching strategic decisions that may occur up to several minutes apart. This slower pace presents a stark contrast to the continual stream of input necessitated by a design such as Chase, granting the scope for longer musical gestures that are more paradigmatically composition-based. I have endeavoured to strike this balance in EvoMusic via asynchronous compositional interventions (4.3.2.4), though the temporal pressures of population growth, as the competitive force, have nonetheless encouraged a sound world predicated upon quickly digestible musical gestures. Chase, on the other hand, relies unabashedly on short, simple, and immediately apparent musical gestures (e.g. changing tempo, velocity) appropriate to its more severe time pressure of a literal pursuit. Even so, the faster and more responsive gameplay of Chase is also more conducive to the temporal exhilaration that I so value in competitive games.\footnote{This contributes substantially to my view of Chase offering the more engaging ludic experience.} As such, potential designers in this space should be: 1) attentive to the compositional incentives emerging from the particular temporality of their chosen form of competitive gameplay; and 2) prepared to negotiate a compromise between their expectations for each.

\section*{4.5 Chapter Summary}

This chapter has introduced EvoMusic and Chase as two contrasting implementations of competitive, game-based composition for single, novice users. EvoMusic allows for deeper and more diverse musical control than Chase, while Chase more closely embodies a traditional competitive game framework. I have detailed the gameplay mechanics, music systems, and competitive dynamics for each (4.1-4.2) and situated their contrasting approaches along design dimensions pertinent to competitive composition games (4.3). This concludes in a discussion of practitioner insights generated through the design process (4.4), highlighting a series of tensions and challenges to be negotiated in designing for competitive, game-based composition:

- Extramusical ludic objectives support more engaging competitive play, but detract from a focus on compositional interaction (4.4.1.1).
Musical accessibility, creative control, and competitive engagement share a delicate balance, where designing for one may detract from another (4.4.1.2).

Different forms of competitive gameplay possess unique temporalities that incentivise particular musical mappings and sonic gestures (4.4.2).

The comparative evaluation of the games in the first user study (Chapter 5) reflects on these challenges and the success of each approach.
Chapter 5: Results and Discussion – Phase One

This chapter discusses the results of a comparative user study (n=24) evaluating *EvoMusic* and *Chase* as an exploration of the player experience of composing within competitive game environments. I outline the study’s design and participant cohort (5.1) before reporting on the results as organised by salient themes (5.2). I then discuss key player insights with reference to the literature and practitioner perspectives outlined thus far (5.3), addressing finally the research questions through a series of design recommendations for competitive composition games (5.3.4). Some contents of this chapter align with an article published in *Organised Sound* for the express purpose of reporting these results (Studley et al., 2020).

5.1 Study Overview

The user study aims to capture player perceptions of musical creativity, control, and ownership to better understand how these notions are influenced by competitive game environments. The study design and analysis methods have been detailed prior (3.3.2-3.3.3); to summarise here, each session is attended by a single participant and is structured as follows:

1) Participant completes five closed questions (either polar or 5-point Likert-scale) relating to their past experience with music and games (Appendix A, Section 1).
2) Participant plays either *EvoMusic* or *Chase* (randomly assigned) for approximately 20 to 30 minutes, including a short built-in tutorial.\(^\text{166}\)
3) Participant responds to the System Usability Scale (Appendix A, Section 2).
4) Participant answers six hybridised questions relating to a set of pre-supposed themes (3.3.1.2); each involves a 5-point Likert-Scale response and short written elaboration (Appendix A, Section 3, Questions 1 to 6).
5) Participant completes two open form responses, identifying what they most enjoyed and suggesting areas for improvement (Appendix A, Section 4).
6) Participant plays the remaining game for approximately 20 to 30 minutes before repeating steps 3 to 5 with reference to the second game.

\(^{166}\) Participants played the games on a MacBook Pro (15-inch, 2016) using the in-built keyboard, an external wireless mouse, and wired headphones (Sennheiser HD 280 Pro) for audio output.
Participant concludes by completing an extended, open-ended comparison between EvoMusic and Chase, nominating a preferred game, if any, and justifying their position (Appendix A, Section 8).

5.1.1 Participant Cohort

A total of 24 participants were anonymously recruited from the undergraduate student cohort at the University of Newcastle, Australia under an HREC approved human ethics protocol. All 24 participants identified as gamers, with four (16.7%) also identifying as musicians. No meaningful comparison can be drawn between the two participant categories due to the small sample size of musicians (n=4) and the fact that all musicians were also gamers. A potential bias is also present as all but two participants (91.7%) described their gaming proficiency as “developed” and reported playing digital games more than three times per week on average. I do not consider this problematic because:

1) Gamers are the primary target audience for my original works, and so reflect an authentic use context as crucial to evaluating musical HCI systems (Stowell et al., 2009).

2) Proficient gamers are presumed to have a richer set of implicit criteria for evaluating game-based systems and interactions than non-gamers: these values, and the perceptions they inform, are central to unpacking the experience of competitive, game-based composition.

No further demographics were collected as they are inapplicable to the research aims and questions (1.2).

5.2 Results

The results of the user study (n=24) are best characterised as divided. This refers not only to participant reception of EvoMusic and Chase, but to an intriguing variety of often conflicting perceptions and values revealed. To best articulate this, my reporting of results is structured as follows:

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167 The protocol is entitled “Evaluating game-based applications for real-time interactive music composition” (H-2018-0510), approved by the Human Research Ethics Committee on 20 February, 2019.
168 “Developed” was option four on a 5-point Likert-scale question (Appendix A, Section 1, Question 5), with the highest proficiency being “expert”.

131
1) The general reception of the games is outlined to provide context (5.2.1);

2) Participant perceptions pertaining to the pre-supposed themes (3.3.1.2) of musical creativity, control, contest, and ownership are compared between games (5.2.2);

3) Player insights regarding the interplay of these themes with the traditional game framework are detailed (5.2.3); and

4) The results are summarised to construct an overall characterisation of each contrasting work and highlight the more successful approach (5.2.4).

5.2.1 General Reception

EvoMusic was the clearly preferred experience when detached from any specific criteria or framing. In the final qualitative comparison, fifteen participants (63\%)\textsuperscript{169} nominated EvoMusic as their explicit preference, six (25\%) nominated Chase, and three (13\%) specified that their preference was dependent on their perceived purpose for playing between music creation (EvoMusic) and gameplay enjoyment (Chase); see Figure 19. This was the first indication of a recurring sentiment in the survey results: that EvoMusic is a more effective compositional experience, while Chase is more successful as a traditional “game”. This dichotomy aligns with the design assumptions detailed prior (4.3): that EvoMusic affords deeper musical control, but Chase more authentically captures a competitive game framework. Six participants (25\%) articulated this relationship in the final comparison, as exemplified by the following excerpts:

\begin{quote}
Chase was more fun, but as a music creation game EvoMusic gave me more variety of sound and more control. (Participant 1)
\end{quote}

\begin{quote}
I preferred Chase on a gameplay standard and EvoMusic on a creativity and music standard. (Participant 3)
\end{quote}

There was also strong support for each sentiment individually. In the final comparison, nineteen participants (79\%) explicitly stated that EvoMusic afforded a greater sense of musical control, creativity, or ownership than Chase, with only two (8\%) suggesting the opposite. Similarly, six participants (25\%) specified a preference for the gameplay of Chase over EvoMusic, with only one (4\%) dissenting opinion. These sentiments are revisited throughout the results discussion.

\textsuperscript{169} All percentages are rounded to the nearest whole integer due to the small sample size (n=24). Tables are rounded to 1 decimal place.
Figure 19: Comparison of preferred game in the final response (Appendix A, Section 8) by participant experience. “Variable Preference” denotes a participant whose preference shifts with their motivation for interacting, between music creation and gameplay enjoyment.

5.2.2 Primary Themes

Each of the pre-supposed themes (3.3.1.2) are addressed through an individual question involving both a Likert-scale and short qualitative response (see Table 9); the exception is usability, addressed through completion of the System Usability Scale (SUS). Quantitative data from these six hybrid questions are summarised in Table 10, with a graphical comparison given in Figure 20. Paired sample t-tests were conducted to compare these results for each theme reported between EvoMusic and Chase. Significant differences were found between EvoMusic and Chase in musical creativity and ownership, with EvoMusic scoring significantly higher in both cases (Table 10). The qualitative responses offer crucial further context, as discussed in the following organisational categories: system control (5.2.2.1), musical creativity (5.2.2.2), compositional contest (5.2.2.3), and ownership (5.2.2.4). In each section, I outline the quantitative data before contextualising with pertinent qualitative responses to construct a representation of player perspectives.
Table 9: Summary of Questions 1-6 for Section 3 of the user studies. The themes are discussed in section 3.3.1.2. *Note: Likert-scale responses to question 1 are: 1 = Game had total control, 2 = Game had most control, 3 = Balance between the game and I, 4 = I had most control, 5 = I had total control.

<table>
<thead>
<tr>
<th>№</th>
<th>Theme</th>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Balance*</td>
<td>How would you describe your level of creative control over the music in the game?</td>
</tr>
<tr>
<td>2</td>
<td>Control</td>
<td>It was easy to direct the music towards a result that I desired in the game.</td>
</tr>
<tr>
<td>3</td>
<td>Challenge</td>
<td>I felt a sense of challenge while creating music in the game.</td>
</tr>
<tr>
<td>4</td>
<td>Creativity</td>
<td>I found that the game helped me to be musically creative.</td>
</tr>
<tr>
<td>5</td>
<td>Competition</td>
<td>I felt that I had to compete against the game for creative control of the music.</td>
</tr>
<tr>
<td>6</td>
<td>Ownership</td>
<td>I felt a sense of ownership over the music created during my time playing the game.</td>
</tr>
</tbody>
</table>

Table 10: Statistical comparisons between EvoMusic and Chase for Likert-scale responses to Questions 1-6 (Appendix A, Section 3). Note: one participant did not answer Question 6.

<table>
<thead>
<tr>
<th>Question</th>
<th>EvoMusic</th>
<th>Chase</th>
<th>Paired-samples t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>1 (balance)</td>
<td>3.08</td>
<td>0.88</td>
<td>2.83</td>
</tr>
<tr>
<td>2 (control)</td>
<td>3.29</td>
<td>1.27</td>
<td>3.21</td>
</tr>
<tr>
<td>3 (challenge)</td>
<td>3.08</td>
<td>1.02</td>
<td>2.79</td>
</tr>
<tr>
<td>4 (creativity)</td>
<td>3.96</td>
<td>0.95</td>
<td>2.83</td>
</tr>
<tr>
<td>5 (competition)</td>
<td>3.29</td>
<td>1.00</td>
<td>3.00</td>
</tr>
<tr>
<td>6 (ownership)</td>
<td>3.09</td>
<td>1.04</td>
<td>2.13</td>
</tr>
</tbody>
</table>

Figure 20: Comparison of mean Likert-scale scores in EvoMusic and Chase (Appendix A, Section 3). Error bars show standard deviation; p-value is shown for significant differences found with paired-samples t-tests.
5.2.2.1 System Control

5.2.2.1.1 Balance

A paired-samples t-test conducted to compare the balance of compositional control between the player and system (Table 10: Question 1) found no significant difference between the *EvoMusic* (M=3.08, SD=0.88) and *Chase* (M=2.83, SD=0.92) conditions; t(23)=1.1867, p = 0.247. The rather central mean responses would at first indicate success in achieving a balance between the player’s and game’s authorial control, as intended for the compositional contest to emerge (3.2.1; 4.1.4; 4.2.4). However, qualitative responses show that this balance was valorised quite differently amongst participants, as evident in these responses to *EvoMusic*:

- I controlled the type and tempo of the music whereas the game randomly enhanced that music. (Participant 11)
- Couldn’t pick specific notes to add or remove. Multiplied out of control after a while. (Participant 17)

5.2.2.1.2 Usability and Access

Both games achieved an acceptable usability rating, meeting the established SUS benchmark of “around seventy” (Bangor et al., 2009) and suggesting that both were appropriately accessible to the largely non-musician cohort. Further, a paired-samples t-test comparing the SUS scores found a significant difference between *EvoMusic* (M=70.94, SD=15.76) and *Chase* (M=80.0, SD=13.85); t(23)=2.1594, p = 0.0415. This suggests *Chase* as the easier game to understand and operate, and by the extension the more accessible to musical novices. However, responses on the subject of compositional control (5.2.2.1.3) indicate that *usability* should be considered a distinct, and even potentially competing, design goal to musical control.

Four participants (17%) throughout the qualitative responses described *EvoMusic* as a valuable point of access to composition\(^\text{170}\) with one participant (4%) expressing the same for *Chase*:

- It gave me (who has no experience making music) an easy way to understand and control my recordings. (Participant 22: *Chase*)

\(^{170}\) Note that neither the musical accessibility nor pedagogical value of *EvoMusic* and *Chase* were specifically investigated through any survey question; participants raised these sentiments unprompted.
I always thought I was tone deaf and struggled in music classes to make any sort of beat. But this felt like I was making it and it sounded good to myself. (Participant 23: EvoMusic)

Three of these participants (13%) even found pedagogical value in EvoMusic:

I found it a good way to learn a bit of music theory in a fun medium. (Participant 18)

I enjoyed how it taught you a little about music specifically seeing how certain elements contributed to others. (Participant 24)

…it’s fun to play, could be an effective learning tool for people who are less experienced with musical composition. (Participant 5)

Most salient, though, is that both games were perceived as accessible to musical novices.

5.2.2.1.3 Compositional Control

A paired-samples t-test to compare the ease of creative control (Table 10: Question 2) found no significant difference for the EvoMusic (M=3.29, SD=1.27) and Chase (M=3.21, SD=1.22) conditions; t(23)=0.2490, p = 0.806. There was also a wide distribution in response frequency (see Table 11), indicating that general perceptions on creative control were polarised.

Table 11: Compared frequency distributions of responses to Question 2 (Appendix A, Section 3): “It was easy to direct the music towards a result that I desired”.

<table>
<thead>
<tr>
<th>Responses (n = 24)</th>
<th>Distribution (EvoMusic)</th>
<th>% (EvoMusic)</th>
<th>Distribution (Chase)</th>
<th>% (Chase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>2</td>
<td>8.3</td>
<td>2</td>
<td>8.3</td>
</tr>
<tr>
<td>Disagree</td>
<td>6</td>
<td>25</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>3</td>
<td>12.5</td>
<td>4</td>
<td>16.7</td>
</tr>
<tr>
<td>Agree</td>
<td>9</td>
<td>37.5</td>
<td>9</td>
<td>37.5</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>4</td>
<td>16.7</td>
<td>3</td>
<td>12.5</td>
</tr>
</tbody>
</table>

Qualitative responses reveal a complex interrelationship between usability, balance, and creative control. Despite Chase having higher reported usability, eighteen participants (75%) described it as affording “limited” musical control in at least one response, with most signalling a desire for additional control inputs or command over more diverse musical dimensions than tempo and density. In contrast, EvoMusic is consistently characterised as offering deeper compositional control at the cost of its more complex operation, as indicated between the following responses:
You have fairly fine control which helps reinforce that your decisions are affecting the music itself on a granular level. (Participant 10)

Micro-managing a screen full of notes even with all the tools was challenging. (Participant 2)

Given also that seventeen participants (71%) awarded superior musical control to *EvoMusic* in the final comparison (Appendix A, Section 8), the implication is that players value deep and diverse compositional control even at the expense of general usability. Exemplifying this is participant fifteen, who scored *EvoMusic* as low as 30 on the SUS, compared to *Chase* at 75, whilst still electing *EvoMusic* as their preferred game with the following justification:

I preferred *EvoMusic*. Players have more control over the music it generates and had more variance. (Participant 15)

As a separate consideration, the stochastic nature of the music generation and gameplay in *EvoMusic* was framed as a hindrance to compositional control by eight participants (33%), as reflected in the excerpts below. Twelve participants (50%) also indicated a desire to define pitch precisely, rather than through the stochastic process of growth and mutation. This perceived “randomness” within *EvoMusic* is a recurring subject throughout the qualitative data.

Growth was random, as was the introduction of new notes. There was no way I could make the tune I wanted. (Participant 15)

The randomness of the game means that a desired result cannot be achieved. (Participant 11)

5.2.2.2 Musical Creativity

A paired-samples t-test comparing the level of musical creativity experienced by players (Table 10: Question 4) found a significant difference between the *EvoMusic* (M=3.96, SD=0.95) and *Chase* (M=2.83, SD=1.13) conditions; t(23)=5.1224, p < 0.0001. It is notable that nineteen participants (79%), including all four musicians, either “agreed” or “strongly agreed” that *EvoMusic* helped them to be musically creative (see Table 12).

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171 “Random” and “randomness” was the language most often used by participants, as shown in the excerpts above.
This not only supports the representation of *EvoMusic* as the superior compositional experience, but also offers a vital contextualisation of wider responses.\(^\text{172}\)

**Table 12**: Compared frequency distributions of responses to Question 4 (Appendix A, Section 3): “I found that EvoMusic/Chase helped me to be musically creative”.

<table>
<thead>
<tr>
<th>Responses (n = 24)</th>
<th>Distribution <em>(EvoMusic)</em></th>
<th>% <em>(EvoMusic)</em></th>
<th>Distribution <em>(Chase)</em></th>
<th>% <em>(Chase)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>Disagree</td>
<td>3</td>
<td>12.5</td>
<td>8</td>
<td>33.3</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>2</td>
<td>8.3</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>Agree</td>
<td>12</td>
<td>50</td>
<td>10</td>
<td>41.7</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>7</td>
<td>29.2</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Qualitative responses revealed that player perceptions of creativity were influenced by multiple factors. For one, a lacking sense of creativity in *Chase* was explicitly attributed to the absence of fine musical control by eleven participants (46%), reiterating the importance of compositional *control* as a player value. Further, the stochastic nature of *EvoMusic* was framed as helpful to exploring new sonic outcomes by six participants (25%), as shown in the following excerpts:

*EvoMusic* randomly spawning cells was good to combine sounds and notes I had not before chosen to combine. (Participant 5)

The mutation element may allow for a player to discover a combination of cells that work well together and therefore help their creative process. (Participant 21)

Interestingly, this contrasts with the reported negative influence of randomness on the player’s sense of creative control (5.2.2.1.3). In fact, two participants (8%) expressed both sentiments between separate responses. Additional factors influencing creativity pertain to player conceptions of the traditional game framework (5.2.3).

5.2.2.3 Compositional Contest

5.2.2.3.1 Competition

The player’s perception of a co-creative contest with the game system is of critical interest to this research. A paired-samples t-test comparing the level of compositional *competition* (Table 10: Question 5) found no significant difference for the *EvoMusic*

\(^\text{172}\) That is, when extracting design insights, any theme or characteristic for which *EvoMusic* was rated as less successful than *Chase* should be contextualised by the fact that *EvoMusic* was also perceived as more conducive to musical creativity.
(M=3.29, SD=1.00) and Chase (M=3.00, SD=1.10) conditions; t(23)=1.0707, p = 0.295. However, the qualitative data revealed that this was a poor representation of participant perception. For instance, seven participants (29%) interpreted “competing against the game” (see Table 9, Question 5) as referring to their reported struggles with the interface, or limited musical control, rather than the nature of any human-computer co-creative dialogue, rendering the quantitative data inconsistent.

Despite this, qualitative responses still indicate that EvoMusic was more successful in eliciting a sense of specifically compositional contest. A total of eighteen participants (75%) identified this sense in EvoMusic, compared to only twelve (50%) in Chase. Crucially, sixteen participants (67%) attributed the compositional contest in EvoMusic to either the random mutation or exponential bifurcation of the cell population, validating the aforementioned assumption that a creative contest could emerge from designing an inexorable musical trajectory into gameplay (3.2.1). The following excerpts exemplify these perceptions:

The random nature of the generation resulted in a constant battle between the program and the user if the user wanted to take creative control over the output. (Participant 5)

The challenge of creating a nice beat from random sounds and trying to preserve the life span of the cells was fun. (Participant 9)

Of course, not all participants who identified the intended compositional contest described it as an enjoyable or desirable dynamic. This is linked to broader perceptions of challenge and its implicit value to each player (5.2.3.2; 5.2.3.3).

5.2.2.3.2 Challenge

A paired-samples t-test to compare the level of challenge while creating music (Table 10: Question 3) found no significant difference for the EvoMusic (M=3.08, SD=1.02) and Chase (M=2.79, SD=1.18) conditions; t(23)=1.1272, p = 0.271. As with competition, however, this quantitative comparison fails to capture the rich divergence in participant values reflected in the qualitative responses. To begin, as shown by the wide frequency distribution of responses (Table 13), there was great difference in the perceived level of challenge itself. Participants then exhibited contrasting valorisations for each perceived level of challenge; in Chase, for instance, a low level of challenge was variably framed as beneficial and detrimental to gameplay enjoyment:
I don’t believe there was a high amount of challenge in this game. The task is laid out very easily and other users would find this to be simple and fun. (Participant 19)

This was the only limiting factor of the game I felt no urge or challenge when the “red man” got close as the sprint/stamina function felt near-infinite and his speed was slower than mine. Perhaps other obstacles or better balancing to increase challenge? (Participant 24)

Table 13: Compared frequency distributions of responses to Question 3 (Appendix A, Section 3): “I felt a sense of challenge while creating music in EvoMusic/Chase”.

<table>
<thead>
<tr>
<th>Responses (n = 24)</th>
<th>Distribution (EvoMusic)</th>
<th>% (EvoMusic)</th>
<th>Distribution (Chase)</th>
<th>% (Chase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>1</td>
<td>4.2</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>Disagree</td>
<td>7</td>
<td>29.2</td>
<td>9</td>
<td>37.5</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>6</td>
<td>25</td>
<td>3</td>
<td>12.5</td>
</tr>
<tr>
<td>Agree</td>
<td>9</td>
<td>37.5</td>
<td>8</td>
<td>33.3</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>1</td>
<td>4.2</td>
<td>1</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Many responses, as those above, addressed *challenge* in this extramusical sense: evaluating the “difficulty” of the ludic structure rather than the nature of any compositional dialogue. For those who did focus on the compositional implications, *challenge* manifested in varied forms. Some noted a challenge in managing the simultaneous compositional and ludic tasks, recalling the notion of *ludocompositional dissonance* (2.2.4.5; 4.4.1.1):

> Just running away from something while creating music was challenging. (Participant 3)

Others described the aesthetics of *challenge*, such as stress, but found it to enhance their experience through its synchrony with the system’s musical trajectory of growing more intense as the Red Man approaches:

> Losing track of the red man felt a little stressful when he could jump out from around a corner, but I feel that added more as the music got more animous [sic].₁⁷³ (Participant 12)

Most crucially, though, participant discussion of *challenge* revealed a complex interplay with perceptions of musical *control* that appears to be informed by varying expectations and criteria for ludic and compositional experiences (4.4.1.1). I unpack these sentiments further in (5.2.3.2).

₁⁷³ I have interpreted the participant’s intended meaning to be “animated” (i.e. lively, fast, loud).
5.2.2.4 Ownership

Both quantitative and qualitative data demonstrated unequivocally that *Chase* did not instil participants with a sense of ownership over the game’s musical output. The paired-samples t-test comparing the level of ownership (Table 10: Question 6) found a significant difference between the *EvoMusic* ($M=3.09$, $SD=1.04$) and *Chase* ($M=2.17$, $SD=1.27$) conditions; $t(22)=3.7607$, $p = 0.0011$. The fact that nine participants (39%) “strongly disagreed” with *Chase* engendering ownership (see Table 14) provided critical context to the game’s persistently cited lack of musical *control*. Eight participants (33%) expressed that *Chase* was “just creating its own music”, with four participants (17%) even suggesting that the music felt pre-generated or pre-composed as shown in the excerpts below. This further highlighted musical control as perhaps the most influential and highly valued design dimension for game-based composition.

I feel like most of the generated music was done before the player ever loads in. (Participant 15)

The music sounded pre-composed, rather than me picking how it would sound exactly, i.e. the notes used. (Participant 20)

Ownership was also shown to be influenced by the recurring subject of randomness in *EvoMusic*. Five participants (21%) indicated that the stochastic design inhibited ownership, while two participants (8%) instead framed randomness as empowering it:

I felt a lack of ownership from the inability to choose notes. (Participant 5)

The fact that I was creating cool beats from random sounds gave it a unique feel which gave me somewhat a feeling of ownership. (Participant 9)

Finally, the diversity of sentiments raised by single participants highlighted the complexity of factors influencing perceived ownership in these settings. Participant three signalled that ownership was tied to an ongoing appraisal of the music’s quality, participant six suggested that ownership was influenced by the player’s gaming proficiency, participant 24 attributed ownership to the ability to record and name the musical output, and participant seven even suggested that the game medium itself delegitimised the act of composition.

You feel ownership when the music sounds good but as soon as one bad sound spawns that feeling is gone. (Participant 3)
I wasn’t good enough at it to produce anything legible. (Participant 6)

By having the ability to save, record and importantly name the music and scenarios created, I had a sense of ownership over the game’s music. (Participant 24)

I felt as if I was playing a game with created sound more than serious composition of music. (Participant 7)

Table 14: Compared frequency distributions of responses to Question 6 (Appendix A, Section 3): “I felt a sense of ownership over the music created during my time playing EvoMusic/Chase”. Note: one participant did not answer this question.

<table>
<thead>
<tr>
<th>Responses (n = 23)</th>
<th>Distribution (EvoMusic)</th>
<th>% (EvoMusic)</th>
<th>Distribution (Chase)</th>
<th>% (Chase)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>1</td>
<td>4.3</td>
<td>9</td>
<td>39.1</td>
</tr>
<tr>
<td>Disagree</td>
<td>7</td>
<td>30.4</td>
<td>7</td>
<td>30.4</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>5</td>
<td>21.7</td>
<td>2</td>
<td>8.7</td>
</tr>
<tr>
<td>Agree</td>
<td>9</td>
<td>39.1</td>
<td>4</td>
<td>17.4</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>1</td>
<td>4.3</td>
<td>1</td>
<td>4.3</td>
</tr>
</tbody>
</table>

5.2.3 Game Framework

Elements of the broader game framework, such as challenge and ludic goals, were a recurring subject throughout the qualitative responses. These design elements, and the participants’ varied expectations for each, were shown to influence the perceived compositional experience through diverse and often antagonistic relationships.

5.2.3.1 Ludic Goals and the Compositional Experience

Three of the six participants (50%) who nominated Chase as their preferred game explicitly attributed this to their perception of a clear ludic goal, which was avoiding the Red Man. While this supported the aforementioned design assumption that Chase better approaches a traditional game framework (4.3.1), there was a more complex interplay between ludic goals and the compositional experience to be unpacked. The responses of participant thirteen exemplified this, suggesting that the lack of a ludic goal in EvoMusic inhibited control and competition, yet also partially aided creativity:

May have been able to take more control or felt I had more control if given a specific goal. (Participant 13)

I don’t feel there was a challenge. Again – no goal set for player. Apart from creating a nice sound, which is a more esoteric goal. (Participant 13)
No boundaries tended to help creativity but also left me feeling lost without a specific goal to achieve. (Participant 13)

Also notable are the emphatic responses of participant eight, who suggested that the absence of goals in *EvoMusic* not only disqualified it as a “game”, but would inhibit the enjoyment of other players:

The game has no goals! It’s a good music software, but it is not a good game! (Participant 8)

As I said, this game needs a goal! Whether it is eliminate black boxes, or score, or something else. Players won’t like a game without goals. (Participant 8)

The implication here is that music creation was too “esoteric” of a motivation to serve as a game’s primary goal in the traditional ludic sense, in turn devaluing the gameplay experience. However, participants 12 and 22 offered a critical dissent in the final comparison (Appendix A, Section 8). They suggested that the absence of a ludic goal in *EvoMusic* actually strengthened it as a platform for composition, whereas the goal in *Chase* potentially confused its purpose:

*Chase* feels like there should be some other goal apart from the music. *EvoMusic* feels like the music is the goal. (Participant 12)

I also feel it [*EvoMusic*] was a better platform for music creation, as *Chase* the main focus was to not be hit and die, then secondly was the music creation. *EvoMusic* was focused on making music first. (Participant 22)

In this vein, three participants (13%) suggested that the ludic goal of avoiding the Red Man in *Chase* eclipsed compositional considerations, even reducing their concern for the musical output to its competitive function:

Game didn’t feel as if the music was the focus. It was only there to tell you where the red man was. (Participant 16)

Forgot that I was controlling the music for a while as I only aimed to avoid the Red Man. (Participant 17)

This again recalls the notion of *ludocompositional dissonance* (2.2.4.5), indicating a design tension between musical creativity and the incentives of competitive gameplay.
5.2.3.2 Ludic Challenge and Musical Control

There was evidence of a similar complex interplay between musical control and ludic challenge. The option to pause the Red Man in *Chase* exemplified this: nine participants (38%) stated that the pause function reduced or even negated the challenge in *Chase*, while eight participants (33%), seven of which were the same, found it critical to creative control. Two of these participants (8%) even suggested removing the pause functionality to increase the level of challenge, indicating a preference for challenging gameplay experiences over ease of compositional control. These positions were captured by the following excerpts:

> The option to pause the Red Man was the most crucial point to allowing control over the music. (Participant 14)

> Only sense of challenge was being chased by the Red Man which could be completely negated by pressing pause. Remove pause button. (Participant 13)

The implication is that ludic challenge and musical control have a somewhat inverse relationship in the context of game-based composition, supporting the aforementioned mechanical tension (4.4.1.2) whereby designing for one may detract from the other. Participant three articulated this relationship in their primary suggestion for improving *EvoMusic* (Appendix A, Section 4, Question 2):

> A bit more challenging without taking control of music away from player. (Participant 3)

This challenge-control tension mirrors the interplay between ludic goals and the system’s effectiveness as a platform for composition (5.2.3.1). That designing for either challenge or ludic goals might have detracted from the compositional experience is emblematic of deeper conceptual tensions between interactive composition and competitive gameplay; I will discuss this shortly (5.3.1; 5.3.3).

5.2.3.3 Player Values and Preferred Design

A comparison of participant justifications when nominating their preferred game (Appendix A, Section 8) highlights the diverse values for gameful and compositional experiences held between players. For the fifteen participants (67%) preferring *EvoMusic*, justifications were centred on the compositional experience (Table 15).
These notably included the game’s clear “focus” on musical creation (5.2.3.1) as well as its heightened elements of musical control, creativity, and ownership. In particular, the frequent attribution of EvoMusic’s increased creative control (Table 15) affirmed it as perhaps the most influential design dimension for game-based composition (5.2.2.1.3; 5.2.2.2; 5.2.2.4; 5.2.3.2).

**Table 15:** Frequency of participant justifications for preferring EvoMusic. Note: some participants expressed multiple justifications.

<table>
<thead>
<tr>
<th>Justification</th>
<th>Frequency</th>
<th>% of participants preferring EvoMusic (15)</th>
<th>% of total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musical control</td>
<td>10</td>
<td>66.7</td>
<td>42</td>
</tr>
<tr>
<td>Musical “variety”</td>
<td>3</td>
<td>20</td>
<td>12.5</td>
</tr>
<tr>
<td>“Focus” on musical creation</td>
<td>3</td>
<td>20</td>
<td>12.5</td>
</tr>
<tr>
<td>Creativity</td>
<td>2</td>
<td>13.3</td>
<td>8.3</td>
</tr>
<tr>
<td>Ownership</td>
<td>1</td>
<td>6.7</td>
<td>4.2</td>
</tr>
<tr>
<td>Simplicity</td>
<td>1</td>
<td>6.7</td>
<td>4.2</td>
</tr>
<tr>
<td>Complexity</td>
<td>1</td>
<td>6.7</td>
<td>4.2</td>
</tr>
<tr>
<td>Pedagogical value</td>
<td>1</td>
<td>6.7</td>
<td>4.2</td>
</tr>
</tbody>
</table>

In contrast, the six participants (25%) preferring Chase focused on aspects of the ludic structure or gameplay experience itself (Table 16). This included both formal elements, such as ludic goals, and high-level preferences for Chase’s interaction metaphor or visual aesthetic. The one dissenting participant (4%) who preferred Chase as a musical experience described it as affording the more pleasing musical output and more easily comprehensible musical control, the latter of which they again attributed to the issue of “randomness” in EvoMusic (5.2.2.1.3; 5.2.2.2; 5.2.2.4):

I understood more about how my actions as the author/player affected my musical creation than in EvoMusic…It had no random occurrences that affected the creation of music. (Participant 14)

**Table 16:** Frequency of participant justifications for preferring Chase. Note: some participants expressed multiple justifications.

<table>
<thead>
<tr>
<th>Justification</th>
<th>Frequency</th>
<th>% of participants preferring Chase (6)</th>
<th>% of total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ludic goals</td>
<td>3</td>
<td>50</td>
<td>12.5</td>
</tr>
<tr>
<td>Gameplay</td>
<td>3</td>
<td>50</td>
<td>12.5</td>
</tr>
<tr>
<td>Graphics</td>
<td>1</td>
<td>16.7</td>
<td>4.2</td>
</tr>
<tr>
<td>Musical control</td>
<td>1</td>
<td>16.7</td>
<td>4.2</td>
</tr>
<tr>
<td>Quality of music output</td>
<td>1</td>
<td>16.7</td>
<td>4.2</td>
</tr>
</tbody>
</table>
The implication is that *EvoMusic* would appeal to players who prioritise the compositional experience over the conventional elements and expectations of competitive digital games, with the inverse being applicable to *Chase*. This division into two distinct audiences, and in turn player value sets, was supported unanimously by the three participants (13%) who instead described a fluid preference that shifted with their desired purpose for interacting with the systems:

*EvoMusic* while giving the player more of a sense of creative control and ownership of the music created, lacked in the sense of a challenge. *Chase* gave the player a massive challenge compared to *EvoMusic* but the music creation was severely lacking. Based on this I preferred *Chase* on a gameplay standard and *EvoMusic* on a creativity and music standard. (Participant 3)

As a tool for musical composition, *EvoMusic* was stronger and gave more creative control. As a game, *Chase* provided more entertainment but I did not feel it was a “music game” I was playing. These games have very obviously different target audiences. (Participant 5)

Both were great. *EvoMusic* is more for making music I believe. A lot more variety and such. *Chase* would be good for content creators. (Participant 23)

This not only offers a useful characterisation of *EvoMusic* and *Chase* as contrasting design approaches, but affirms the design tensions between competitive and compositional gameplay interactions (5.2.3.1; 5.2.3.2).

### 5.2.3.4 Modes of Composition: Pre-Game Parameter Configuration

Both *EvoMusic* and *Chase* offer two modes of composition: “live” and “pre-game” (4.1.2, 4.2.2). Qualitative responses highlighted the distribution of musical decision-making between these two modes as an influential factor in shaping participant perceptions. With *EvoMusic*, thirteen participants (54%) noted that the pre-game settings – which are used to define high-level musical parameters for each game session (4.1.2) – were integral to their perceptions of compositional control. Of these thirteen participants, three (13%) also linked these pre-game configurations to a sense of ownership and four (17%) found that they engender creativity, as exemplified below:

The settings allowed complete customisability with all of the elements in the game which resulted in the potential for creativity. (Participant 24)
I set up the framework for the music even if I was not always in control of how it shaped. I could opt out of particular types of sounds, making it feel less random and that it was mine. (Participant 17)

Two participants (8%) went further, suggesting that the pre-game settings were either more important for creative control than in-game interactions (e.g. manipulating cells) or even the only avenue for control:

The initial settings before the actual game begins gives the player much more control over the sound than their actions in game. (Participant 6)

The only aspect that allowed you to direct the music was at the start you could choose which sounds and instruments show up in game. (Participant 4)

As discussed prior (4.1.2), this pre-game mode of composition occurs externally to the intended competitive dynamic between player and system. It involves asynchronous compositional decisions which are distinct from live gameplay despite influencing its musical outcomes. That these non-competitive, pre-game affordances had such a strong weighting on the perceived compositional experience offers a vital reflection on the tensions and design challenges of composing through competitive gameplay. This is particularly evident when considering that Chase, which offers comparatively minimal pre-game parameter configuration (4.2.2), was framed by seventeen participants (71%) as affording inferior control.

5.2.4 Summary of Results

The results of the user study present clear and contrasting characterisations of each game. EvoMusic unequivocally presented the more successful composition experience: it engendered musical creativity (5.2.2.2), afforded a higher level of compositional control (5.2.2.1.3), and was the clearly preferred system for these reasons (5.2.3.3). EvoMusic was also more successful at eliciting a compositional contest between the player and system (5.2.2.3.1), with eighteen of the twenty-four participants (75%) expressly identifying the intended competitive dialogue. Chase, in contrast, was a more successful game in the delimited ludic sense: it had more enjoyable gameplay (5.2.3.3), was easier to use and understand (5.2.2.1.2), and exhibited defined goals (5.2.3.1). However, Chase was also decisively characterised as the weaker compositional experience, affording only limited creative control (5.2.2.1.3) and widely failing to
evokes a sense of ownership in players (5.2.2.4). It was also less successful at inspiring a sense of human-computer contest (5.2.2.3.1), with only twelve participants (50%) identifying the intended compositional dialogue. To summarise their relationship: EvoMusic was preferred for music creation, Chase was preferred for gameplay.

5.2.4.1 Significant Quantitative Results
Statistically significant\textsuperscript{174} results from the paired-samples t-tests comparing EvoMusic and Chase are as follows:

- In perceived musical creativity, EvoMusic (M=3.96, SD=0.95) rated higher than Chase (M=2.83, SD=1.13); \( t(23)=5.1224, p < 0.0001 \)
- In perceived ownership of the musical output, EvoMusic (M=3.09, SD=1.04) rated higher than Chase (M=2.17, SD=1.27); \( t(22)=3.7607, p = 0.0011 \)
- In perceived system usability, Chase (M=80.0, SD=13.85) rated higher than EvoMusic (M=70.94, SD=15.76); \( t(23)=2.1594, p = 0.0415 \)

Each of the above conclusions were strongly supported by qualitative responses and so are taken as accurate representations of player experience. It should be noted, however, that the parametric tests did not effectively capture participant perceptions of themes with diverse underlying values, such as competition (5.2.2.3.1) and challenge (5.2.2.3.2).

5.3 Discussion
The diversity of player experience captured by the user study offers substantial insight into the challenges and potentials of composing through competitive gameplay. In unpacking this, I first characterise the salient player insights (5.3.1) to explore their implications for the design assumptions held in the literature (5.3.2). I then discuss how these insights relate to my practitioner findings (5.3.3), concluding with preliminary design recommendations consolidated from the three perspectives (5.3.4).

5.3.1 Constructing Player Insights
Participant responses provided clear characterisations of EvoMusic and Chase (5.2.4). Players articulated the strengths and weaknesses of each design and, by extension, of the two contrasting approaches to competitive, game-based composition that they

\textsuperscript{174} The threshold for significance was set at a confidence interval of 95\% (\( \alpha = 0.05 \)).
embody (4.3). Furthermore, these characterisations were overwhelmingly consistent between participants; despite diverging perceptions on individual themes such as *challenge*, there was scarce dissent on the characterisations of *EvoMusic* and *Chase* as the superior compositional and competitive gameplay experiences respectively (5.2.1). These consistent characterisations, along with the clear indication of *EvoMusic* as the more successful design overall, allowed for the construction of relationships between themes and design dimensions that few individual participants articulated in their entirety. For instance, a design tension between musical accessibility and compositional control may be interpreted from *Chase*’s consistent characterisation as being easier to use, learn, and understand, but also offering limited musical control as compared to *EvoMusic*. Though favouring participants’ explicit language where possible, I have used this approach to construct a representation of player insights appropriate for interrogating literature perspectives (5.3.2) and my own practitioner findings (5.3.3) on designing competitive composition games.

At the broadest scale, the games’ contrasting characterisations implicitly align compositionality with *paidic* interaction. *Chase* was framed as the more ludic design but weaker compositional experience, while *EvoMusic* emerged as the weaker game but stronger composition system. Already this highlights a conceptual tension between musical creation and competitive gameplay, reflecting also the characterisations of composition as *paidic* within the literature (2.3.3). A depth and diversity of musical control appeared to be the most influential factor shaping both compositional perceptions and overall design preference. *EvoMusic*, with its uncontested attribution of deeper compositional control, was not only the preferred design, but was specifically chosen for its superior control at several times the frequency of any other consideration (5.2.3.3; Table 15). *Chase* was attributed with greater system usability, more enjoyable gameplay, and the more defined competitive game framework, yet was still only explicitly preferred by a quarter of participants (5.2.1). The implication is that compositional control is valued above these design elements, and perhaps even at their expense.

While these may seem redundant insights to designers of interactive composition systems, there are more complex conceptual relationships to be navigated. First, there is a significant tension between providing creative control and meeting the diverse player expectations for competitive gameplay experiences. The fact that seven participants...
(29%) described the “pause” feature as simultaneously crucial to control and detrimental to a sense of challenge and competition (5.2.3.2) frames these two design goals as seemingly polarised; at least, within the context of my chosen approach (3.2.1). It is notable, then, that six participants (25%) expressed a desire for greater challenge between the games, with two players even suggesting that the “pause” feature be removed entirely to accommodate this – despite their acknowledgement of its importance to exerting compositional control. The implication is that players variably value compositional or competitive game interaction over the other, presenting a significant design challenge given that they seem opposed.

This was also reflected in perceptions of ludic goals (5.2.3.1), with the preferences of some players even bordering on ontological criteria. Having taken a Wittgensteinian (1953 [2010]) approach to games (2.1.3), I had not expected such formal distinctions to emerge in participants, infrequent though they were. Chase contains only a loss-condition with no objective means of victory, yet even this partial goal structure was enough to attract the preference of a small cohort of players, with participant eight even asserting that “good” games require goals (5.2.3.1). Conversely, other participants preferred EvoMusic’s lack of ludic goals for allowing a “focus” on compositional interaction in the manner described by Dolphin (2014) (2.3.4.2). In fact, participant seven implied that to position music creation within a game at all delegitimises the act of composition:

I did not feel ownership over the music as it was evident to me that it was a significant element of the game. I felt as if I was playing a game with created sound more than serious composition of music. (Participant 7)

Once more this illuminates the diversity and complexity of underlying values informing player experience in this novel context. While diverse player tastes are simply an immutable reality of game design, the fact that a variable penchant for challenge and musical creativity could so comprehensively shape player perceptions is a crucial consideration for designers (5.3.4.3).

Despite these clear tensions, the successes of EvoMusic should not be overlooked. Given that sixteen participants (75%) identified the intended compositional contest between player and system (5.2.2.3.1), the strong consensus that EvoMusic still engendered musical creativity (5.2.2.2) suggests that there are indeed latent potentials for interactive composition within competitive game environments. Most crucially,
fourteen participants (58%) expressed both sentiments, describing *EvoMusic* as simultaneously creative and compositionally competitive. This insight is key: for at least some types of players, composition and competitive gameplay could be reconciled within a musically accessible, single-user system.

5.3.1.1 Summary of Constructed Player Insights

Below is a summary of the salient insights I have constructed from participant responses. Note that the following are general characterisations of participant experience, as perceptions are divided for many themes:

- Preferred compositional experiences were more *paidic* than preferred competitive gameplay experiences.
- Musical *control* was the most influential design dimension shaping player perceptions and preference.
- Deep musical *control* was often prioritised over system *usability*, game *challenge*, and the competitive game framework.
- There were mechanical design tensions between composition and competitive gameplay, with the prime examples being:
  - Increasing either musical *control* or the level of *challenge* may inversely detract from the other; and
  - Ludic goals distracted from a focus on composition, but strengthened the competitive gameplay experience.
- Players variably prioritised competitive or musically creative interactions over the other within composition game contexts.
- Players had diverse criteria and expectations for desirable gameplay and compositional experiences.
- For select types of players, musical creativity and competitive gameplay could be reconciled in an accessible, single-user design.

Further, the broader design approach represented by *EvoMusic* – which focused on granular control and compositionality with only a limited, abstract competitive framework – was suggested as being:

- More successful in engendering a compositional contest between player and system;
- More successful in reconciling musical creativity and competitive gameplay; and
• The preferred experience overall, despite being a weaker gameplay experience.

5.3.2 Reflecting on Literature Perspectives

Much of the insights revealed through the user study support the prevailing literature perspective of a conceptual disparity between musical creation and competitive gameplay. However, the literature thus far has yet to capture the complexity of these tensions, address the diversity of player preferences, and take seriously the creative potentials that lie between. In particular, the results of the study highlighted a crucial distinction in how mechanical and aesthetic tensions were reflected in the player experience.175

5.3.2.1 On Literature Perceptions of Mechanical Tension

The study results offered clear support for the mechanical design tension anticipated by Dolphin (2014): that the presence of objectively fixed ludic goals, such as avoiding death, may distract from the compositional primacy of the experience (2.3.4.2) or otherwise confuse its purpose for certain player types. While I too found this to be intuitive from a practitioner perspective (4.4.1.1), participant responses crucially affirmed that this ludocompositional dissonance was not merely a theoretical assumption, but a tangible tension occurring within the player experience itself (5.2.3.1). Other mechanical tensions highlighted by the study, such as the inverse relationship of musical control with ludic challenge (5.2.3.2), were also supportive of Kassabian and Jarman’s (2016) more broadly conceived incongruity between composition and competitive gameplay – though only insofar as a specifically mechanical critique.

5.3.2.2 On Literature Perceptions of Aesthetic Tensions

Participant responses did not support literature assumptions of an aesthetic tension between compositional and competitive game interaction (2.3.4.1; 2.3.4.2), even contradicting them in certain cases. To begin, though, there were some notable alignments between player and literature characterisations. That the preferred compositional experience (EvoMusic) was characterised as the more paidic design (5.3.1) reflects the ludomusical mappings of Austin (2016a) and Kassabian and Jarman

175 Note that the discussion in this section relies heavily on the meanings of “mechanics” and “aesthetics” as set out in Hunicke et al. (2004). I have summarised their distinction prior (2.2.3.1).
(2016), which frame musical creativity more broadly as a paidic activity (2.3.3).

Further, I am confident that the participants’ preference for EvoMusic as an overall experience would be shared by the designers and scholars I have reviewed thus far. Exemplifying this is the anonymous reviewer of my submission to the 7th International Workshop on Musical Metacreativity (Studley et al., 2019), who showed a positive and negative reception to EvoMusic and Chase respectively:

The red man chasing the player will induce a fear/flight-type of response, which is not something we associate with any type of art or creativity. (Reviewer, regarding Chase)

I buy this gameplay mechanic! In contrast to Chase, it feels as if the user could with skill and persistence create something they would feel a sense of ownership over. (Reviewer, regarding EvoMusic)

The reviewer was not critiquing that Chase is mechanically competitive, as they enjoyed these elements within EvoMusic; they took issue specifically with the aesthetic experience that Chase was believed to induce. It is here that player experience diverged from literature perspectives.

Among participants, there was no opposition towards the conventional aesthetic experiences of competition or challenge (2.2.3.2). In fact, feelings of stress, pressure, anxiety, intensity, or fear were scarcely mentioned, save for brief allusions as desirable experiences. The excerpts below demonstrate this, with keywords placed in bold for emphasis:

Losing track of the red man felt a little stressful when he could jump out from around a corner, but I feel that added more as the music got more animous [sic].\(^\text{176}\) (Participant 12)

I preferred Chase over EvoMusic…EvoMusic did not have the intensity or the flair of Chase (Participant 11).

The new concepts of sound production implemented into a videogame. The fluid movement and controls. The sense of intensity while the chaser was close to me. (Participant 6, asked which features they most enjoyed about Chase)

\(^{176}\) I have interpreted the participant’s intended meaning to be “animated” (i.e. lively, fast, loud).
The closest support for a supposed *aesthetic* incongruity was *Chase*’s broader characterisation as an inferior compositional experience, yet this was primarily attributed to its limited musical *control* – a critique at the *mechanics* level. A related sentiment is expressed by Dolphin (2.3.4.2) and Kassabian and Jarman (2.3.4.1), who suggest that aesthetics of challenge and competition are unconducive more specifically to *accessible* music-making interaction. Not only did both games meet an acceptable usability benchmark (5.2.2.1.2), but *Chase*, as the more competitive experience, was characterised as being easier to use and understand. Once more, then, participant responses did not reflect the literature’s *aesthetic* concerns for competitive composition. Perhaps the clearest evidence for this is that *EvoMusic* was described as conducive to both musical creativity and co-creative contest by 58% of participants (5.3.1).

To clarify, little in the participant responses suggested that competitive game environments were any more conducive to interactive composition than their non-competitive counterparts. They simply highlighted that players have diverse tastes, values, and expectations for gameful experiences. It is this complexity that scholars and designers have failed to address in their *aesthetic* opposition to competitive composition games, despite being reflected in the limited psychological investigations of competitive musical creativity (2.4.3). That the competitive and creative interactions of *EvoMusic* could be reconciled for fourteen participants (58%) shows that we should not broadly assume an aesthetic incongruity between them, intuitive though it may seem to some designers and composers. While the appropriate balance between the two is likely unique to each player, it is in these unexplored perceptions that new design potentials may be found.

5.3.2.3 Summary of Literature Reflections

Player insights offered distinctly contrasting reflections on the two design assumptions prevalent in the literature (2.7.1), as outlined below:

A1) “The presence of competitive *mechanics*, such as points, goals, or win-loss conditions, detracts from a focus on compositional interactions”.

  o Player experience supported the *mechanical* tension expressed by Dolphin (2.3.4.2) and Wang (2.3.3.3), which may be described as *ludocompositional dissonance* (2.2.4.5).
• Player experience also highlighted additional mechanical tensions unaddressed in the literature, such as the potentially inverse relationship between musical control and challenge (5.2.3.2).

A2) “The aesthetic experience of competitive gameplay, such as challenge, conflict, or pressure, is unconducive to musical creation”.

• Player experience offered no clear support for the aesthetic incongruity presumed by Dolphin (2.3.4.2) and Kassabian and Jarman (2.3.4.1).

• Players had diverse tastes and expectations for competitive gameplay which are unaddressed within the literature’s aesthetic assumptions.

To summarise, only the literature’s mechanical design assumptions were supported by player experience; there was little evidence of the perceived aesthetic incongruities.

5.3.3 Reflecting on Practitioner Insights

The three primary insights gleaned from my development of the games (4.5) were variably reflected in the study results. Unsurprisingly, what I found to be my most apparent design insight was also the most explicitly supported: that ludic objectives facilitate more engaging competitive play, but readily detract from a focus on musical creation (4.4.1.1). Both sentiments were reported by participants (5.2.3.1), with each player’s implicit values then leading them to prioritise either compositional or ludic interaction over the other. This ludocompositional dissonance also aligned with the mechanical tensions identified in the literature (5.3.2.1), and so is supported by all three of the literature, practitioner, and player perspectives explored within this research (3.1.1).

My second practitioner insight assumed a potentially antagonistic relationship between designing for musical accessibility, creative control, and competitive gameplay (4.4.1.2). This was only partially supported by participant responses: an antagonistic relationship between musical control and game challenge was shown (5.2.3.2), though participants did not struggle with musical accessibility in either game, nor was there any clear relationship to the deeper control of EvoMusic or higher competitive engagement of Chase. This might suggest that control and competition do not strongly influence perceived accessibility within composition game contexts, though I expect that designs
with substantially deeper musical control, or higher levels of competitive challenge, would prove otherwise.

My final insight, that the temporal experience of competitive gameplay incentivises shorter musical gestures (4.4.2), was not addressed by participants. The nearest exception was participant twelve, who described the synchrony between rising musical tempo and ludic danger in *Chase* as adding to their gameplay experience. I had expected some participants to comment on an inability to affect “longer” sonic outcomes, be it macrostructural interventions or simply musical events of greater duration, yet this was not reflected. One might take this to suggest that shorter musical gestures are well-suited to competitive environments and hence warranted no objection, though I find it more likely that participants were not concerned with this temporal relationship.

5.3.3.1 Further Insights and Implications for Phase Two of Practice

Player characterisations of *EvoMusic* and *Chase* were closely aligned with their intended design approaches (4.3.1). This lent confidence to my understanding of each approach, and so allowed an informed assessment of which design strategy more successfully balanced the *mechanical* tensions between composition and competitive gameplay. The approach embodied by *EvoMusic* was the clear candidate in this regard, engendering both the preferred experience overall (5.2.1) and a more successful fusion of creativity and contest (5.3.1). For this reason, I have carried *EvoMusic* forward into the second phase of creative practice as a benchmark for comparison with an additional composition game, *Idea* (Chapter 6). A key motivation of this third game is to explore any novel or unexpected insights arising from participant responses, amongst which I count the following trends:

1) The degree to which pre-game parameters informed perceptions of creative *control* in *EvoMusic* (5.2.3.4); and

2) The formality and influence of participants’ criteria for “games” (5.2.3.1).

Despite having discussed *EvoMusic*’s “pre-game” mode of composition (4.1.2; 4.2.2), I did not anticipate that so many participants would view the pre-game musical parameters as affording greater creative *control* than the live gameplay interventions – or for some, the *only* control (5.2.3.4). This may have suggested that *EvoMusic*’s in-game controls were inadequate, or that the specific high-level parameters manipulable via the pre-game menu were more crucial to perceptions of musical control. In either
case, these compositional decisions occur externally to the competitive game structure (4.1.2), and so a key interest of my third game (Idea) is to explore if these high-level controls can be integrated into live gameplay interaction (6.1.2; 6.2.2.6).

Similarly, I did not anticipate that an expectation for ludic goals could have exerted such an influence on specifically compositional perceptions. For participant thirteen, EvoMusic’s lack of goals simultaneously hindered control, but aided their creativity (5.2.3.1). Given also that participant eight based their preference for Chase on clear ontological criteria, it seems that future evaluations would benefit from investigating more explicitly the system’s perception as a “game”. For instance, a case study of the game piece Tonify, developed under the GAPPP project (1.6.1.8), asked audience members to rate the work on a scale from “game” to “artwork” (Lüneburg, 2018). Though the aims of the GAPPP project differ from this research, this line of inquiry may offer further insight into how ludic expectations influence the player’s compositional experience; I explore this in the second user study through two additional survey questions (7.1.1).

5.3.4 Design Recommendations: Reflecting on the Research Questions

Having reconciled the phase one player insights with practitioner and literature perspectives on competitive game-based composition, it is appropriate here to address the core research questions (1.2.1) before moving into the second phase of creative work and evaluation. In doing so, I derive preliminary design recommendations for accessible, single-player, competitive composition games.

5.3.4.1 What are the aesthetic assumptions and design challenges underpinning interactive composition in competitive game settings?

Despite literature concerns, players were not perturbed by the aesthetic experiences of competitive gameplay within music creation contexts (5.3.2.2) – a minority even enjoyed their inclusion. However, participant responses highlighted a number of mechanical design challenges, the primary two being:

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177 For example, a case study of the game piece Tonify, developed under the GAPPP project (1.6.1.8), asked audience members to rate the work on a scale from “game” to “artwork”.

178 The project aims, research questions, methodology and researcher team can be found at: http://gappp.net/index.html (retrieved 8 April, 2020).
• Increasing musical *control* may detract from the level of game *challenge*, and vice versa; and
• Ludic goals distract from a focus on composition, but strengthen the competitive gameplay experience.

Potential designers should not be as concerned with reconciling the *aesthetics* of composing and competing as with negotiating these *mechanical* challenges. Elements of compositionality are carefully balanced with those of competitive gameplay in this context, and a compromise seems necessary if both are desired. Specifically, designers should carefully consider the underlying values of their target player-base, such as their penchant for challenge, to ensure an appropriate prioritisation of compositional versus ludic design elements.

5.3.4.2 How can musical creativity and competitive gameplay be reconciled in a digital game while maintaining a focus on accessible sound composition?

*EvoMusic* was clearly the more successful at integrating musically creative and competitive gameplay interaction, as well as the preferred design overall. It also aided musical novices and achieved the system usability benchmark (5.2.2.1.2), showing that its creative-competitive fusion did not come at the expense of accessible composition. As such, potential designers aiming to reconcile composition and competitive gameplay should align with the design approach embodied by *EvoMusic* over that of *Chase*. The dimensions for this approach were discussed and visualised prior (4.3.2; Figure 18), but can be summarised as prioritising deep compositional control over explicit *ludic* elements such as objective goals. Again, though, it is crucial that designers consider their desired target audience, as a select cohort of players value traditional competitive gameplay over compositionality (5.2.3.3).

*EvoMusic* and *Chase* are two contrasting implementations of a larger conceptual strategy: competing against a *proactive* game system for authorial control of a shared musical output (3.2.1). The success of *EvoMusic* in reconciling accessible music creation with competitive gameplay validates this larger strategy as one approach to engendering a gamified co-creative contest. More broadly, this demonstrates the wider potentials for digital games as a novel platform for interactive composition.
5.3.4.3 How do competitive game settings shape player perceptions of musical control, creativity, and ownership?

Elements of competitive game settings variably shaped the player’s compositional experience as dependent upon their values and expectations for each. To reiterate, though, it was the mechanical and not aesthetic qualities of competitive gameplay that affected this influence (5.3.2). Notable relationships included: 1) game challenge detracting from creative control (5.2.3.2); and 2) the complex influence of ludic goals, which shaped perceptions of creativity, control, and ownership (5.2.3.1). Musical control also emerged as a key dimension shaping both compositional and gameplay perceptions (5.3.1), with many even valuing control over system usability or the competitive game framework. This suggests that prioritising a depth and diversity of musical control could serve as a useful heuristic when designing competitive composition games. Any further recommendations are crucially contingent upon individual player preference. Designers should be attentive to the ludic expectations of their target audience, yet prepared to reconcile these expectations with how the inclusion or exclusion of competitive mechanics may shape the compositional experience.

5.4 Chapter Summary

This chapter has concluded Phase One of the research by reporting on the results of a user study comparing EvoMusic and Chase (5.2). Player insights (5.3.1) were discussed in relation to literature and practitioner perspectives (5.3.2, 5.3.3). The research questions were then addressed by consolidating these three perspectives into design recommendations for accessible, single-player, competitive composition games (5.3.4). The pertinent findings were as follows:

- **EvoMusic** (4.1) was the preferred creative experience, overall design, and more successfully engenders a compositional competition (5.3.1).
- **Chase** (4.2) had more enjoyable gameplay, a stronger competitive game framework, and was preferred by a minority for these values (5.2.3.3).
- Music creation and competitive gameplay could be reconciled for particular players (5.3.1), validating my broader design strategy (3.2.1) as one successful approach.
Tensions perceived by the literature between composition and competitive gameplay are only partially supported by player experience:

- *Mechanical* design challenges are strongly supported (5.3.2.1; 5.3.3);
- *Aesthetic* incongruities are not reflected (5.3.2.2); and
- Incongruities between competitive gameplay and *accessible* composition are not reflected (5.3.2.2; 5.3.3).

Designers of competitive composition games should consider the following:

- Musical control was the most influential design dimension, even at the expense of usability or ludic challenge;
- Players had diverse expectations for gameplay and compositional experiences which shaped their preferences and perceptions; and
- The expectations of a target player-base should guide any balancing of the mechanical design challenges presented.

Phase Two further explores these insights through an additional creative work (Chapter 6) and its comparative evaluation alongside *EvoMusic* (Chapter 7), the more successful design approach from Phase One.
Chapter 6: Creative Works – Phase Two

This chapter presents Idea, a third original composition game, as the second phase of creative research. I outline its design impetus (6.1) before detailing the gameplay mechanics, music system, and competitive framework employed (6.2). I then chart Idea along salient design dimensions to compare its approach to EvoMusic and Chase (6.3), concluding with a discussion of the practitioner insights generated through the development process (6.4). Unlike EvoMusic and Chase, I have not addressed the aims nor design of Idea in any publication during this research.

6.1 Design Impetus

The development of Idea was guided by two broad design motivations which stemmed from the findings of the phase one user study:

1) To synthesise the most successful elements of EvoMusic and Chase within one design while addressing salient player feedback.
2) To further investigate the novel insights and conclusions drawn from the players’ experience of EvoMusic and Chase.

6.1.1 Synthesising Design Elements

The most successful element of EvoMusic was its depth of creative control. At a mechanical level, this greater control supported higher perceptions of creativity and ownership, and was also responsible for EvoMusic’s characterisation as the superior compositional experience. For Chase, the most successful features were its gameplay and ludic structure, in particular the clear goal of avoiding death that was noted as lacking in EvoMusic. These contrasting elements draw a polarity of the compositional versus the ludic, and so a central design goal of Idea was to synthesise these features within a single system: to join EvoMusic’s granular, note-level control with Chase’s clear goal structure and gameplay treatment, including its explicit combat and three-dimensional environment. Though this might be construed as a “design-by-committee” approach, it aligned with the core research aim: to explore how musical creativity and competitive gameplay, which are represented by the most successful features of EvoMusic and Chase respectively, may be reconciled in one digital game.
6.1.2 Investigating Novel Insights

*Idea* was also designed to interrogate any novel findings from the first user study that warranted further practical investigation. I explored each insight by implementing them as design elements within *Idea* to be investigated during the second comparative user study, allowing exploration from both practitioner and player perspectives. The findings explored and my approaches to addressing them are as follows:

a) Players appeared to value musical *control* at the expense of *usability* (5.2.2.1.3). With *Idea*, I followed an overarching design principle of favouring musical *control* and ludic structures over *usability*, allowing the second user study to test this conclusion and its resulting design strategy.

b) Players found the perceived “randomness” of *EvoMusic* to hinder *control*, aid *creativity*, and variably help or hinder *ownership*. With *Idea*, I maintained stochastic musical processes to harness their perceived benefits, yet also provided an avenue for more direct control of note and durational content if desired (6.2.2.1). This should also result in a greater level of compositional *control* than *EvoMusic*.

c) The complex relationship found between ludic goals and the compositional experience suggested that the notion of *ludocompositional dissonance* warranted a more targeted practical investigation. *EvoMusic* and *Chase*, though representing two contrasting approaches, both sought to minimise tensions between ludic and compositional incentives (4.1.4.1; 4.2.4). With *Idea*, I have implemented a more conventional ludic framework (6.2.2; 6.2.4) that invites a greater risk of extramusical incentives to explore its influence on compositional perceptions – particularly in light of *Idea*’s aim for increased musical *control*.

d) Players framed the pre-game configuration of high-level parameters, such as tempo and key, as being crucial to creative *control*, yet these compositional decisions occurred externally to any competitive interaction. *Idea* attempts to translate these parameters into the ludic structure of live gameplay, gamifying them as compositional resources to be discovered, earned, and protected (6.2.2.6). Though this may harm the compositional usability of *Idea*,\(^{179}\) its

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\(^{179}\) Players may find it quicker and easier to define high-level musical parameters in a single, concise settings interface (as with *EvoMusic*, see Figure 12) than through live gameplay interactions, where each abstract mapping takes time and effort to action (e.g. navigating, finding items, defeating enemies).
contrast to *EvoMusic* allows a useful design investigation: pre-game versus gamified control of high-level parameters.

The mechanical implementation of these aims is discussed in section 6.2.

### 6.1.3 Changes to *EvoMusic* in Phase Two

No mechanical changes have been made to *EvoMusic* in this phase of creative work. Participants in the second user study experienced the same *EvoMusic* as evaluated in the first, with the exception of minor bug fixes implemented to avoid diluting participant responses.\(^{180}\) Rather than taking participant feedback and directly iterating upon *EvoMusic*, I have used these insights to inform design elements within *Idea*. The intention was to preserve a comparison between *EvoMusic*’s original design strategy and the synthesised approach of *Idea* as a departure (6.1.1), allowing new insights to emerge from their juxtaposition as occurred successfully with *EvoMusic* and *Chase*. Preserving the state of *EvoMusic* also enabled methodological evaluation, such that a consistent characterisation of *EvoMusic* between the two studies would lend confidence to their capacity to capture accurate representations of the wider player experience.

### 6.2 *Idea*

#### 6.2.1 Overview

*Idea* is a three-dimensional, first-person musical maze with a more explicit focus on traditional game elements: primarily, ludic goal structures and game *progression* (2.5.3). Players explore a series of labyrinthian game levels to discover new compositional resources, such as new pitches and timbres, whilst avoiding the various hostile agents attempting to steal and pervert them. Music is created by toying with “ideas”, short musical motifs embodied as physical game objects (Figure 21), which have diverse compositional interactions with the game’s environment, agents, and one another. The player opens new pathways throughout each level by creating music with their “ideas”, aiming ultimately to find the “exit” and so progress to the next level and its new compositional resources. Players are defeated if they lose too many musical resources to the hostiles patrolling the game level; unlike *Chase*, though, the player can also fight back by creating music in certain configurations (6.2.2.4). What results is a

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\(^{180}\) For instance, cells in *EvoMusic* could infrequently break out of the on-screen game space, preventing them from being deleted and resulting in unexpected sounds for one participant.
progression of compositional sandboxes that broaden in scope as the ludic incentives are addressed – that is, as enemies are defeated and new environments are unlocked. A video demonstration of interaction with Idea is provided in the accompanying media (see “Creative Works”, p. xv).

6.2.2 Compositional Gameplay Mechanics

6.2.2.1 Interacting with “Ideas”

The core compositional interaction within Idea involves discovering and manipulating physics-based game objects called “ideas” (Figure 21), which each contain a short musical motif. “Ideas” begin with stochastically generated content (6.2.3.1) and appear in two variants: pitched (spheres) and percussion (tetrahedrons). Players can first audition an idea’s content by holding them (Figure 21) and then “activate” the idea by placing or throwing it within the game environment. In this “active” state, ideas recursively perform their motif as well as triggering diverse musical interactions within the gameworld. The simplest of these behaviours are outlined below:

- Colliding with the game environment produces a single melodic tone.
- Colliding with other ideas results in the following:
  - Pitch colliding with pitch = single chord with bass accompaniment.
  - Percussion colliding with percussion = short percussive gesture.
  - Pitch colliding with percussion = both of the above.
- Being close to other ideas “connects” the two (Figure 22), resulting in the following for as long as they remain connected:
  - Pitch connecting with pitch = single, continuous melodic tone for each unique connection.
  - Percussion connecting with percussion = additional percussive layer for each unique connection.
  - Pitch connecting with percussion = both of the above for each unique connection.

With these behaviours, players can activate multiple ideas to set in motion a dynamically shifting composition. Each idea also acts as the sound source for playback
of its motif, allowing players to dynamically mix the musical output by moving around the game space.

Figure 21: A pitched “idea” being held and auditioned by the player.

Figure 22: Ideas “connected” in the gameworld, one pitched (sphere) and two percussion (tetrahedrons).

A more direct form of creative control can also be achieved by editing the sonic content of ideas using a sequencer-esque interface (Figure 23). Players can alter the

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181 That is, playback of the sonic content belonging to a particular “idea” attenuates with the player’s proximity to the respective game object.
pitch and duration of notes, add or remove notes, shorten or lengthen motifs, and change the timbre used for performance. Importantly, this feature is not necessary for the game’s core ludic objectives (6.2.4), allowing expert musicians to take advantage of the deeper control affordances without precluding novices from compositional engagement. Non-musicians intimidated by the interface can rely upon the stock of stochastically generated ideas, searching for desired motifs to then explore musical outcomes through their serendipitous combination. Expert musicians can also reap the creative benefits of this initial “randomness” (5.2.2.2) as a source of inspiration or experimentation to supplement their more precise compositional interventions. In this way, Idea addresses the desire for more precise control (5.2.2.1.3) while preserving both musical accessibility and the perceived creativity of stochastic processes (5.2.2.2).

**Figure 23**: Editable interface for pitched ideas.

6.2.2.2 Using Ideas to Progress

Beyond their compositional functionality, ideas are also the primary means of addressing the game’s ludic objectives. Within each level, players have the overarching goal of finding the “exit” to progress to new levels and compositional resources. To do so, players must open “doors” throughout the level by activating a prescribed number of ideas within the respective room; the required quantity is numerically displayed above a blue hexahedron within the room (visible in Figure 21-Figure 22), which also communicates the player’s progress towards opening the door by spinning at increasing
speeds. There is no restriction on the musical content needed to open doors – such as requiring a specific melody, rhythm, or timbre – so as to avoid becoming an exercise in musical matching (2.3.1.3) and restricting free creation. Players need only activate ideas, and so compose, to progress towards the exit.

6.2.2.3 Earning Compositional Resources

Players earn new compositional resources as they progress within individual levels (micro-progression) and over the course of the game (macro-progression). Opening doors reveals new ideas, offering further inspiration as well as enabling more complex musical textures. This also makes available new notes and timbres, which are embodied as small collectible gems scattered throughout the level (Figure 24). Once collected by the player, these can be used when editing ideas (6.2.2.1) but also widen the constraints for the system’s stochastic generation of new ideas (6.2.3.1). The “notes” collected are constrained to a global scale for the purpose of compositional accessibility, allowing players to slowly “earn” the complete scale from an initially limited selection (Table 17) by exploring the level. Completing levels then unlocks new environments which, like Chase (4.2.2), each offer a unique harmonic constraint (Table 17). With each new level, players also gain access to a variety of gameworld agents which offer new compositional affordances, as discussed shortly (6.2.2.4; 6.2.2.5).

Figure 24: Collectible “notes” (yellow) and “timbres” (blue) within the game environment. The quantity of each currently held by the player are displayed in the top left.

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182 That is, by having a greater quantity of “ideas” to deploy simultaneously.
Table 17: Summary of the completed and initial harmonic constraints for each level in Idea. Note: scales are presented as a scale degree formula and its equivalent as semitones from a given tonal centre.

<table>
<thead>
<tr>
<th>Level</th>
<th>Complete Scale (two octaves)</th>
<th>Initial Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day</td>
<td>Natural Minor: 1-2-b3-4-5-b6-b7; [0 2 3 5 7 8 10]</td>
<td>1-b3-4-5-b7-7; [0 3 5 7 10 12]</td>
</tr>
<tr>
<td>Night</td>
<td>Harmonic Minor: 1-2-b3-4-5-b6-7; [0 2 3 5 7 8 11]</td>
<td>1-b3-4-5-b6-7-8; [0 3 5 7 8 11 12]</td>
</tr>
<tr>
<td>Snow</td>
<td>Major: 1-2-3-4-5-6-7; [0 2 4 5 7 9 11]</td>
<td>1-2-3-5-6-8; [0 2 4 7 9 12]</td>
</tr>
<tr>
<td>Red</td>
<td>Lydian-Dominant: 1-2-3-#4-5-6-b7; [0 2 4 6 7 9 10]</td>
<td>1-3-#4-5-b7-8; [0 4 6 7 10 12]</td>
</tr>
<tr>
<td>Luna</td>
<td>Chromatic: all twelve tones</td>
<td>1-3-5-8; [0 4 7 12]</td>
</tr>
</tbody>
</table>

6.2.2.4 Hostile Agents

The compositional resources earned by the player can be stolen by a number of hostile agents patrolling each level. Whenever music is created within a hostile agent’s room, they begin pursuing the player and consuming any active ideas in their proximity (Figure 25). Each the time a hostile agent reaches the player or consumes an active idea, the player loses one “note” from their collection (6.2.2.3). These notes also act as the player’s “health”, such that losing all notes results in loss of the game. Beyond this ludic incentive, however, hostile agents also pose varying compositional threats. Their most explicitly competitive behaviour is stealing notes to limit the player’s creative affordances, though hostile agents also disrupt the musical output by perverting any consumed ideas with abrasive timbres and altered pitches before re-contributing them to the player’s composition (6.2.3.4). In both cases, and as with EvoMusic and Chase, the player is tasked with defending their degree of creative control through compositionally-laden gameplay interactions. Unique to Idea, though, is that players can somewhat defeat the system through ludic means. If players “connect” (6.2.2.1) enough ideas in proximity to a pursuing hostile agent, it is instead trapped and destroyed (Figure 26). As before, there are no creative restrictions on which ideas can achieve this: players simply need to connect enough ideas for the size of the hostile agent, being two for small hostiles and three for large. In defeating these opponents, players can gradually earn for themselves a less competitive sandbox for free musical creation.
6.2.2.5 Non-Hostile Agents

Players can also encounter a variety of non-hostile agents within Idea. These do not target the player directly, but influence active ideas with unique compositional behaviours (Table 18). The four types of non-hostile agents appear in both stationary (Figure 27) and mobile (Figure 28) variants, with the latter perpetually seeking out active ideas within the game environment. Their behaviours (Table 18) can lead to the
serendipitous discovery of emergent outcomes, but may also be perceived as an entropic force threatening the player’s organised composition – particularly if carefully constructed in the idea editing interface (6.2.2.1). Given that players increasingly encounter the agents as they complete each level, this offers two potential forms of traditional ludic progression: “content-unlocking” (Buckley et al., 2018) through the new compositional affordances earned, yet also the escalating challenge that often characterises successive game “levels” (Buckley et al., 2018).

Table 18: Summary of non-hostile agents in Idea and their effect on pitched and percussion “ideas”.

<table>
<thead>
<tr>
<th>Colour</th>
<th>Summary</th>
<th>Effect on Pitched Ideas</th>
<th>Effect on Percussion Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Complexify</td>
<td>Adds an additional harmonising note for every original note, occurring after a small quantised delay. Can accumulate 3 times (for 3 extra notes per original).</td>
<td>Adds an additional note for every original note, and on a different instrument from each. Can accumulate 3 times (for 3 extra notes per original).</td>
</tr>
<tr>
<td>Red</td>
<td>Simplify</td>
<td>Removes one layer of notes added by the “complexify” agent. Does not affect unaltered ideas.</td>
<td>Removes one layer of notes added by the “complexify” agent. Does not affect unaltered ideas.</td>
</tr>
<tr>
<td>Blue</td>
<td>Timbre</td>
<td>Selects a new timbre for the idea at random, but restricted to timbres collected by the player.</td>
<td>Shifts the instrument used for each note in the motif (e.g. from hi-hat to snare).</td>
</tr>
<tr>
<td>Yellow</td>
<td>Shuffle</td>
<td>Stochastically generates a new melody by reordering the original notes, preserving the pitch and duration of each.</td>
<td>Stochastically generates a new percussion motif, but restricted to instruments present in the original (e.g. a new hi-hat rhythm).</td>
</tr>
</tbody>
</table>

Figure 27: Stationary non-hostile agents in Idea. The “shuffle” agent is affecting the nearby active idea.
6.2.2.6 Gamifying High-Level Parameters

In contrast to EvoMusic, the tempo and key of musical output in Idea are manipulated during live gameplay. Players can discover a tempo and key “cube” (Figure 29) within each level; these allow for either precisely defining the respective parameter (Figure 30) or stochastically determining new values for free experimentation. Like other compositional resources, however, these high-level parameters are also explicitly gamified. After first searching for the key and tempo cubes, players are incentivised to protect them from the hostile agents attempting to consume them. If either cube is stolen by a hostile agent, the respective parameter begins shifting erratically – potentially disrupting the player’s composition. As before, though, players can fight back: destroying the offending hostile agent (6.2.2.4) releases the key or tempo cube back into the player’s control. The intention is to integrate high-level musical parameters into the core competitive gameplay by encouraging the player to seek, protect, and reclaim these resources through predominantly compositional motivations – namely, earning and maintaining creative control (3.2.1).
6.2.2.7 On Usability in *Idea*

*Idea* is substantially more complex than *EvoMusic* or *Chase* with regard to the range of mechanics and behaviours that must be understood by players to fully harness the system’s compositional potentials. This stems from an overarching design principle introduced prior (6.1.2), where I have prioritised granular musical *control* and a more explicit competitive framework over considerations of *usability* and ease of learning. For instance, the motif editing feature (6.2.2.1) provides an avenue for direct, deterministic control over note-level content in response to participant’s noted issues.
with “randomness” in EvoMusic (5.2.2.1.3), but may also present a hurdle to novice access with its potentially intimidating interface. Similarly, the introduction of several explicit ludic goals – which at the least includes opening doors, defeating hostiles, finding new “notes” for health, and ultimately reaching the exit – adds substantially to the cognitive demands on players who are simultaneously attempting to create music.

To alleviate this steep learning curve, I have implemented a tutorial which gradually introduces each mechanic and agent behaviour in a sequence resembling their explanation herein, and which itself acts as a source of ludic and compositional progression. I have also endeavoured to ensure that each individual interaction remains easily comprehensible. In the idea editor (Figure 23), for instance, novice players can drag their mouse over the interface in the manner of a pencil to quickly sketch new melodic contours using the intuitive visual relationship of y-axis for pitch and x-axis for duration. To be clear, though, it is nonetheless my intention with Idea to favour compositional control and competitive elements over usability as a deliberate departure from EvoMusic. Through their juxtaposition, the second user study can then reflect on how this design approach influences the player’s compositional experience.

6.2.3 Music System Design

The music system for Idea comprises various sub-systems for organising the musical behaviours and playback of each game object and agent. No matter their function, each sub-system obeys the global tempo and key defined by the player or hostile agents (6.2.2.6). All output is rhythmically quantised to a 32nd note grid, including the musical results of object collisions as well as the onset of “connections” (6.2.2.1) between active ideas. I will briefly describe the algorithmic design of each sub-system, though all may be summarised as using stochastic and rule-driven approaches similar to those employed in EvoMusic (4.1.3) and Chase (4.2.3). Further, all audio playback is again achieved by passing generated or player-defined MIDI data through software instruments and effects plug-ins.
6.2.3.1 Ideas: Generation and Playback

The initial content for each idea is stochastically generated once first picked up by the player. This process is as follows:

1. A timbre is randomly selected from the player’s available timbres; that is, those collected as in-game tokens by exploring the level (6.2.2.3).
2. A motif length is randomly selected from three pre-defined sizes: 8, 12, or 16 quavers. Motifs of other lengths are achieved through idea editing.
3. A rhythm to fit the motif length is generated using the *drunk* object\(^{183}\) to output a sequence of quaver, crotchet, and minim values. Different note durations are achieved through “idea editing” (6.2.2.1; Figure 23).
4. Pitch values for the motif rhythm are generated using the *drunk* object to step between pitches permitted by the level’s overarching harmonic constraint (Table 17) and the player’s currently available notes (6.2.2.3). For percussion ideas, this step determines which percussive instrument is used for each note.
5. An octave for performance of the motif is randomly selected; this does not apply to percussion ideas.

Note that motif generation does not rely on markov chains or grammars to more selectively guide the output, as done in *EvoMusic* and *Chase*. The intention is to enable greater variance between ideas, which number above 50 in some levels, to encourage players to search the game environment for new motifs that are favourable, interesting, or otherwise inspiring if not used directly.

Every idea maintains its own playback system so that each may attenuate in relation to the player’s proximity. This is organised by the *poly*~ object, which supports multiple independent instances of one audio system with dynamic control over their quantity and the functionality of each instance.\(^{184}\) Unlike *EvoMusic* and *Chase*, playback does not involve stochastic performance: idea content recurs in a fixed loop until stopped or edited by the player. The playback systems simply pass the MIDI content of the respective idea through software instruments and effects plug-ins.

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\(^{183}\) The *drunk* object in Max outputs random integers within a specified step range of the previous output with each successive generation. The intended metaphor is a “drunken” walk, moving gradually but inconsistently within a larger defined range.

\(^{184}\) For example, this allows inactive ideas to cease digital signal processing and so minimise CPU load.
6.2.3.2 Ideas: Storage and Editing

Ideas are assigned an identifying integer, its “ID”, when first picked up; this is also displayed in-game as a floating numeral above each idea (visible in Figure 26), allowing players to quickly locate motifs within the gameworld. Using this ID, the pitch, rhythm, and timbre content of each idea are stored in text lists to be recalled as needed for either playback or editing. Editing itself begins by using the idea’s currently stored content to fill out the in-game edit interface (Figure 23). The player’s modifications then overwrite that idea’s stored content, such that the new motif is now recalled whenever the ideas is auditioned, activated, or further edited. *Max* is also responsible for communicating playback information to *Unity* whenever a motif is auditioned, including while editing, which allows visual feedback on which note is currently sounding for the aid of musical novices.

6.2.3.3 Collisions and Connections

A separate sub-system is maintained for each type of collision between game objects, as well as each type of “connection” between nearby active ideas (6.2.2.1). For brevity, I will outline the systems for pitched ideas:

- *Collision between two ideas* – at the moment of collision, one of nine pre-defined chords for the level’s harmonic framework is stochastically selected and immediately performed. A pre-defined first order markov chain is used to guide suitable chord transitions.

- *Collision between idea and game environment* – at the moment of collision, the *drunk* object is used to stochastically select one pitch from the player’s available notes to be immediately performed.

- *Connection between two ideas* – at the moment a connection is formed, one unused pitch from the player’s available notes is stochastically selected using the *urn* object. The pitch sounds until the connection is broken, with each connection maintaining a separate playback system using the *poly~* object.

All of the above musical occurrences attenuate with player proximity, including the ongoing output of each individual “connection” between active ideas. The onset of each

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185 Note that ideas which have yet to be picked up do not display a numeric ID.

186 The *urn* object in Max outputs random, non-duplicate integers within a range. This is used to randomly select a pitch that is not currently used by any other connection between ideas.
musical gesture is also rhythmically quantised to aid with cohesion. My intention is for musical novices to engage with these gestures as serendipitous perturbations\textsuperscript{187} that synchronise with their composition, not as “random” or chaotic occurrences apathetic to the core musical output.

6.2.3.4 Hostile and Non-Hostile Agents

As with ideas, each hostile agent (6.2.2.4) maintains a separate playback system using the \textit{poly}– object to allow for independent attenuation with player proximity. When a hostile agent consumes an active idea, the idea content joins a pool of all motifs stolen by that agent. The hostile agent then cycles randomly through the stolen motifs, rendering them with a more abrasive timbre as well as stochastically modifying the octave and a small number of pitches with each repeated playing. While this is a predominantly antagonistic behaviour, players can also harness the hostile system to explore new arrangements of multiple ideas in stochastic sequences, including wilfully “feeding” ideas to hostiles. Finally, consuming the key or tempo “cube” (6.2.2.6) prompts \textit{Max} to commence an indeterminately recurring shift in the respective global parameter. Key changes are quantised to coincide with crotchet beats while tempo gradually approaches the new value whenever a shift is triggered. Successive changes occur after a random number of beats which is independently allocated for each parameter, ceasing only once the player has destroyed the responsible hostile agent.

Non-hostile agents (6.2.2.5) do not produce musical output of their own, instead manipulating the stored content of any proximate ideas. The treatment of each agent’s musical behaviour (Table 18) is outlined below, focusing again on pitched ideas:

- \textit{Complexify} – additional layers of complexity contribute the following cumulative effects to each individual note in the original motif:
  
  1) A new note one-third above the original within the level’s harmonic framework, occurring one quaver later;
  
  2) A new note one-fifth above the original within the level’s harmonic framework, occurring one dotted quaver later; and
  
  3) A new note one octave above the original, occurring one dotted crotchet later.

\textsuperscript{187} Players could not accurately predict the complete musical outcome of letting ideas loose in the environment, such as of each collision and connection over time. See Herber (2008), 2.3.1.5, for further details.
• *Simplify* – removes one of the above layers of complexity from the affected idea. These two agents do not affect the original idea’s stored content.

• *Timbre* – overwrites the stored timbre information of the affected idea with a stochastic selection from the player’s currently available timbres.

• *Shuffle* – stochastically re-orders the notes within the motif, preserving the pitch and duration relationship of each, before overwriting the idea’s stored content.

Any changes made to an idea are also preserved if consumed by a hostile agent; for instance, hostiles perform motifs with any layers of complexity accumulated by the idea during its lifespan (see above). The exception is manipulations by the “timbre” agent, as hostile agents enforce their own timbral changes upon consumed ideas.

### 6.2.4 Competitive Game Framework

*Idea* employs aspects of the same conceptual strategy explored in *EvoMusic* and *Chase*: competing for creative *control* of a shared musical output (3.2.1). Where *Idea* departs, however, is that this dialogue acts as only one element of a broader ludic framework and is no longer “inexorable”. Hostile agents threaten the player’s compositional resources and *proactively* posit their own musical gestures by manipulating stolen ideas, yet they can also be permanently defeated by the player (6.2.2.4) – a feature for which *EvoMusic* and *Chase* have no analogue. Rather than a ceaseless compositional “tug-of-war”, then, *Idea* allows players to gradually expand their creative sandbox through competitive but compositionally-laden interactions. With persistence, and if desired, players could even clear a level of hostile threats to remove this competitive dialogue entirely.  

*Idea*’s broader competitive framework is instead focused on ludic *progression* (2.2.1.2), for which the player’s explicit compositional combat with hostile agents is but one example. Having players progress through environments in search of an “exit”, and in turn through successive game levels, allows a more defined ludic goal structure that better reflects player expectations; for instance, that games should be “winnable”. As introduced prior (6.1.2), my intention with this approach is to support an investigation of how more conventional ludic structures influence the player’s compositional experience in comparison to *EvoMusic*’s absent ludic goals (4.1.4).

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188 Albeit temporarily and confined to that particular level.
6.2.4.1 On Ludocompositional Dissonance

The heavy ludic incentives pervading *Idea*'s design undoubtedly invite ludocompositional dissonance, and far more so than either previous game. I have sought to alleviate this tension by ensuring that any aspect of ludic *progression* is equally motivated by compositional goals. Similarly, each core creative interaction is assigned a clear ludic purpose. These relationships are summarised in Table 19 and aim to support a close integration of compositional and ludic incentives. I would reiterate, though, that *Idea* intentionally embraces an explicit goal structure as a departure from *EvoMusic*, and so it has not been my aim to entirely prevent ludocompositional dissonance. In fact, I anticipate a palpable tension between compositional and ludic motivations within *Idea*, despite their frequent alignment. This allows the second user study to explore how a more acute ludocompositional dissonance influences the player experience, particularly in light of what I presume to be higher degrees of musical *control* and ludic enjoyment in *Idea*.

Table 19: Summary of the ludic and compositional incentives for interactions within *Idea*.

<table>
<thead>
<tr>
<th>Interaction</th>
<th>Ludic Incentive</th>
<th>Compositional Incentive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activating ideas</td>
<td>Open doors to progress, defeat hostile agents.</td>
<td>Primary means of compositional intervention, most direct control.</td>
</tr>
<tr>
<td>Exploring level / opening doors</td>
<td>Search for exit, find more “gems” to increase health.</td>
<td>Explore to acquire new compositional resources: new ideas, additional notes and timbres (6.2.2.3), control over key and tempo (6.2.2.6).</td>
</tr>
<tr>
<td>Reaching level “exit”</td>
<td>Complete level (“win”), progress to new levels to enable game completion.</td>
<td>Progress to unlock new compositional affordances: new harmonic constraints, parameter controls (6.2.2.6), and agent behaviours (6.2.2.5).</td>
</tr>
<tr>
<td>Collecting gems</td>
<td>Increase health to minimise risk of defeat.</td>
<td>Additional pitches and timbres available for use in new idea generation, idea editing, and environmental music gestures (6.2.3.3).</td>
</tr>
<tr>
<td>Defeating hostiles</td>
<td>Preserve health to avoid defeat.</td>
<td>Remove threats to creative control, expand compositional sandbox, regain control of tempo and key parameters if applicable.</td>
</tr>
</tbody>
</table>
6.3 Positioning *Idea* Within the Body of Creative Works

6.3.1 Overview

*Idea* aims both to synthesise the successful elements of *EvoMusic* and *Chase* (6.1.1) and explore novel insights from the phase one user study (6.1.2). Addressing these aims, *Idea*’s relationship to my body of work can summarised as follows:

- *Idea* offers deeper compositional control than *EvoMusic*, including avenues for direct manipulation of note content beyond stochastic generation.
- *Idea* offers a stronger competitive framework than *Chase* through its goal hierarchy, ludic progression structure, and explicit combat.
- As a result, *Idea* has lower usability and a greater ludocompositional dissonance than either *EvoMusic* or *Chase*.

Here, I position *Idea* along the design dimensions used prior (4.3.2) to explicate its departure from the phase one games (6.3.2). A visual summary and comparison of all three works is provided following (6.3.3).

6.3.2 Design Dimensions

6.3.2.1 Paidia versus Ludus

*Idea* reflects the base compositional contest of *EvoMusic* and *Chase* via its hostile agents, but is the only game allowing players to fight back in any extramusical sense. Beyond this more explicit combat, *Idea* also exhibits a more defined ludic framework: it has a clear hierarchy of ludic goals within and between levels, supporting elements of game progression (2.2.1.2) at the macro- and micro-scale. In particular, the ability to win levels and eventually complete the game more faithfully invokes the intention of *ludus* as a bounded competition (2.1.1.1). A clear victor is crowned through fixed and quantifiable objectives, contrasting the transitory “victories” achieved in *EvoMusic* or *Chase* whenever the player attains a desired musical state – and only so long as they defend it. These structures are absent from the phase one games, and so *Idea* is the closest representation of *ludus* in the body of works.

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189 Within each level, the player is the victor if they reach the “exit”, while the game is the victor if the player loses all health to hostile agents.
6.3.2.2 Mixing versus Making

_Idea_ affords a wide scope of musically creative interactions. The endless supply of complete, stochastically generated motifs allows for novice experimentation in a manner analogous to combining pre-packaged audio loops. Conversely, the idea editing feature (6.2.2.1; Figure 23) offers direct control over the precise pitch, rhythm, and timbre content of motifs, along with their size, in a manner more resembling traditional composition. These two modes of creation characterise music-mixing and making respectively (2.3.1.3). Despite both being supported by _Idea_, it is most useful here to describe the system as being a stronger representation of music-making interaction than _EvoMusic_ (and _Chase_ by extension). This framing highlights _Idea_’s intention to address the perceived “randomness” of creative control in _EvoMusic_ (5.2.2.1.3) through its support of deeper and deterministic content manipulation.

6.3.2.3 Core versus Peripheral

As discussed prior (6.2.4.1), _Idea_ invites a substantially greater risk of ludocompositional dissonance due to its complex structure of ludic incentives. Efforts have been made to align the player’s compositional and ludic incentives where possible (Table 19). When considering _EvoMusic_ or _Chase_, however, it remains clear that _Idea_ exhibits a comparatively peripheral integration of music creation and competitive gameplay. This is evidenced by the fact that the ludic structure of _Idea_ retains meaning even without its compositional elements; if the sound output were to be muted, players could still experience a game with combat, clear objectives, progression, and eventual victory. In contrast, _EvoMusic_ and _Chase_ posit no meaningful objective or ludic victory beyond striving for musical outcomes, and so exhibit a comparatively core integration of composition and competitive gameplay.

6.3.2.4 Instrument versus Composition

As with mixing and making interaction (6.3.2.2), _Idea_ offers a broader cross-section of instrument- and composition-based interaction than either of the phase one games. _EvoMusic_ and _Chase_ are entirely predicated on “Continuous Feedback Interaction” (Hunt et al., 2017), where the parameters for generative output are continuously updated by the user or system.\(^{\text{190}}\) _Idea_ additionally supports “One Shot Interactions”, where an

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\(^{\text{190}}\) Examples include the Red Man’s proximity in _Chase_, or the cell population’s size and constitution in _EvoMusic_; these are continually updated by the player and game state.
output is mapped to a single control input or button push. These interactions are markedly more instrumental, and include: 1) colliding ideas with the game environment or one another; and 2) manually auditioning ideas with the space bar. Conversely, Idea also exhibits compositional “perturbations” (2.3.1.5), in that the player cannot accurately model the complete sonic results of throwing ideas – that is, every sonified collision and connection, every interaction with hostile and non-hostile agents, and so on. Players can also precisely edit musical content prior to its enactment within the game,\(^{191}\) reflecting the temporal separation of conception and performance that traditionally characterises music composition. Like Idea’s instrumental interactions, this pre-emptive form of composition is largely absent from EvoMusic and Chase.\(^{192}\) As such, Idea represents greater extremes of instrument- and composition-based interaction than either of the phase one games (6.3.3).

6.3.2.5 Abstract versus Explicit Representation

Sonic content is abstracted to varying degrees in Idea. For much of gameplay, complete musical motifs are represented as single game objects. Visually, these only denote the type of idea via shape, the layer of “complexity” via colour (6.2.2.5), and the idea’s content via an arbitrary numerical reference which the player is required to remember. While this is undoubtedly less abstract than Chase, EvoMusic’s assignment of a unique cell to each sonic event is in turn the more explicit representation of musical content. The exception, however, is Idea’s editing interface (6.2.2.1; Figure 23). Pitch and durational relationships are visualised using an intuitive sequencer-esque display with explicit terminology marking each control, such as “pitch”, “octave”, and “volume”. The percussion editing interface even specifies the instrument assigned to each node (Figure 31). Through this feature, Idea exhibits the most explicit representation of sonic content amongst the three works.

\(^{191}\) That is, players can edit and audition an idea’s pitched, rhythmic, and timbral content before “activating” the idea and contributing its music to the larger sonic output.

\(^{192}\) Exceptions include the player’s ability to determine the instruments used prior to the game session in EvoMusic and Chase, as well as the pre-game manipulation of key and tempo in EvoMusic.
Figure 31: Editing interface for percussion ideas.

6.3.2.6 Metacreative Autonomy

_Idea_ initiates its own musical gestures via the behaviours of hostile and non-hostile agents, thus attaining _proactivity_ (level 4) with reference to the Eigenfeldt et al. (2013) taxonomy of metacreative autonomy (2.6.1.1). Conversely, _Idea_ does not display any meaningful change in behaviour over time and so does not reflect the _adaptability_ (level 5) of _EvoMusic_’s variable population behaviour (4.3.2.6). Hostile agents in _Idea_ have two states of ludic behaviour: 1) idly patrolling their room; and 2) actively pursuing the player. I do not consider this to satisfy the intention of _adaptability_ as the change is only triggered by the direct player action of activating ideas near the hostile agents – it is simply reactive. Further, it does not constitute a shift in _musical_ behaviour: if a hostile agent has consumed an idea, then its musical output is identical between its two ludic states of patrolling and pursuing. Like _Chase_, then, _Idea_ is best described as a _proactive_ metacreative system.
6.3.3 Visual Summary: Idea, EvoMusic, and Chase

The following (Figure 32) is a visualisation of how my three creative works are positioned along the design dimensions I have taken as pertinent to competitive composition games. Their spatial placement does not adhere to any scale; it is simply a visual reference to summarise and compare their contrasting approaches. Brackets are used to denote that a wide cross-section of a particular design dimension is represented between multiple features in Idea, as discussed prior (6.3.2.2; 6.3.2.4).

Figure 32: Visual comparison of design dimensions in Idea, EvoMusic, and Chase; E (blue) = EvoMusic, C (red) = Chase, I (green) = Idea.
6.4 Practitioner Insights: Phase Two

To conclude this chapter, I discuss the design insights gained through my development of Idea, revisit the insights generated during phase one, and consolidate the findings of my creative research from a practitioner perspective (6.5).

6.4.1 Revisiting the Tension Between Competitive Gameplay and Composition

In phase one, I outlined two mechanical tensions persisting throughout the conceptualisation, development, and testing of EvoMusic and Chase: ludocompositional dissonance (4.4.1.1) and a tripartite tension between control, competition, and access (4.4.1.2). Each of these is more acutely exemplified by Idea through its design aim of synthesising the prior games’ successful features. In aspiring simultaneously towards deeper creative control and a stronger ludic framework, the resulting costs and compromises reveal new insights into the nature of these design challenges.

6.4.1.1 Ludocompositional Dissonance: Victory and the Primacy of Ludus

I had previously found Chase’s ludic incentive of avoiding defeat to distract from compositional considerations, dividing the experience into frequently oscillating yet separate modes of creative versus competitive interaction (4.4.1.1). With Idea, however, the division is made ever more apparent by the hierarchy of fixed, extramusical objectives – none more so than the possibility of “victory” over levels or the game itself. Players do not simply monitor health in trepidation of defeat: they maintain long-term motivations towards achievable ludic outcomes that inform much larger sequences of decision-making. As a result, and in my own experience playing Idea, a more active effort must be made to transition between the modes of composing and competing: a conscious forgoing of one to make progress with the other. This ludocompositional dissonance has emerged despite my efforts to balance ludic and musical incentives (6.2.4.1; Table 19), but was nonetheless an expected outcome of Idea’s explicit goal structure. What I did not anticipate, though, was the subtle primacy of competitive engagement over compositional consideration.

In my time of testing Idea, I found the ludic objective of striving for victory to more readily demand my attention than any musical goal. This is a distinct intuition from game competition being a more engaging mode of interaction (4.4.1.1). Rather, I had the impression that compositional motivations are the easier of the two to put aside for
the momentary benefit of the other. I felt a certain allure to address any competitive incentive foremost, despite my equal interest in each. This may be attributable to the inherent structure of *Idea*, which encourages first clearing hostiles so that the player may enjoy an expanded musical sandbox (6.2.4). Alternatively, it may be linked to the *aesthetic* experience of competitive gameplay (2.2.3.2), such that the inherent pressures of escaping enemies or searching for an exit frames ludic objectives as the more urgent to address. 193 In any case, there seems a certain ludic character that overpowers compositional motivations which I had not experienced until introducing the possibility of victory. If supported by the player experience, and not simply an artefact of my own predilection for competitive gameplay, then this novel relationship between musical creativity and ludic structures bears crucial design implications for competitive composition games. It might even suggest that an *aesthetic* incongruity between creation and competition indeed arises (2.3.4.1), though localised to the specific design juncture of composing within winnable games.

6.4.1.2 Revisiting Control, Access, and Competition

Previously, I discussed a tripartite tension between designing for musical control, accessibility, and competition where each aim strains against the other (4.4.1.2). *Idea* further illuminates this tension by deprioritising system usability, particularly as it concerns the aspiration for deeper creative control. Throughout the design process, I remained acutely aware of the potential for complex control inputs and interfaces to inhibit or discourage musical novices. My principal solution was a quasi-sequencer editing tool that, while still allowing precise control, allows novices to intuitively sketch a desired melodic contour (6.2.2.7). The issue remains, however, that *Idea* does not attain the expressive affordances that expert composers might expect of an interactive system. There is no fine articulation or timbral control beyond prescribed options, no manipulation of envelopes or oscillators, no access to frequencies beyond the harmonic constraint, and no simple means of macro-structural intervention save for prolonged gameplay interaction. *Idea* refrains from these affordances to avoid deterring novices with an intimidating DAW-like interface and feature set, not least for how they limit the scope of gameplay design. And yet, *Idea*’s design tensions go beyond simply

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193 At the risk of overt extrapolation, this may even be grounded in a biological incentive to address threats with urgency. By extension, competitive pressures might instinctively precede acts of creation in the natural priorities of players.
reaffirming the challenge of balancing an accessibly constrained experience with satisfactory musical control (Blaine & Forlines, 2002; Jordà, 2003).

*EvoMusic* and *Chase* centre their competitive frameworks around a player-versus-system contest for control, and so some tension between control and competition seems inherent (4.4.1.2). The competitive focus of *Idea*, however, rests on *progression* through a structure of successive ludic goals (6.2.4). New players are required to learn a complex series of game mechanics to address these goals (6.2.2.7), presenting a hurdle to ease of learning that is readily exacerbated by efforts for deep musical *control*; the player’s difficulty in modelling their affordances grows with every new editing interface or game object mapped to an additional sonic parameter. The designer’s difficulties are also compounded, as any feature implemented to serve musical control or competitive gameplay would ideally be woven into the interests of the other\textsuperscript{194} (6.2.4.1; Table 19). What this highlights, then, is that even distinct approaches to a compositionally competitive game framework seem inevitably to incur a tension between the triumvirate design aims of musical control, accessibility, and competition. Whether following the strategy employed in *Idea*, the phase one games, or otherwise, the need to carefully balance these aims remains a crucial consideration for designers.

### 6.4.2 Musical Macro-Structure in Competitive Composition Games

For my competitive composition games, no particular musical structure is enshrined within or enacted by the music system itself. Rather, the flow and cadence of the designed gameplay loop defines a macro-structural possibility space under which the player’s live actions reify particular musical forms, whether consciously or otherwise. In short, designing gameplay is defining the music’s structural potentials. Given this relationship, it becomes apparent that *Idea*’s victory condition exerts structural influences on the player’s composition. *EvoMusic* and *Chase* eschew any means of ludic victory,\textsuperscript{195} and so posit no extramusical motivation to end a game session. With *Idea*, though, the promise of victory and progression incentivises players to reach the exit, thereby ending the level and so concluding their composition. Players are not strictly precluded from ad infinitum creation, as there is no designed limit on how long

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\textsuperscript{194} Salen and Zimmerman (2003) describe this “integration” of outcomes as crucial to meaningful play.

\textsuperscript{195} With “ludic” victory, I mean to delimit objectives like “reaching the exit” from the subjective compositional victories of achieving a desired musical state or discovering a novel musical outcome.
they can remain in any given level. Regardless, the fact that extramusical structural incentives emerge at all warrants careful consideration from designers in this context.

The looming potential of victory introduces a temporal pull towards ending the composition which, even if ignored by players, is notably absent from EvoMusic and Chase as designs without fixed, completable objectives. This applies to ludic victories of any scale: for instance, the allure of defeating hostile agents – a minor victory in the goal hierarchy – may prompt players to make compositional interventions sooner or later than they might have otherwise. As such, designers should be attentive to how their hierarchy of goals will structure the musical output and the player’s decision-making so that these relationships may be harnessed towards design aims. One might, for instance, impose certain musical structures through gameplay as a creative challenge or constraint. From a pedagogical perspective, one might explore the potential for victory and other ludic incentives to foster a proficiency in manipulating compositional form. In any case, the influence of Idea’s victory conditions reveals a valuable design insight: just as the temporality of competitive gameplay introduces compositional incentives for designers (4.4.2), so too may certain game elements harbour unexplored compositional incentives for players.

6.4.2.1 On Fixed Time Limits in Competitive Composition Games
Understanding these incentives allows reflection on the compositional suitability of particular competitive mechanics, for which fixed “time limits” are an exemplar. Time limits pervade game design; beyond their use for resolving protracted stalemates, time constraints offer an intuitive source of challenge and competitive strife in agonistic games. Whether appearing as an explicit numerical countdown or woven into the game environment, time limits nonetheless present a fixed duration within which the ludic objectives must be satisfied. Imposing a pre-ordained end point in this manner arbitrarily restricts the player’s free creation, depriving in particular their agency over musical form. As a game mechanic, then, fixed time limits can be understood as less conducive to real-time composition than competitive frameworks that need not rely on them. One might extend this reasoning to suggest that temporal pressures more generally are inconducive to composition, such as the need to intervene in EvoMusic’s

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196 For instance, the game environment might progressively become dangerous or inaccessible to the player as they run out of time, such as by flooding, igniting, or disappearing.
population growth before losing control of the musical output (4.1.4). The key
distinction, though, is that players can strain against such pressures for as long as they
desire; they enact and maintain composition through persistent competitive interaction,
an experience which in *EvoMusic* was conducive to musical creativity for nineteen of
the twenty-four participants (5.2.2.2).

6.4.2.2 On Puzzle-Design in Competitive Composition Games

Related is the use of puzzles as the basis of a competitive framework, the compositional
limitations for which I have outlined prior (2.2.2.3). Requiring a fixed series of
gameplay actions as a “solution”, and so too their sonic outputs, disincentivises free
experimentation with musical structure and content. This persists even when multiple
solutions are permitted, as with the sequencer-bridge puzzles in *Fract OSC*197 (2.5.3.2),
because the ludically correct or efficient musical outcomes are still incentivised over
other possibilities. A liberal interpretation might frame *Idea* as a series of open, multi-
solution puzzles due to the nature of its objective: combining musical motifs to open
doors in search of the correct path to the “exit”. Even so, *Idea* escapes the compositional
limitations of puzzle-designs by ensuring that no musical solution is superior to any
other with regard to their ludic functionality (6.2.2.2; 6.2.2.4). As with fixed time limits
(6.4.2.1), puzzles exemplify that certain competitive mechanics are markedly less
conducive to the compositional experience than other ludic design elements. My
approaches to circumventing these mechanics in my body of work, and their analysis
herein, illustrate how an awareness of gameplay’s compositional incentives can benefit
the realisation of design aims in the context of competitive composition games.

6.4.3 On *Idea*’s Broad Coverage of Design Dimensions

*Idea* exhibits a wider cross-section of select design dimensions, as shown prior (6.3.3;
Figure 32). This is the result of multiple features being discretely positioned along a
shared design dimension; with musical control, for instance, the basic interaction with
ideas supports an abstract and easily accessible compositional control, while the
advanced and comparatively explicit editing feature allows for more precise
interventions. This multi-tiered approach – where varying degrees of one dimension are
offered between separate, optional features – expands player choice by widening the

197 A demonstration is available at: https://www.youtube.com/watch?v=WYAf66otMNe&t=1m33s
(retrieved 30 April, 2020).
scope of interactions afforded by the system. As such, a “broad coverage” of design dimensions shows promise as a strategy for meeting the diverse expectations that players bring to composition game contexts (5.2.3.3; 5.3.1). However, there are associated design costs that warrant consideration, for which Idea’s response to the issue of “randomness” (6.1.2; 6.2.2.1) presents a demonstrative case.

Stochastic processes play a pivotal role in my composition games. They establish a point of entry for musical novices by assuming partial creative responsibility, offering an ever-renewing palette of compositional resources to be selectively harnessed by the player. For experts, the indeterminate content generation supports serendipitous discovery, a key aesthetic of creative experiences (2.2.3.2), while also providing a means of compositional challenge. The first study participants noted these creative benefits in EvoMusic (5.2.2.2), yet also lamented the lack of deterministic musical control that the stochastic design precluded (5.2.2.1.3). In response, Idea provides an avenue for the precise manipulation of initially stochastic content, thereby preserving the boons of indeterminate design while also addressing player expectations for more direct control. This illustrates a “broad coverage” approach as being useful for resolving design issues that stem from divergent player values, yet also suggests a notable cost to system usability and ease of learning (6.2.2.7). Each new feature or mechanic increases the cognitive demand on the player, lowers the barrier to entry, even if minimally, and incurs additional development costs for designers. It seems appropriate, then, for potential designers to carefully consider their target audience: those targeting a narrow player base with known expectations may benefit from a tightly scoped feature set that preserves system usability, while those targeting wider appeal to both novices and experts should consider a diverse feature set that affords multiple modes of interaction.

6.5 Chapter Summary

This chapter concludes my creative research. I have introduced Idea as a synthesis and further exploration of the player and practitioner insights revealed through phase one (6.1). The gameplay mechanics, music system, and competitive framework were detailed (6.2) before positioning Idea within the body of creative works (6.3). Finally, a discussion of practitioner insights generated through the development process reveal new design challenges and considerations to be negotiated in the context of competitive
composition games (6.4). My consolidated findings from the creative research are summarised following:

- Extramusical ludic objectives support more engaging competitive play, but detract from a focus on compositional interaction (4.4.1.1). In particular, the possibility of ludic victory promotes a primacy of extramusical decision-making (6.4.1.1).
- Musical accessibility, creative control, and competitive engagement share a delicate balance, where designing for one may detract from another (4.4.1.2). This persists across diverse approaches to implementing a competitive game framework (6.4.1.2).
- Different forms of competitive gameplay possess unique temporalities that incentivise particular musical mappings and sonic gestures (4.4.2). Certain competitive mechanics, such as victory, can also introduce unique structural and content incentives into player composition (6.4.2).
- Implementing diverse compositional features can address a wider cross-section of player expectations, though at cost to usability and ease of learning (6.4.3).

The comparative evaluation of Idea and EvoMusic (Chapter 7) will reflect on these findings, following which the literature, practitioner, and player insights are consolidated to address the research questions (7.4).
Chapter 7: Results and Discussion – Phase Two

This chapter discusses the results of a comparative user study (n=6) evaluating *EvoMusic* and *Idea* to further explore the player experience of composing through competitive gameplay. I introduce the study design and participant cohort (7.1) before reporting on the study results (7.2). Key player insights are then discussed with reference to literature and practitioner perspectives, revealing the design challenges and potentials of competitive composition games (7.3). I conclude by consolidating the phase one and two findings to address the research questions through a series of design recommendations and theoretical insights (7.4). The results discussed in this chapter have been not reported in any publication.

7.1 Study Overview

This user study continues the aims and design of the first (5.1), with the exception of two additional questions (7.1.1) and the substitution of *Idea* in place of *Chase*. An overview of the session structure is reiterated below:

1) Participant completes five closed questions (either polar or 5-point Likert-scale) relating to their past experience with music and games (Appendix A, Section 1).

2) Participant plays either *EvoMusic* or *Idea* (randomly assigned) for approximately 20 to 30 minutes including a short built-in tutorial.\(^{198}\)

3) Participant responds to the System Usability Scale (Appendix A, Section 2).

4) Participant answers eight hybridised questions relating to a set of pre-supposed themes (3.3.1.2); each involves a 5-point Likert-Scale response and short written elaboration (Appendix A, Section 3, Questions 1 to 8).

5) Participant completes two open form responses, identifying what they most enjoyed and suggesting areas for improvement (Appendix A, Section 4).

6) Participant plays the remaining game for approximately 20 to 30 minutes before repeating steps 3 to 5 with reference to the second game.

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\(^{198}\) Participants played the games on a MacBook Pro (15-inch, 2016) using the in-built keyboard, an external wireless mouse, and wired headphones (Sennheiser HD 280 Pro) for audio output.
7) Participants concluded by completing an extended, open-ended comparison between *EvoMusic* and *Idea*, nominating a preferred game, if any, and justifying their position (Appendix A, Section 8).

### 7.1.1 Alterations from the Phase One User Study

As discussed prior (5.3.3.1), the first user study revealed that participants’ implicit criteria for gameful experiences influenced both their overall enjoyment and specifically *compositional* perceptions. With the second user study, I aimed to more explicitly capture this relationship through two additional questions investigating the system’s perception as a “game” and “music creation” experience respectively (Appendix A, Section 3, Questions 7 & 8). These questions followed the hybrid format of a 5-point Likert scale response with a subsequent justification (3.3.2); Likert responses are summarised in Table 20. In prompting participants to “rate” each system through the separate ontological frameworks of “game” and “music creation”, I aimed to draw out the latent criteria and expectations for each that most shape player experience. This targeted format also facilitated a more focused evaluation of each system’s gameful and compositional affordances.

**Table 20:** Likert scale responses to the two additional questions in the second user study (Appendix A, Section 3, Questions 7 & 8).

<table>
<thead>
<tr>
<th>Likert Scale Response</th>
<th>Question</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>How would you rate <em>EvoMusic/Idea</em> as a <strong>music creation</strong> experience?</td>
<td>Very poor</td>
<td>Poor</td>
<td>Neither good nor poor</td>
<td>Good</td>
<td>Very good</td>
<td></td>
</tr>
<tr>
<td>How would you rate <em>EvoMusic/Idea</em> as a <strong>game</strong>?</td>
<td>Very poor</td>
<td>Poor</td>
<td>Neither good nor poor</td>
<td>Good</td>
<td>Very good</td>
<td></td>
</tr>
</tbody>
</table>

The only further alteration to the second study was the substitution of *Chase* with *Idea* as the game being evaluated alongside *EvoMusic*. This did not influence the structure of the study sessions: participants still experienced the games in a randomly prescribed order, and for the same duration of approximately 20 to 30 minutes.

### 7.1.1.1 On the Continued Use of Parametric Tests and Likert Scale Questions

In the first user study, parametric tests failed to accurately represent player perceptions of themes with diverse underlying values, such as *competition* (5.2.2.3.1) and *challenge* (5.2.2.3.2). Taking *challenge* as an example, this is attributable to the following:
Participants framed *challenge* through various aspects of interaction, such as gameplay difficulty or ease of musical control;

Participants held diverse criteria for assigning levels of *challenge* to each of these framings, such as what constitutes high or low challenge;

Participants demonstrated diverse valorisations of each assigned level of *challenge*, such as high challenge being desirable; and

Participants then justified these valorisations with varying contextual criteria, such as high challenge being desirable in games but not in composition;

The complexity of such interpretations was not articulated through quantitative analyses of Likert scale responses, as the diverse justifications for electing a response are lost once collapsed to a mean. Nonetheless, I have chosen to preserve the quantitative questions and their parametric testing for their contributions to the findings of the first phase of research. Firstly, all statistically significant differences between the games were strongly supported by qualitative responses, lending confidence to their respective conclusions; for instance, that *EvoMusic* was more creative than *Chase*. Secondly, the Likert scale responses of individual participants provided useful insight when interpreting their qualitative sentiments. Finally, comparison between an individual’s Likert and qualitative responses aided in identifying themes with complex underlying values; a qualitative sentiment with diverging Likert scale representations, or vice versa, suggested that a variety of criteria was shaping player perception.

### 7.1.2 Participant Cohort

Six participants were anonymously recruited from the undergraduate student cohort at the University of Newcastle, Australia under an HREC approved human ethics protocol. Three participants professed experience as both musicians and gamers, whilst the remaining three participants identified as neither. No meaningful quantitative comparisons could be drawn between these categories due to their limited sample sizes (n=3). However, the three inexperienced participants offered valuable qualitative insights.

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199 For complex themes like *challenge*, each possible Likert scale response posed a different meaning to each participant as informed by both their interpretation of “challenge” and their proclivity for it in creative and competitive contexts. As a result, comparing the “mean response” between games becomes less meaningful because it fails to capture the diversity of player values and interpretation.

200 For instance, it may clarify that a participant desires more challenge *despite* an already challenging design, rather than due to a *lack* of challenge.

201 The protocol is entitled “Evaluating game-based applications for real-time interactive music composition” (H-2018-0510), approved by the Human Research Ethics Committee on 20 February, 2019.
insights as the rare few to identify as gaming novices out of the 30 total participants surveyed during this research. No further demographics were collected as they are inapplicable to the research aims and questions (1.2).

7.1.2.1 Impact of COVID-19

The second user study was scheduled to run between March and May, 2020, over which I anticipated a similar number of participants to the first user study (n=24). Following the outbreak of COVID-19, however, the study was concluded prematurely for the safety of all involved. The resulting sample size (n=6) precluded the statistical confidence of the first user study, detracting in particular from the meaningfulness of the intended quantitative analysis methods (3.3.3.1). Nonetheless, the novel insights offered by the few participants were of value to this research, reflecting crucially upon the phase one findings, literature and practitioner perspectives, and research questions at large. The uncertain timeline of COVID-19 also precluded any certainty that a postponed user study would conclude within the four-year doctoral program prescribed by the Australian Qualifications Framework. For these reasons, I have proceeded with reporting the second study results in their current state.

7.1.2.2 Presentation of Statistical Data

In light of the small sample size (n=6), it is necessary to address a matter of data presentation. My reporting of the second study results (7.2) follows the format of the first (5.2): I present the results of statistical comparisons such as t-tests and frequency distributions in full detail, while also addressing these quantitative data in analysis. This raises a methodological concern regarding the validity of quantitative data comparisons, and any conclusions drawn from them, with so few participants. Nonetheless, I have reported all quantitative results to: 1) maintain data transparency; 2) compare responses to *EvoMusic* between studies; and 3) offer insight into the perceptions of participants with limited gaming experience, which the first study failed to capture (5.1.1). It should not be construed from this manner of statistical presentation that the second study results share an equal degree of significance or reliability to those of the first study (n=24). Qualitative responses should be taken as the primary expression of player experience.

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202 The final study session was conducted on Friday 20th March. Remaining sessions were cancelled to make clear that no participant would have an obligation to attend during the COVID-19 crisis. A state-wide lockdown of New South Wales, Australia commenced soon after on Tuesday 31st March.

203 Available at: https://www.aqf.edu.au/ (retrieved 7 May, 2020).
perceptions herein – particularly regarding complex themes such as *challenge* where statistical tests were shown to obscure a diversity of underlying player values (7.1.1.1).

7.2 Results

The user study results present unified characterisations of *Idea* and *EvoMusic* as contrasting designs. Their juxtaposition revealed a significant design tension between players’ ludic and compositional expectations. To articulate this, my reporting of results is structured as follows:

1) The general reception of the games is outlined to provide context (7.2.1);
2) Participant perceptions of primary themes are compared between games (7.2.2);
3) Responses pertinent to the interplay of composition and the competitive game framework are detailed (7.2.3); and
4) The results are summarised to construct characterisations of each design (7.2.4).

7.2.1 General Reception

*Idea* was the preferred experience overall when detached from any specific criteria. Four participants (67%) nominated *Idea* as their explicit preference, with the remaining two (33%) asserting that their preference was dependent on whether the primary motivation for playing was musical creation (*EvoMusic*) or gameplay enjoyment (*Idea*); see Figure 33. The excerpts below illustrated this dichotomy:

For gameplay and challenge it was *Idea*. For strict first-time use, for music control it was *EvoMusic*. (Participant 1)

I preferred *Idea* as a game to play - this is because it was much more interactive and challenging than *EvoMusic*, with clear goals to get people motivated. However, I preferred *EvoMusic* as a way to express creativity… (Participant 6)

All six participants described *Idea* as the superior gameplay experience, frequently attributing its ludic goals, progression, combat, or challenge. However, five participants (83%) also framed these elements as detracting from a compositional focus, revealing a marked ludocompositional dissonance within *Idea*’s design. This relationship is inverted for *EvoMusic*, which was characterised as the superior music creation experience, yet also as a poor “game” for lacking the same ludic elements that promoted
tension within Idea. This interplay crucially reflects on the research questions (1.2.1), as discussed further in (7.4).

Figure 33: Comparison of preferred game in final response (Appendix A, Section 8) by participant experience. “Variable Preference” denotes a participant whose preference shifted with their motivation for interacting, between music creation and gameplay enjoyment. *Note: no participant preferred EvoMusic.

7.2.2 Primary Themes

Likert-scale questions were used to address each of the pre-supposed themes (3.3.1.2), which now included the two additional inquiries into compositional and gameful expectations (7.1.1), as summarised in Table 21. The results of paired-samples t-tests comparing these themes between EvoMusic and Idea are summarised in Table 22; a graphical comparison is given in Figure 34. Despite the small sample size, significant differences were found in the level of challenge (Question 3: Table 22) and the overall game experience (Question 8: Table 22) between the two systems, with Idea rating higher in both cases. This characterisation of Idea as the superior, more challenging game design was uncontested throughout the qualitative responses and notably aligned with its design aims (6.1). Here, I outline participant perceptions of primary themes within EvoMusic and Idea using the following organisational categories: system control (7.2.2.1), compositional experience (7.2.2.2), and ludic experience (7.2.2.3).
Table 21: Summary of Questions 1-8 for Section 3 of the second user study. Likert-scale responses are available in Appendix A, Section 3.

<table>
<thead>
<tr>
<th>№</th>
<th>Theme</th>
<th>Question</th>
</tr>
</thead>
</table>
| 1  | Balance| How would you describe your level of creative control over the music in [the game]?
| 2  | Control| It was easy to direct the music towards a result that I desired in [the game].
| 3  | Challenge| I felt a sense of challenge while creating music in [the game].
| 4  | Creativity| I found that [the game] helped me to be musically creative.          |
| 5  | Competition| I felt that I had to compete against [the game] for creative control of the music. |
| 6  | Ownership| I felt a sense of ownership over the music created during my time playing [the game]. |
| 7  | Composition| How would you rate [the game] as a music creation experience?          |
| 8  | Game  | How would you rate [the game] as a game?                                |

Table 22: Statistical comparisons between EvoMusic and Idea for Likert-scale responses to Questions 1-8 (Appendix A, Section 3).

<table>
<thead>
<tr>
<th>Question</th>
<th>EvoMusic</th>
<th>Idea</th>
<th>Paired-samples t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>1 (balance)</td>
<td>3.33</td>
<td>1.21</td>
<td>3.33</td>
</tr>
<tr>
<td>2 (control)</td>
<td>2.67</td>
<td>1.37</td>
<td>2.83</td>
</tr>
<tr>
<td>3 (challenge)</td>
<td>2.17</td>
<td>1.17</td>
<td>4.00</td>
</tr>
<tr>
<td>4 (creativity)</td>
<td>3.33</td>
<td>1.03</td>
<td>2.67</td>
</tr>
<tr>
<td>5 (competition)</td>
<td>3.67</td>
<td>1.03</td>
<td>3.33</td>
</tr>
<tr>
<td>6 (ownership)</td>
<td>2.67</td>
<td>1.51</td>
<td>2.67</td>
</tr>
<tr>
<td>7 (composition)</td>
<td>3.33</td>
<td>1.03</td>
<td>3.17</td>
</tr>
<tr>
<td>8 (game)</td>
<td>2.67</td>
<td>0.82</td>
<td>4.00</td>
</tr>
</tbody>
</table>
Figure 34: Comparison of mean Likert-scale scores in *EvoMusic* and *Idea* (Appendix A, Section 3). Error bars show standard deviation; p-value is shown for significant differences found with paired-samples t-tests.

7.2.2.1 System Control

7.2.2.1.1 Balance

There was no qualitative or quantitative indication of a substantial difference between games with regard to the balance of compositional control between player and system. Both were roughly characterised as a balanced dialogue, as shown by the frequency distribution of Likert-scale responses (Table 23) and the following excerpts:

You could choose and delete music bubbles, but you didn't have total control because the bubbles formed created random noises within that bubble's category. (Participant 6: *EvoMusic*)

The game automatically gave a tone/idea, and then you could change/alter it if you wanted. (Participant 6: *Idea*)

Table 23: Compared frequency distributions of responses to Question 1 (Appendix A, Section 3): “How would you describe your level of creative control over the music in *EvoMusic*/*Idea*”.

<table>
<thead>
<tr>
<th>Responses (n = 6)</th>
<th>Distribution (EvoMusic)</th>
<th>% (EvoMusic)</th>
<th>Distribution (Idea)</th>
<th>% (Idea)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game had total control</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Game had most control</td>
<td>2</td>
<td>33.3</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>Balance between game and I</td>
<td>1</td>
<td>16.7</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>I had most control</td>
<td>2</td>
<td>33.3</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>I had total control</td>
<td>1</td>
<td>16.7</td>
<td>1</td>
<td>16.7</td>
</tr>
</tbody>
</table>
7.2.2.1.2 Usability and Access

A paired-samples t-test comparing the SUS scores found no significant difference between EvoMusic (M=77.08, SD=13.17) and Idea (M=62.08, SD=16.54) conditions; t(5)=2.2361, p = 0.0756. However, only EvoMusic attained the usability benchmark of “around seventy” (Bangor et al., 2009), with two participants (33%) also describing the experience as accessible or even helpful to musical novices:

You didn't need really any gaming or musical experience to play.
   (Participant 3)

Helpful for those not knowing where to start in music creativity as it gives them various starting points to choose from. (Participant 5)

In contrast, qualitative responses supported a perception of Idea as complex to learn and understand:

A lot going on so I couldn't control as much, but good challenge.
   (Participant 1)

It was easy to edit ideas to how you wanted them individually, but I didn't understand how you were meant to make a composition/put them together. (Participant 3)

The ways you could control the music with hoops and tones was a little confusing, but with practice would probably become easier. (Participant 6)

The above excerpts were drawn from the three participants with limited musical or gaming experience, who found no such usability issues with EvoMusic. In fact, a paired-samples t-test comparing the SUS scores of the non-musician participants found a significant difference between EvoMusic (M=79.17, SD=13.77) and Idea (M=53.33, SD=17.74); t(2)=7.7500, p = 0.0162. This suggests Idea as being potentially inaccessible to novice users, reflecting the reduced usability that I had anticipated with Idea’s design (6.2.2.7; 6.3.1). As such, I am confident that Idea would demonstrate significantly lower usability than EvoMusic given a larger sample size.

7.2.2.1.3 Compositional Control

A paired-samples t-test comparing the ease of creative control (Table 22: Question 2) found no significant difference for the EvoMusic (M=2.67, SD=1.37) and Idea (M=2.83, SD=1.17) conditions; t(5)=0.2774, p = 0.7926. There was also little
qualitative indication of a notable difference, as each game had three participants (50%) perceive it as affording greater control than the other. The factors reported as influencing control were distinct for each game. For EvoMusic, as in the first study (5.2.2.1.3), the perceived “randomness” of music generation and gameplay detracted from a sense of direct creative control, regardless of whether participants perceived a high or low degree of control:

You could choose and delete music bubbles, but you didn’t have total control because the bubbles formed created random noises within that bubble’s category. (Participant 6, justifying a 4/5 rating for ease of control [Table 21: Question 2])

You had no control over any rhythm and very little over the notes. So really there was no way to actively shape it into being anything other than what the game created for you. (Participant 4, justifying a 1/5 rating for ease of control)

For Idea, the factor detracting from control was the need to address multiple competitive mechanics and incentives. For three participants (50%), this manifested as a usability issue, as exemplified prior (7.2.2.1.2). Of greater interest, though, is the two participants (33%) for whom the presence of competitive forces disincentivised efforts towards musical control in the first place:

When the “enemy” type things were added in I was more focused on destroying them than the overall sound. (Participant 4)

I enjoyed the experience more when I stopped trying to have control over what the music sounded like. (Participant 2)

This revealed a ludocompositional dissonance promoted by Idea’s design, which recurred throughout the results as a crucial influence upon other compositional perceptions. For now, a notable result is that Idea was not viewed as offering any deeper creative control than EvoMusic, contradicting my initial design presumptions (6.3.1).

7.2.2.2 Compositional Experience

7.2.2.2.1 Musical Creativity

A paired-samples t-test comparing the level of musical creativity experienced by players (Table 22: Question 4) found no significant difference between EvoMusic (M=3.33, SD=1.03) and Idea (M=2.67, SD=1.21); t(5)=1.3484, p = 0.2354. However, the
frequency distribution of responses (Table 24) suggested that *EvoMusic* was the system more conducive to musical creativity. This was supported by the final qualitative comparison (Appendix A, Section 8); although each game was equally represented as offering greater *control* than the other, only *EvoMusic* was described as affording greater *creativity* specifically:

… I preferred *EvoMusic* as a way to express creativity - this is because I had a large amount of creative control over the music produced… (Participant 6)

Table 24: Compared frequency distributions of responses to Question 4 (Appendix A, Section 3): “I found that *EvoMusic/Idea* helped me to be musically creative”.

<table>
<thead>
<tr>
<th>Responses (n = 6)</th>
<th>Distribution (EvoMusic)</th>
<th>% (EvoMusic)</th>
<th>Distribution (Idea)</th>
<th>% (Idea)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
<td>33.3</td>
<td>4</td>
<td>66.7</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>Agree</td>
<td>4</td>
<td>66.7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>16.7</td>
</tr>
</tbody>
</table>

For *EvoMusic*, the depth and diversity of musical *control* was shown as the primary factor influencing perceived *creativity*:

The range and control the user has. (Participant 4, justifying a 4/5 rating for musical creativity [Table 21: Question 4])

To be creative I believe you need to have control over what you are doing. In this game the player was pretty much at the mercy of the computer. (Participant 3, justifying a 2/5 rating for musical creativity)

For *Idea*, the predominant factor shaping perceived musical *creativity* was the system’s ludic status. Four participants (67%) described the ludic framework as inhibiting creativity, whether by distracting from their compositional focus with competitive incentives or by delegitimising the compositional act via its gameful context:

I was more focused on passing the level than being musically creative. (Participant 6)

I didn't really feel like the game was helping me compose music or be creative. It was something you could chose to do, but it didn't really feel like the game was focused on composing. It was more of a game. (Participant 3)

More game like than music creation based. (Participant 1)
I enjoyed the game as a whole but wouldn’t use it to create music. Maybe…I could use it to play around with and brainstorm before the “real” music-making. (Participant 2)

Again, this demonstrated a player experience of ludocompositional dissonance when interacting with *Idea*.

7.2.2.2.2 Ownership

The paired-samples t-test comparing the level of ownership over musical outcomes (Table 22: Question 4) found no significant difference for the *EvoMusic* (M=2.67, SD=1.51) and *Idea* (M=2.67, SD=1.37) conditions; t(5)=0, p = 1. For *EvoMusic*, ownership was primarily influenced by the perceived degree of creative control. Regardless of the level of ownership reported, five participants (83%) referenced control in their qualitative justifications, as exemplified below:

The large amount of creative control meant that I felt responsible for the music created. (Participant 6)

I was not the one creating the music, it was all done by the computer and was out of my control so I cannot take/feel ownership over it. (Participant 3)

For *Idea*, the factor most shaping perceived ownership was again the interference of the ludic framework. Four participants (67%) described a focus on addressing *Idea’s* ludic incentives over compositional decision-making, rendering the musical output as “secondary” or “background” to the competitive gameplay experience and so precluding a sense of ownership:

The game created the music as I tried to pass the level. If I wanted, I could change/edit it, but I wasn’t really focused on doing this. (Participant 6)

I didn't really feel like I was creating music, more just that I was playing a game. The music was secondary and I wasn’t really super conscious of it or manipulating it too much, so it didn’t really feel like ownership. (Participant 3)

Too busy doing other tasks. Felt like I just had it going on in background. (Participant 1)

[The music] had a more background vibe to it. (Participant 4)
Compositional Expectations

A paired-samples t-test comparing the systems as music creation experiences (Table 22: Question 7) found no significant difference between *EvoMusic* (M=3.33, SD=1.03) and *Idea* (M=3.17, SD=0.98); t(5)=0.4152, p = 0.6952. However, the frequency distribution of responses (Table 25) shows that only one participant (17%) rated *Idea* as at least a “good” music creation experience, compared to four participants (67%) for *EvoMusic*. This characterisation was supported by responses to the final qualitative comparison (Appendix A, Section 8), which suggested that *EvoMusic* was the superior compositional experience:

...I preferred *EvoMusic* as a way to express creativity – this is because I had a large amount of creative control over the music produced. (Participant 6)

For gameplay and challenge it was *Idea*...for music control it was *EvoMusic*. (Participant 1)

**Table 25**: Compared frequency distributions of responses to Question 7 (Appendix A, Section 3): “How would you rate *EvoMusic*/*Idea* as a music creation experience?”

<table>
<thead>
<tr>
<th>Responses (n = 6)</th>
<th>Distribution <em>(EvoMusic)</em> % <em>(EvoMusic)</em></th>
<th>Distribution <em>(Idea)</em> % <em>(Idea)</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Poor</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>Neither good nor poor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Good</td>
<td>4</td>
<td>66.7</td>
</tr>
<tr>
<td>Very good</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

As the excerpts above show, compositional *control* emerged as the key value informing participant expectations for music creation experiences. Five participants (83%) attributed their perception of *EvoMusic*’s compositional efficacy, whether good or poor, to its degree of musical control:

A lot of creative control. Easy to use and modify the music produced. An interactive way of creating music. (Participant 6)

...the user was not expressing their own creativity as able to take control over the creative process. (Participant 2)

This extended to *Idea*, with three participants (50%) indicating that musical control influenced their ratings, whether good or poor:
The editing view was very simple to use and offered a wide variety of music sound to choose from. (Participant 5)

Not as much direct control [as EvoMusic]. (Participant 1)

These sentiments solidify musical control as the principal design dimension informing players’ compositional expectations and experience – particularly given its reported influence on perceived creativity (7.2.2.2.1) and ownership (7.2.2.2.2).

Beyond control, Idea’s reception as a music creation system was again shaped by the interference of ludic incentives. Three participants (50%) once more positioned composition as secondary or a “backdrop” to the game experience:

It’s interactive, challenging and fun. But, the main focus was on the game rather than music creation. (Participant 6)

As a music creation experience I’d say poor because it felt like just any random game rather than specifically a “music creation experience”. (Participant 3)

I enjoyed the experience more when I stopped trying to have control over what the music sounded like…the sounds…were a fun backdrop to the gameplay. (Participant 2)

Considered overall, the pronounced ludocompositional dissonance in Idea has been shown to influence perceptions of musical control (7.2.2.1.3), creativity (7.2.2.2.1), ownership (7.2.2.2.2), and Idea’s broader conception as a music creation system. The design implications are discussed further in (7.3.1.3).

7.2.2.3 Ludic Experience

7.2.2.3.1 Challenge

Interacting with Idea was unequivocally perceived as the more challenging experience. A paired-samples t-test to compare the level of challenge while creating music (Table 22: Question 3) found a significant difference between the EvoMusic (M=2.17, SD=1.17) and Idea (M=4.00, SD=0.63) conditions; t(5)=5.9656, p = 0.0019. As a comparative evaluation, all six participants rated Idea as more challenging than EvoMusic; as an absolute evaluation, five participants (83%) at least “agreed” that Idea was challenging whereas four participants (67%) either “disagreed” or “strongly disagreed” that EvoMusic was challenging (Table 26).
Table 26: Compared frequency distributions of responses to Question 3 (Appendix A, Section 3): “I felt a sense of challenge while creating music in EvoMusic/Idea”.

<table>
<thead>
<tr>
<th>Responses (n = 6)</th>
<th>Distribution (EvoMusic)</th>
<th>% (EvoMusic)</th>
<th>Distribution (Idea)</th>
<th>% (Idea)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly disagree</td>
<td>2</td>
<td>33.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Disagree</td>
<td>2</td>
<td>33.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Neither agree nor disagree</td>
<td>1</td>
<td>16.7</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>Agree</td>
<td>1</td>
<td>16.7</td>
<td>4</td>
<td>66.7</td>
</tr>
<tr>
<td>Strongly agree</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>16.7</td>
</tr>
</tbody>
</table>

For *EvoMusic*, two participants (33%) attributed their perceived lack of challenge to the absence of extramusical goals or obstacles to strain against:204

There was no goal or anything in particular to “fight” against or avoid; the cubes205 could be added or removed at my discretion and I found I used them only to destroy all of the sounds and start again. (Participant 2)

I wasn’t really striving to achieve anything - really just playing around and experimenting with the sounds. (Participant 6)

Notably, participant six excludes “experimentation” with sound from consideration as a motivating goal – a sentiment reflected in the first study results (5.2.3.1). For *Idea*, five participants (83%) framed their explicit combat with the game’s hostile agents as the source of challenge, with participant three also attributing the sequential progression of game levels:

The enemies were a good challenge that brought a sense of gameplay to this music creating game. Also being able to lose a level brought more challenge. (Participant 5)

The hostiles made it challenging… Also the sequential levels contributed to a sense of challenge. (Participant 3)

These responses suggested that players, when considering challenge in game contexts, expected traditional forms of ludic competition: explicit combat, ludic progression, or strife towards extramusical goals. This also implicitly positioned compositional interaction as external to the expected ludic challenge structure – a sentiment made explicit by participant two:

…the real “challenge” felt like it wasn’t necessarily the music itself but the levels. (Participant 2)

---

204 No other participants provided a clear justification for why *EvoMusic* was found to be challenging.

205 This referred to the “destructive cells” in *EvoMusic* (see 4.1.4).
7.2.2.3.2 Competition

A paired-samples t-test comparing the level of compositional contest (Table 22: Question 5) found no significant difference between EvoMusic (M=3.67, SD=1.03) and Idea (M=3.33, SD=1.63); t(5)=0.3953, p = 0.7089. However, the qualitative responses offer critical further insight. Five participants (83%) identified the intended competitive dynamic in EvoMusic, referencing the system’s proactive gestures, such as cell growth, rather than any struggle against usability issues:

Cells dividing creating more sound and more random cells gives a sense of being overwhelmed by the sheer number of cells and the noise. I felt I needed to control the situation so it wouldn't go further out of hand. (Participant 5)

The growth of the bubbles as well as the unpredictable nature of the timing and sound of the music they emitted left me frustrated. (Participant 2)

While participant two (above) showed that this competitive dialogue was not always enjoyed or desired, four of these participants (67%) also “agreed” that EvoMusic engendered a sense of musical creativity.

No participant identified a specifically compositional contest within Idea. Two participants (33%) described a high level of musical control as precluding their sense of competition:

I was in complete control of the music being able to change any sound however I wanted. (Participant 5, justifying a 1/5 rating for level of compositional contest [Table 21: Question 5])

If I wanted to, I could change the music that was given. (Participant 6, justifying a 2/5 rating for level of compositional contest)

Inversely, three participants (50%) did identify the competitive dynamic within Idea, but described music creation as peripheral to this dialogue:

The aims of the levels were not to create music (strictly), they were to have a specific number of sounds playing at once while avoiding enemies and competing with both the movements of the sound and their interactions with other stationary and moving objects. (Participant 2)

Again, the enemies. More focused on just destroying them than sound. (Participant 4, justifying a 5/5 rating for level of compositional contest)
Once more, this highlighted the pervasive ludocompositional dissonance underpinning interaction with *Idea* and its wide influence on compositional perceptions.

### 7.2.2.3.3 Ludic Expectations

A paired-samples t-test comparing the systems as games (Table 22: Question 8) found a significant difference between *EvoMusic* (M=2.67, SD=0.82) and *Idea* (M=4.00, SD=0.63); t(5)=3.1623, p = 0.0250. The frequency distribution of responses (Table 27) also supported *Idea* as better meeting players’ ludic expectations, with five participants (83%) rating it as at least “good” compared to only one participant (17%) for *EvoMusic*.

**Table 27**: Compared frequency distributions of responses to Question 7 (Appendix A, Section 3): “How would you rate *EvoMusic*/*Idea* as a game?”

<table>
<thead>
<tr>
<th>Responses (n = 6)</th>
<th>Distribution (%)<em>EvoMusic</em></th>
<th>Distribution (%)<em>Idea</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Very poor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Poor</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Neither good nor poor</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>Good</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>Very good</td>
<td>0</td>
<td>16.7</td>
</tr>
</tbody>
</table>

Qualitative justifications were similarly unified. For *EvoMusic*, five participants (83%) suggested that the lack of traditional ludic goals, progression, or challenge lessened its value as a “game”, linking this in particular to “motivation” or “interest”:

Not very challenging and no real “aim” to keep you motivated. (Participant 6)

It was visually appealing and vaguely entertaining, but overall kind of pointless. There was no way to improve or progress and any player would lose interest very easily. (Participant 3)

For *Idea*, three participants (50%) valued the higher level of challenge when rating it as a “good” game, with participant five also referencing the reward and progression structure:

It had challenge with its enemy system and the ability to lose the level. Also being able to collect tones and sounds is a good reward for players seeking to diversify their ideas they find. (Participant 5)

A lot of challenges and tasks. (Participant 1, justifying a 5/5 rating as a “game” [Table 21: Question 8])
It’s interactive, challenging and fun. (Participant 6, justifying a 4/5 rating as a “game”)

This suggested challenge as being central to players’ ludic expectations, implicating by extension the elements of combat, progression, and goals that were reported as core expectations of challenging gameplay (7.2.2.3.1).

7.2.3 Composition and the Game Framework

Thus far, the dissonance between ludic and musically creative incentives in Idea has been shown to comprehensively influence the compositional experience, shaping perceptions of musical control (7.2.2.1.3), creativity (7.2.2.2.1), ownership (7.2.2.2.2), compositional contest (7.2.2.3.2), and the game’s reception as a composition system more generally (7.2.2.2.3). This relationship warrants closer examination, particularly considering that none of the thirty total participants surveyed across both user studies alluded to such a tension within EvoMusic.

7.2.3.1 Factors Informing Ludocompositional Dissonance

Ludocompositional dissonance was referenced by five participants (83%) in at least one qualitative response, for a total of nineteen unique mentions throughout the survey. The factors informing these perceptions are compared in Table 28, as categorised by total mentions and per unique participant. The most frequent explanation, given by four participants (67%), was Idea’s general “ludic focus” – a perception that music creation was peripheral to the gameplay experience without attributing any specific design element:

More game like than music creation based. (Participant 1)

…it was more of a game with background music. (Participant 3)

It’s interactive, challenging and fun. But, the main focus was on the game rather than music creation. (Participant 6)
Table 28: Frequency of justifications for ludocompositional dissonance by total mentions and per unique participant. Note: some participants expressed multiple justifications per mention.

<table>
<thead>
<tr>
<th>Justification</th>
<th>№ of mentions</th>
<th>% of total mentions (19)</th>
<th>Frequency in participants</th>
<th>% of total participants (6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ludic focus</td>
<td>12</td>
<td>63.2</td>
<td>4</td>
<td>66.7</td>
</tr>
<tr>
<td>Combat</td>
<td>6</td>
<td>31.6</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Goals/victory</td>
<td>5</td>
<td>26.3</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>Challenge</td>
<td>2</td>
<td>10.5</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>Aesthetic</td>
<td>1</td>
<td>5.3</td>
<td>1</td>
<td>16.7</td>
</tr>
</tbody>
</table>

A range of competitive game elements were reported to supersede compositional decision-making as a player priority (Table 28). Three participants (50%) prioritised combating hostiles over the musical outcome, two (33%) prioritised meeting the goals or victory conditions, and two (33%) prioritised the sense of challenge invoked by engaging these competitive mechanics. These sentiments are respectively exemplified below:

When the “enemy” type things were added in I was more focused on destroying them than the overall sound. (Participant 4)

…felt like the aim of the game was to get through the levels, not create the music you may necessarily want to. (Participant 2)

…the real “challenge” felt like it wasn't necessarily the music itself but the levels. (Participant 2)

Finally, *Idea* also prompted what can be construed as the first *aesthetic* objection to the synthesis of competitive and musically creative interaction; the following excerpt stood as the singular case across all qualitative responses in both user studies:

The hostiles made it challenging…I’d rather just make music, not be chased around by something eating my notes. (Participant 3)

Only participant five did not allude to a ludocompositional dissonance. Not only did they greatly enjoy *Idea*, but readily reconciled the competitive elements as a valuable addition to the music-making experience:

The enemies were a good challenge that brought a sense of gameplay to this music creating game. (Participant 5)

*Idea* had objects, it had risk of enemies taking away some of the things you used to create music and it rewarded you with new tones, Ideas,
percussion and sound. It was very enjoyable, I wish I could have played longer. (Participant 5)

This showed that even a more explicit ludic framework – with combat, challenge, risks, and rewards – could be reconciled with musical creativity by certain outlying player types. To reiterate, though, five of the six participants (83%) found Idea’s ludic elements to conflict with, disincentivise, or distract from composition.

7.2.3.2 Player Suggestions: Ludic versus Compositional Expectations

A comparison of participant suggestions for improving each game (Appendix A, Section 4, Question 2) revealed a surprising design convergence: that the changes suggested for EvoMusic would bring it closer to Idea’s design, and vice versa. Five participants (83%) advised the addition of either ludic goals or increased challenge in EvoMusic to further motivate engagement:

Creating a more challenging version of the game with a clear aim or goal would help to get people interested in the game. (Participant 6)

There was no particular aim to the game which isn’t bad in and of itself but I felt kind of lost…Introduce some sort of challenge? (Participant 2)

An added purpose or point system. (Participant 4)

However, the same five participants (83%) perceived these elements as detracting from a compositional focus within Idea (7.2.3.1). In turn, the most frequent suggestion for Idea was to support a greater focus on music creation, as articulated by three participants (50%):

Make the music creation more pertinent. (Participant 3)

There wasn’t a large focus on music creation – somehow incorporate this a bit more? The focus tends to be on the game itself and passing levels. (Participant 6)

…a mechanic where you could just make music freely separate to the gameplay and be able to access all tones and save music if you wish. (Participant 5)

These responses revealed a tension between players’ ludic and compositional expectations. Reducing the ludic elements in Idea might regain its compositional focus, though EvoMusic was perceived as a poor “game” precisely for lacking such elements
(7.2.2.3.3). In turn, to introduce these elements into *EvoMusic* – as five participants (83%) suggested – would risk inviting the same ludocompositional dissonance identified within *Idea*, and so the issue recurs. Two participants (33%) articulated both sentiments,\(^{206}\) indicating that there is perhaps a balance point between the two designs where players’ ludic expectations could be met without eclipsing compositional interaction. Conversely, participant five suggested that *Idea* would benefit from a separate mode for free musical creation, as shown in the excerpt above. The design implications are discussed further in (7.3.1.1; 7.3.1.2).

7.2.3.3 Ludic Challenge and Musical Control

As with the first user study (5.2.3.2), qualitative responses highlighted a design tension between compositional control and ludic challenge. Three participants (50%) described *EvoMusic*’s pause function as significant to exerting musical control, with participant three even framing it as the only avenue for creative intervention:

> The only way to have any kind of control over the music was to pause the game and try to delete everything which sounded wrong. (Participant 3)

However, the pause function also circumvents *EvoMusic*’s competitive dialogue by halting the population’s exponential growth, thereby reducing the level of challenge in exchange for heightened musical control. Responses to *Idea* similarly reflected this tension. Two participants (33%) indicated that a high level of musical control precluded a sense of compositional competition:

> If I wanted to, I could change the music that was given. (Participant 6, justifying a 2/5 rating for level of compositional contest [Table 21: Question 5])

> I was in complete control of the music being able to change any sound however I wanted. (Participant 5, justifying a 1/5 rating for level of compositional contest)

Inversely, participant two found that *Idea*’s competitive elements encouraged the outright abandonment of musical control:

---

\(^{206}\) That is, expressing that *EvoMusic* should introduce ludic goals and challenge to increase motivation, yet also that *Idea* should be more focused on music creation.
...I quickly realised that because of the presence of hostiles and drones I wouldn't have the time to modify a single idea’s sounds as I wanted, let alone all those on a level. (Participant 2)

I enjoyed the experience more when I stopped trying to have control over what the music sounded like. (Participant 2)

Despite first experiencing this disincentivising effect in Idea, participant two still went on to express a desire for greater challenge in EvoMusic (7.2.3.2). As before (5.2.3.2), this highlighted the somewhat inverse relationship between designing for either musical control or ludic challenge.

7.2.3.4 Comparing Player Preferences

Finally, a comparison of how participants justified their preferred game (Appendix A, Section 8) offered critical context to Idea’s position as the preferred design overall (7.2.1). Four participants (67%) explicitly nominated Idea as their preferred experience; the remaining two participants (33%) were divided, instead providing potential justifications for each game. The resulting six justifications for preferring Idea were centred on the gameplay experience, focusing particularly on its ludic goals and increased challenge (Table 29).

<table>
<thead>
<tr>
<th>Justification</th>
<th>Frequency</th>
<th>% of total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gameplay</td>
<td>4</td>
<td>66.7</td>
</tr>
<tr>
<td>Goals</td>
<td>4</td>
<td>66.7</td>
</tr>
<tr>
<td>Challenge</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>Combat/enemies</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>Musical control</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>Rewards</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>Graphics</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>Sound quality</td>
<td>1</td>
<td>16.7</td>
</tr>
</tbody>
</table>

In contrast, the two participants (33%) offering justifications for preferring EvoMusic focused on the compositional experience, noting both improved musical control and perceived creativity (Table 30).

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207 Participant two played Idea before EvoMusic.
Table 30: Frequency of justifications for preferring *EvoMusic* in the final comparison (Appendix A, Section 8). Note: some participants expressed multiple justifications.

<table>
<thead>
<tr>
<th>Justification</th>
<th>Frequency</th>
<th>% of total participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Musical control</td>
<td>2</td>
<td>33.3</td>
</tr>
<tr>
<td>Creativity</td>
<td>1</td>
<td>16.7</td>
</tr>
<tr>
<td>Ease of learning</td>
<td>1</td>
<td>16.7</td>
</tr>
</tbody>
</table>

The contrasting foci of these justifications for *Idea* and *EvoMusic* aligned with their perceptions as the stronger “game” (7.2.2.3.3) and composition experience (7.2.2.2.3) respectively, suggesting that *Idea* was preferred for gameplay and *EvoMusic* for music creation. In light of *Idea* being the preferred design overall, then, one potential implication is that players may value their ludic expectations above those for musical creation in the context of competitive composition games. The limitations and design implications of this conclusion are discussed further in (7.3.1.2).

### 7.2.4 Summary of Results

The study results characterise *EvoMusic* and *Idea* as two opposing poles of a design tension between players’ ludic and compositional expectations. *Idea* was the clearly preferred gameplay experience (7.2.1, 7.2.3.4) due to its increased challenge (7.2.2.3.1), ludic goals, progression, and combat (7.2.2.3.3). However, these competitive elements were shown to inhibit the compositional experience (7.2.3.1), relegating music creation to the “background” (7.2.2.2.2) or even disincentivising compositional interaction altogether (7.2.2.1.3, 7.2.3.3). Inversely, *EvoMusic* was characterised as the stronger composition experience (7.2.2.2.3, 7.2.3.4), yet also as the weaker “game” for its lack of goals, progression, and challenge (7.2.2.3.3, 7.2.3.2). To summarise: *Idea*’s ludic focus weakened its compositional experience, and *EvoMusic*’s compositional focus weakened its ludic experience. Two further results become significant in light of this relationship: that while *Idea* was the preferred experience overall (7.2.3.4), *EvoMusic* was the more successful at eliciting a compositional contest between player and system (7.2.2.3.2).
7.2.4.1 Significant Quantitative Results

Statistically significant\textsuperscript{208} results from the paired-samples t-tests comparing EvoMusic and Idea are as follows:

- In perceived challenge, Idea (M=4.00, SD=0.63) rated higher than EvoMusic (M=2.17, SD=1.17); t(5)=5.9656, p = 0.0019
- In reception as a game experience, Idea (M=4.00, SD=0.63) rated higher than EvoMusic (M=2.67, SD=0.82); t(5)=3.1623, p = 0.0250
- In perceived usability among non-musicians, EvoMusic (M=79.17, SD=13.77) rated higher than Idea (M=53.33, SD=17.74); t(2)=7.7500, p = 0.0162

Despite the small sample size (n=6), these conclusions were strongly supported by qualitative responses and so were taken as accurate representations of player experience.

7.3 Discussion

The results of the second user study offered substantial insight into the challenges and potentials of competitive, game-based composition. Here, I unpack the salient player insights (7.3.1) before exploring their implications for the literature (7.3.2) and practitioner (7.3.3) perspectives addressed thus far.

7.3.1 Constructing Player Insights

7.3.1.1 Composition as Paidia and its Expectations

EvoMusic was characterised as a stronger compositional experience than both Idea and Chase, yet also as the weaker “game” in each comparison. As before (5.3.1), the fact that EvoMusic offered preferable music creation to its more ludic counterparts implicitly aligns compositional interaction with paidia. It is notable, then, that musical control once more emerged as the most significant value informing players’ compositional perceptions and expectations (7.2.2.2.3). A high degree of musical control was shown in both studies as detracting from challenge and competition, and vice versa (5.2.3.2; 7.2.2.3.2; 7.2.3.3). That musical control, as the most valued compositional expectation, existed in tension with these core aspects of ludus again characterises composition as a paidic activity.

\textsuperscript{208} The threshold for significance was set at a confidence interval of 95\% (\( \alpha = 0.05 \)).
Players’ compositional values not only conflicted with *ludus* in the abstract, but with their mechanical expectations for game design. Both studies featured participants who simultaneously expressed: 1) the importance of musical control, 2) its inverse relationship with challenge, and 3) a desire for greater challenge (5.2.3.2; 7.2.3.3). Both also revealed a desire for additional ludic goals in *EvoMusic* (5.2.3.1; 7.2.3.2), despite their characterisation in *Idea* as being detrimental to the music creation experience (7.2.3.1) and a subsequent desire for composition to be made more prominent (7.2.3.2). Most explicitly, three participants (50%) even suggested a separation of ludic and compositional interaction in *Idea*:

I enjoyed it a lot more when I was either playing right through the levels or playing with the music in sandbox mode.\(^{209}\) (Participant 2)

I’m unsure if this was in there but a mechanic where you could just make music freely separate to the gameplay and be able to access all tones and save music if you wish. (Participant 5, suggesting how *Idea* might be improved)

I’d rather just make music, not be chased around by something eating my notes. (Participant 3)

One suggestion here is that music creation and competitive gameplay are simply better enjoyed as discrete experiences. Conversely, the design convergence implied by participant suggestions (7.2.3.2) would indicate that an appropriate balance between the two may indeed be attainable – even if differing for each player. Either case reveals a fundamental design tension: that composition and competitive games, in the way there are experienced, characterised, and valued by players, seem in many ways opposed.

### 7.3.1.2 The Primacy of Ludus

The ludic elements within *Idea* were shown to interfere with compositional interaction (7.2.3.1). Interestingly, this did not occur in reverse: there were no reported circumstances where musically creative aims took precedence over *Idea*’s ludic imperatives. Implicit here is the suggestion that players may prioritise ludic over compositional engagement whenever the two coincide. The small sample size (n=6) precludes confidence in this conclusion, whilst the first user study contradicts it: *Chase*,

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\(^{209}\) In *Idea*, “sandbox mode” referred to a setting which disabled all hostiles and door opening mechanics, removing the competitive framework entirely. No other participant noticed its availability, as shown by participant five’s request for such a feature.
as the more ludic design than *EvoMusic*, was preferred at less than half the frequency (5.2.1). However, *Idea*’s position as the preferred design overall was clearly attributed to its gameplay, challenge, ludic goals, and combat (7.2.3.4), seemingly superseding *EvoMusic*’s reception as the stronger composition experience (7.2.2.2.3). For participant two, *Idea*’s competitive framework even encouraged a reframing and subsequent renouncement of compositional affordances in terms of their ludic necessity:

The aims of the levels were not to create music (strictly)...I had to collect the tones which I ended up skipping as time progressed because they weren't necessary. (Participant 2)

That such a relationship emerged at all bears significant design implications for competitive composition games, and so warrants an accounting.

To begin, this apparent ludic primacy may be a structural and temporal idiosyncrasy of games with loss conditions. The encroaching hostiles in *Idea* and *Chase* present an imminent threat to the play session itself, and so must be addressed with greater urgency than the player’s musical aims. A further possibility is that competitive gameplay is a more engaging mode of interaction than musical creation. Requests for clearer goals and greater challenge in *EvoMusic* were often linked to “motivation” or “interest” (7.2.2.3.3), while *Idea* was often described as the more “fun”, “interactive”, or “meaningful” experience in the final comparison (Appendix A, Section 8) as a result of these elements:

*Idea* – it was more fun because there was something you were working towards, to get to the doors and destroy the enemies. (Participant 4)

I preferred *Idea* as a game to play – this is because it was much more interactive and challenging than *EvoMusic*, with clear goals to get people motivated. (Participant 6)

I definitely preferred *Idea*. It looked nicer, sounded nicer, there were more options with both gameplay and sound, it actually had some meaningful gameplay and I enjoyed my time with it. (Participant 2)

This is reflected in the aims of gamification more broadly (1.4.3), being to motivate and engage through goals and challenge (2.2.3.3). As such, it seems likely that competitive gaming more readily invokes desirable psychological experiences – such as *competence* (Ryan et al., 2006) or Flow (Csíkszentmihályi, 1990) – than any of the compositional interactions afforded by *EvoMusic, Chase*, and *Idea*. In this vein, one further possibility
is that gameplay, given its current cultural pervasion (1.4.1), simply has wider appeal than the comparatively esoteric act of composition.

In any of these cases, it must still be reconciled that Chase was not preferred as often as the markedly less ludic EvoMusic, making pertinent a consideration of how Chase and Idea differ. Both can be “lost”, both feature hostile agents, and they even harness a similar pursuit metaphor, yet Idea by far posits the more explicit ludic framework through its elements of victory, progression, and direct combat (6.3.2.1). It is perhaps the case, then, that this ludic primacy only emerges from a traditionally “complete” game framework. Ludocompositional dissonance was only rarely noted in Chase (5.2.2.3.2) despite a similar structural-temporal urgency to forego musical decision-making when escaping imminent defeat. This unearths a crucial design consideration: that stronger game frameworks may eclipse the music creation experience, but appeal to player preference and are nonetheless expected within gameful contexts.

7.3.1.3 Composition Competitions

Despite the many design challenges revealed thus far, there are also latent potentials at the nexus of interactive composition and competitive gameplay. Five participants (83%) identified the compositionally competitive dialogue within EvoMusic (7.2.2.3.2), with four (67%) of these participants also characterising EvoMusic as a musically creative experience (7.2.2.2.1). This recalled the first study (n=24), in which fourteen participants (58%) described EvoMusic as simultaneously creative and compositionally competitive (5.3.1). Of the 30 total participants surveyed, then, eighteen (60%) were able to reconcile the competitive dynamic of EvoMusic with composition, suggesting once more (5.3.1) that the two can successfully coexist for certain types of players. The contrasting response to Idea, however, offered crucial further insight.

No participant characterised Idea as a specifically compositionally contest (7.2.2.3.2). This was an unsurprising result, given that five participants (83%) reported a focus on ludic elements rather than musical creation during their play session (7.2.3.1). Only one participant (17%) described Idea as a musically creative experience (7.2.2.2.1). Critically, this same participant was also the sole respondent who did not allude to a ludocompositional dissonance within Idea, suggesting instead that they enjoyed the fusion of competitive and musically creative elements (7.2.3.1). The key design
implication is that ludocompositional dissonance – and so the ludic elements that invite it (7.2.3.1) – preclude the reconciliation of musical creativity and competitive gameplay.

Several insights emerge from this finding. First, it suggests *EvoMusic*’s minimal ludic framework as the more successful approach to realising a gamified, compositional contest (4.1.1, 4.1.4). There is no loss nor victory as an extramusical incentive – simply an agonistic dialogue between player and system, bounded only by the player’s disposition, and for which the outcomes are wholly compositional. From a design standpoint, then, it seems best to focus one’s efforts on cultivating this dialogue rather than imposing traditional game elements if one’s primary goal is the core integration of composition and gameplay (2.2.4.4). A second insight, however, is that adhering to such an approach seems also to require weakening the “game” experience as it relates to players’ ludic expectations. It should not be overlooked that *Idea* was the preferred experience overall despite its conceptual tensions, nor that ludic goals and increased challenge were such common requests for *EvoMusic*. Certain players simply prioritised a ludically rich experience over the close integration of music-making interaction – even when the leading request for *Idea* was to make composition a more prominent focus (7.2.3.2). Once more this reiterates the need for potential designers to carefully consider the expectations of their intended audience (5.3.4). Ultimately, though, *EvoMusic* offers one path forward for the synthesis of accessible musical creation and competitive gameplay, revealing an as yet untapped potential for competitive composition games despite their many conceptual challenges.

7.3.1.4 Summary of Constructed Player Insights

Following is a summary of the salient insights constructed from participant responses to the second user study:

- Preferred compositional experiences were strongly aligned with *paidia* (7.3.1.1).
- Players’ expectations for compositional and competitive gameplay experiences were in many ways opposed (7.3.1.1).
- Strong ludic frameworks (e.g. victory, combat, goals) detracted from music creation, but were nonetheless expected in gameful contexts (7.3.1.2).
- Players prioritised ludic interaction over music creation in gameful contexts, whether as a mechanical imperative or by virtue of gameplay being the more appealing mode of interaction (7.3.1.2).
A majority of players were able to reconcile musical creativity and competitive gameplay in the context of a minimal ludic framework (7.3.1.3).

Inversely, strong ludic frameworks precluded this reconciliation by inviting ludocompositional dissonance (7.3.1.3).

Player insights also offered the following characterisations of my works and the contrasting design approaches they represent:

- *EvoMusic* was more successful in engendering a compositional contest between player and system;
- *EvoMusic* was more successful in reconciling musical creativity and competitive gameplay; and
- *Idea* was the superior competitive gameplay experience, and the preferred design overall for this reason.

Finally, this second user study provided further context to the following insights from the first study (5.3.1.1):

- “Musical control was the most influential design dimension shaping player perceptions and preference”:
  - This did not hold in the context of stronger ludic frameworks, where players’ ludic expectations were more influential in shaping preference;
  - However, musical control remained the most significant value informing specifically compositional perceptions and expectations.
- “Players variably prioritised competitive or musically creative interactions over the other within composition game contexts”:
  - This did not hold in the context of stronger ludic frameworks, where gameplay imperatives often superseded compositional considerations.
- “For select types of players, musical creativity and competitive gameplay could be reconciled in an accessible, single user design”:
  - This is also critically dependent on the type of ludic framework employed: a minimal ludic framework with no objective loss best supported the synthesis of composition and competitive gameplay.
7.3.2 Reflecting on Literature Perspectives

The second study did not offer a substantially different reflection on the literature perspectives explored herein (5.3.2), only further context. Foremost, it reinforced that there are serious mechanical tensions between composition and competitive gameplay, yet little suggestion that aesthetic incongruities are a live concern of players (5.3.2.3).

7.3.2.1 On Literature Perceptions of Aesthetic Incongruity

The second user study produced what could be construed as the first aesthetic objection to introducing competitive elements into musically creative interaction:

The hostiles made it challenging…I'd rather just make music, not be chased around by something eating my notes. (Participant 3)

However, that only one participant of the 30 surveyed (3%) expressed this sentiment speaks to its lack of representation in the larger player base. Eighteen total participants (60%) described EvoMusic as both a competitive and musically creative experience, demonstrating that we should not broadly assume an aesthetic incongruity between the two when weighing the potentials of competitive composition games.

As before (5.3.2.2), there were still notable alignments between player and literature characterisations of competitive composition. The implicit alignment of composition with paidia (7.3.1.1) reflects the ludomusical mappings drawn by Austin (2016a) and Kassabian and Jarman (2016). It might also be interpreted that the aesthetic experiences of challenge or competition (2.2.3.2), even if not strictly undesired in compositional contexts, are at least the result of design elements that invite a ludocompositional dissonance, and so detract from the compositional experience in a nonetheless objectionable manner. Regardless, it cannot be overlooked that Idea was the preferred experience overall, nor that players desired greater challenge in EvoMusic – even as the superior music creation experience. Ultimately, then, to presume that the aesthetics of competitive gameplay are outright unconducive to musical creativity seems to ignore the diversity of perceptions, values, and expectations held by players.

7.3.2.2 On Literature Perceptions of Mechanical Tensions

The strong reporting of ludocompositional dissonance within Idea was an undeniable endorsement of Dolphin’s (2014) mechanical concern: that the presence of objectively evaluated, extramusical competition may distract from the compositional primacy of the
experience (2.3.4.2). I found this to be clear in both phases of my creative work (4.4.1.1; 6.4.1.1), and there were suggestions in the first user study that even Chase’s partial goal structure might have distracted from composition (5.3.1). Only with Idea, however, did participants express this mechanical tension in such explicit terms as Dolphin (2014). In doing so, participants revealed that combat and victory are the two design elements most directly responsible for inviting a conflict between compositional and ludic incentives (7.2.3.1), thereby offering a more complete understanding of Dolphin’s mechanical concern and how it might be avoided. Once again, though, this also alludes to a larger conceptual tension: that these same elements were not only expected in gameful contexts (5.2.3.1; 7.2.2.3.3; 7.2.3.2), but substantially informed player preference (7.2.3.4). Reconciling this tension remains a central design challenge for the prospect of competitive composition games.

With these insights, it is appropriate here to reflect on Austin’s (2016b) question: “Does a player follow the stated or implied rules of the game at the expense of the music in order to win, or should a player sacrifice lives, time, and strategic advantages in order to produce better music?” (p. 122). Participant responses to Idea offered one answer: that for many, sufficiently strong ludic incentives would take priority over musical decision-making (7.3.1.2). In turn, weaker ludic environments such as EvoMusic would encourage a focus on composition, yet are still capable of balancing music-making with competitive dialogues for most players (7.3.1.3). This answer may suffice as a heuristic for designers, though a further complexity must be noted. Half of the participants desired a greater compositional focus within Idea, yet most suggested that EvoMusic, which afforded this focus, would still benefit from stronger ludic elements (7.2.3.2). Critically, then, the answer to Austin’s question – as with the appropriate balance between creative and competitive interaction – is contingent upon the values of each player.
7.3.2.3 Summary of Literature Reflections

Consolidating the player insights constructed during this research offers the following reflections on the two design assumptions prevalent in the literature (2.7.1):

A1) “The presence of competitive mechanics, such as points, goals, or win-loss conditions, detracts from a focus on compositional interactions”.

- Player experience supported the mechanical tension expressed by Dolphin (2.3.4.2) and Wang (2.3.3.3), which may be described as ludocompositional dissonance (2.2.4.5).
- Combat and victory were the design elements most responsible for inviting ludocompositional dissonance (7.2.3.1), though were also shown to be desirable in gameful contexts (5.2.3.1; 7.2.2.3.3; 7.2.3.4; 7.3.1.2).
- Player experience also highlighted additional mechanical tensions unaddressed in the literature, such as an inverse relationship between musical control and challenge (5.2.3.2; 7.2.3.3).

A2) “The aesthetic experience of competitive gameplay, such as challenge, conflict, or pressure, is unconducive to musical creation”.

- Player experience offered only scarce support (7.3.2.1) for the aesthetic incongruity presumed by Dolphin (2.3.4.2) and Kassabian and Jarman (2.3.4.1).
- Players have diverse tastes and expectations for competitive gameplay which the literature’s aesthetic assumptions do not account for (5.3.2.2; 7.3.2.1).

In short: the literature’s mechanical assumptions articulate significant design challenges for competitive composition games, though the presumed aesthetic incongruities do not represent a live player concern.

7.3.3 Reflecting on Practitioner Insights

The practitioner insights gleaned through my development of Idea (6.4) were each reflected by the results of the second user study. Most directly supported was my presumption that the possibility of victory would have promoted a primacy of ludic interaction over musical decision-making (6.4.1.1). Alongside combat, Idea’s victory conditions were primarily responsible for the ludocompositional dissonance
experienced by most participants (7.2.3.1). *Idea* also exemplified the original insight from *Chase’s* design: that ludic objectives support more engaging competitive play, but detract from a focus on compositional interaction (4.4.1.1). Despite inviting a ludocompositional dissonance, *Idea*’s ludic elements also fostered its perception as a stronger “game” (7.2.2.3.3), a more engaging experience (7.3.1.2), and the preferred design overall (7.2.3.4).

My second insight had presumed an antagonistic relationship between the tripartite design goals of musical accessibility, creative control, and competitive gameplay (4.4.1.2; 6.4.1.2). While both user studies highlighted musical *control* as being in tension with *challenge* (5.2.3.2; 7.2.3.3) and *competition* (7.2.2.3.2), the initial comparison of *EvoMusic* with *Chase* revealed no such relationship with musical accessibility (5.3.3). This changed with *Idea*, which not only failed to meet the *usability* benchmark (Bangor et al., 2009) but was characterised as significantly less usable for musical novices (7.2.2.1.2) due to its many musical controls and ludic mechanics:

A lot going on so I couldn't control as much but good challenge.  
(Participant 1)

It was fairly easy to move around etc, but there were some aspects e.g. the hostiles, that I didn't really understand how to beat. (Participant 3)

The ways you could control the music with hoops and tones was a little confusing, but with practice would probably become easier. (Participant 6)

This affirmed my presumption that attempts to provide a wider cross-section of creative and competitive features in *Idea* would come at the expense of usability and ease of learning (6.4.3). More broadly, though, it revealed that each of my original composition games only strongly met player expectations for two of the three competing design aims, as visualised in Figure 35. This ultimately supports that musical control, competition, and access indeed exist in a delicate tension (4.4.1.2; 6.4.1.2). Striking a context-appropriate balance between the three is a key challenge for potential designers.
Figure 35: Visual comparison of the player expectations strongly met by each original work.

A final practitioner insight was that certain game mechanics – such as victory and surmountable combat – would have introduced structural incentives into player composition (6.4.2). Participants did not express this in such explicit language: no player framed Idea’s design as incentivising particular musical forms, nor even consciously musical decisions. Rather, Idea’s competitive elements overrode compositional incentives altogether, with some participants outright abandoning musical control (7.2.3.3). In this way, any subtle structural incentives imposed by elements like victory are eclipsed by the ludocompositional dissonance they provoke, and so become less of a concern than avoiding this tension in the first place. Even so, these incentives remain an important consideration for designers. The structure and temporality of chosen game mechanics influence the scope of musical mappings and gestures appropriate to the environment (4.4.2; 6.4.2). For this reason, any choice in gameplay metaphor will implicitly shape the system’s compositional affordances.
7.4 Reflecting on the Research Questions

I now conclude the second phase of research by consolidating the player, practitioner, and literature findings to reflect on the research questions (1.2.1). In doing so, I make design recommendations for navigating the challenges and potentials of competitive composition games.

7.4.1 What are the aesthetic assumptions and design challenges underpinning interactive composition in competitive game settings?

There exists an assumption that the aesthetic experience of competitive gameplay is opposed or unconducive to that of composition, particularly for musical novices (2.3.4.1; 2.3.4.2). Intuitive though this may seem, such a tension was scarcely reported in the player experience (5.3.2.2; 7.3.2.1) and should not preoccupy designers working in the space of gamified composition. Rather, the primary challenge of competitive composition games lies in negotiating a series of mechanical design tensions, the principal two being:

- Musical control, musical accessibility, and competitive engagement form a delicate tripartite tension, where designing for one may detract from the others (4.4.1.2; 6.4.1.2; 7.3.3);
- Ludic elements, such as goals, combat, or victory, disincentivise a focus on compositional interaction (7.2.3.1), but strengthen the competitive gameplay experience (7.2.2.3.3) and are expected in gameful contexts (7.3.1.2).

Navigating either tension requires that a context-appropriate balance be struck by the designer, in turn necessitating careful consideration of the target audience and design aims. I address this further in answering the second and third research questions.

7.4.2 How can musical creativity and competitive gameplay be reconciled in a digital game while maintaining a focus on accessible sound composition?

Among the three original composition games discussed herein, EvoMusic was undoubtedly the most successful in reconciling musical creativity and competitive gameplay interaction (7.3.1.3). It also remained an accessible composition experience, having consistently achieved the system usability benchmark and aiding musical novices (5.2.2.1.2; 7.2.2.1.2). EvoMusic is thereby demonstrative of one successful approach to the synthesis of real-time composition and competitive gameplay for single,
novice users. Key to this approach was eschewing traditional ludic incentives, such as victory and defeat, in favour of a competitive but strictly compositional dialogue between the player and system. Extramusical objectives were shown to preclude the core integration of music-making with competitive gameplay (7.3.1.3). *EvoMusic* instead cultivated ludic interaction through a contest for authorial control over a shared musical output, pitting the player’s sonified game actions against the system’s proactive musical behaviours (3.2.1; 4.1).

There is a notable caveat to *EvoMusic’s* approach. *Idea* was preferred by players for precisely the ludic elements that inhibited its reconciliation of composition and competitive gameplay (7.3.1.3). As such, it is crucial for designers to carefully consider the roles of both compositional and competitive interaction in this context. If one’s foremost aim is ludic engagement with music-making as a novel mechanical twist, then game elements like combat, progression, and extramusical goals should be included to meet player expectations (7.2.2.3.3; 7.2.3.4). If one’s goal is to explore composition as competitive gameplay, as a ludic dialogue itself, then these extramusical elements should be minimised for their intrusive influence on the compositional experience. It is in the latter that I find a novel potential in competitive digital games as a platform for accessible composition: in playful systems that both challenge and collaborate, and in human-computer dialogues that are at once musically competitive and co-creative.

7.4.3 How do competitive game settings shape player perceptions of musical control, creativity, and ownership?

Competitive game settings have a diverse influence on players’ compositional perceptions as dependent upon their values and expectations for each. The following two relationships were clear:

1) Strong ludic frameworks distract from musically creative interaction (7.3.1.2), and so exert a comprehensive and eclipsing influence on compositional perceptions including: musical control (7.2.2.1.3), creativity (7.2.2.2.1), ownership (7.2.2.2.2), compositional contest (7.2.2.3.2), and general value as a compositional experience (7.2.2.2.3).

2) Otherwise, the depth and diversity of musical control is the most significant dimension shaping players’ compositional perceptions and expectations (5.3.1; 7.2.2.2.3; 7.3.1.1).
Particularly notable was the apparent primacy of *ludus* in player decision-making when faced with strong ludic elements (7.3.1.2), such that musically creative choices were either deprioritised, abandoned, or even reframed in terms of their ludic necessity (5.2.3.1; 7.3.1.2). Beyond these explicit effects of ludocompositional dissonance, compositional perceptions were variably shaped by individual aspects of competitive game settings. This diverse influence, insofar as player perceptions of *EvoMusic, Chase, and Idea*, is outlined in Table 31.

**Table 31**: Influence of game elements on perceptions of musical control, creativity, and ownership.
*Note: “Game Status” refers to the player’s ontological acknowledgement of the experience as a “game”.

<table>
<thead>
<tr>
<th>Game Element</th>
<th>Control</th>
<th>Creativity</th>
<th>Ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge</td>
<td>Hindered (5.2.3.2; 7.2.3.3)</td>
<td>Helped (5.2.2.2)</td>
<td>-</td>
</tr>
<tr>
<td>Combat/Enemies</td>
<td>Hindered (7.2.2.1.3)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Goals/Victory</td>
<td>-</td>
<td>Hindered (7.2.2.2.1)</td>
<td>Hindered (7.2.2.2.2)</td>
</tr>
<tr>
<td>Stochastic Gameplay</td>
<td>Hindered (5.2.2.1.3)</td>
<td>Helped (5.2.2.2)</td>
<td>Helped &amp; hindered (5.2.2.4)</td>
</tr>
<tr>
<td>Game Status*</td>
<td>-</td>
<td>-</td>
<td>Hindered (5.2.2.4)</td>
</tr>
</tbody>
</table>

Only five participants between both studies (17%) framed the competitive game setting as a decisively *beneficial* addition to the compositional experience. These sentiments centred on the “fun” brought to composition rather than any strictly musical benefit, as exemplified below:

> It was interesting to see how fun it was to test things in *Chase*, biome specific music, distance from red man and health percentages made it fun to create music…the creation of music was more fun as a game.
> (Participant 14: Study 1)

> I found it a good way to learn a bit of music theory in a fun medium.
> (Participant 18: Study 1)

In this way, competitive composition games may be characterised as a new form of composition that complicates\(^\text{210}\) music creation in return for the heightened engagement

\(^{210}\) I say “complicate” to stress that competitive elements are not purely detrimental to composition; see Table 31.
of challenging, competitive game environments (1.4.3; 7.3.1.2). I view this as analogous to the tradition of constraining composition within accessible contexts: a degree of control and expression are forfeited to make available a new form of musically creative interaction (1.6.1.3; 1.6.1.4; 4.4.1.2). This suggests that competitive games should not be engaged as an improved expression of interactive composition, but as a novel context for its continued exploration.

To conclude with some design insights: providing deep musical control and avoiding extramusical incentives are valuable heuristics for designing competitive composition games, though the intended outcomes of introducing a ludic framework should not be overlooked (7.4.2). There are roles for music creation within competitive games beyond acting as their core focus – whether as an occasional paidic diversion in the musicalised puzzles of Fract OSC (2.5.3.2), or as a serendipitous outcome of Idea’s combat. It is crucial to note that some players preferred the ludic engagement born of such a hierarchy (7.3.1.2), while others desired a compositionally focused experience (5.2.3.1; 5.3.1). Designers should harbour no apprehensions towards harnessing ludic dialogues within systems for interactive composition – so long as they remain attentive to their audience’s expectations, and prepared to reconcile these expectations with their influence on the compositional experience (7.2.3.2).

7.5 Chapter Summary

This chapter has concluded Phase Two of the research. After reporting on the results of a user study comparing EvoMusic and Idea (7.2), the emerging player insights (7.3.1) were discussed in relation to the literature and practitioner perspectives explored herein (7.3.2; 7.3.3). The findings of both research phases were then consolidated to reflect upon the research questions, informing design insights for navigating the challenges and potentials of competitive, game-based composition (7.4). Pertinent findings from the second phase of research are as follows:

- **EvoMusic** (4.1) was the preferred creative experience and more successfully engendered a compositional competition (7.3.1.3)
- **Idea** (6.2) was the preferred gameplay experience and overall design, but eclipsed compositional interactions with its strong ludic elements (7.3.1.2).
- Music creation and competitive gameplay could be reconciled for a majority of players, so long as strong ludic incentives were avoided (7.3.1.3)
Tensions perceived by the literature between composition and competitive gameplay were only partially supported by player experience:

- Mechanical design tensions were strongly supported (7.3.1; 7.3.2.2).
- Aesthetic incongruities were scarcely reflected (7.3.2.1).
- Incongruities between competitive gameplay and accessible composition were reflected in Idea only (7.3.3).

Designers of competitive composition games should consider the following:

- Musical control, musical accessibility, and competitive gameplay are interconnected in a design tension (4.4.1.2; 6.4.1.2; 7.3.3);
- Strong ludic frameworks disincentivise a focus on compositional interaction (7.2.3.1), but strengthen gameplay (7.2.2.3.3) and are expected in gameful contexts (7.3.1.2);
- Individual ludic elements each have a diverse influence on the compositional experience (7.4.3; Table 31).
- Musical control is central to players’ compositional perceptions and expectations (7.2.2.2.3; 7.3.1.1);
- All design decisions in this context should be balanced against the ludic and compositional expectations of the target player audience (7.4).
Chapter 8: Conclusion

This research has explored the concept of accessible, real-time music composition via competitive gameplay interactions. Through the iterative development of three creative works and their evaluation in two comparative user studies, I have illuminated a network of design tensions that arise between competitive gameplay and music creation. I have also shown that competitive human-computer dialogues, despite these tensions, can support accessible, creatively stimulating composition experiences. This chapter concludes the thesis by providing an overview of the research process (8.1), summarising my findings (8.2), addressing their contributions (8.3), and nominating potential areas for future research (8.4).

8.1 Overview of the Research

8.1.1 Context

As games and playful identities increasingly suffuse contemporary culture (1.4.1), the far-reaching lineage of game-based compositional praxis (1.6.1.1) has blossomed into a rich landscape of sound toys, gamified performances, playful installations, and music-making apps (1.6.1). Whilst some of these works have explored composition via competitive game structures or adversarial dialogues, scarce few are designed for interaction by a single, musically novice user (1.6.4.1). A review of related works, games, and literature in Chapter 2 revealed a series of design challenges and presumptions underscoring this avoidance of competitive gameplay within accessible music-making media. These principally include the following:

- It is difficult to conceive of a game system that could fairly score, evaluate, or assign ludic outcomes to a player’s compositional interactions without imposing arbitrary constraints on free creation (2.2.4).
- Many scholars and designers presume that competitive game mechanics, such as victory or combat, would distract from a focus on compositional decision-making (2.2.4.4; 2.3.4.2).
• The aesthetic experiences of creativity and competition are polarised within gameful contexts (2.2.3.2), informing a presumption that competitive gameplay is unconducive to composition, particularly for novice users (2.3.4.1-2.3.4.2).

Lacking in this space was an accounting of the player experience of composing within competitive game environments, and so too the practical insights by which the above design challenges might be interrogated. Further, the concept of a game system as a proactive compositional opponent was largely unexplored in musical metacreation (2.6.3). It is these latent potentials that my practice-based research has sought to investigate.

8.1.2 Phase One: Initial Investigation

I began with the design of EvoMusic and Chase (Chapter 4) as two contrasting approaches to competitive, game-based composition. In EvoMusic, players could not win or lose, but contested the inexorable growth of an evolving musical population to curate and defend a desired sonic output (4.1). Chase introduced notions of danger and defeat, assigning musical outcomes to the player’s attempts to evade a pursuing hostile agent (4.2). Both were conceived as contests between the player and system for authorial control of a shared musical output (3.2.1), but each explored opposing design dimensions as an initial investigation of the design space (4.3). In Chapter 5, a mixed-methods comparative user evaluation (n=24) of these games revealed EvoMusic as both the preferred compositional experience and the more successful in reconciling musical creativity with competitive gameplay, while Chase was characterised as the stronger and more engaging ludic experience (5.2.4). Participant responses highlighted a diversity of player expectations which informed these perceptions (5.3.1). This provided new insights into a series of mechanical design tensions between composition and the competitive game framework, reflecting also on extant literature perspectives (5.3). My initial investigation concluded with a series of preliminary design recommendations for competitive composition games (5.3.4).

8.1.3 Phase Two: Further Exploration

A second phase of research commenced with my development of Idea (Chapter 6). As informed by the player and practitioner insights from my initial investigation, Idea

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211 The study design, analytic methods, and methodological consideration for the user studies are discussed in Chapter 3 (Section 3.3).
served as both a synthesis of successful features from *EvoMusic* and *Chase* and a further exploration of the tensions emerging between accessible composition and the ludic framework (6.1). *Idea* maintained the player-system dialogue of competitive co-creation, but additionally implemented stronger ludic elements such as explicit combat, objective victory, and game progression (6.2). In Chapter 7, a comparative evaluation of *Idea* with *EvoMusic* (n=6) revealed *Idea* as the more engaging ludic experience and preferred design overall, though *EvoMusic* was again characterised as the superior compositional experience and the more successful fusion of competitive gameplay and music creation. Participant responses to *Idea*’s more explicit game framework offered deeper insight into how competitive elements influence the compositional experience; most notably, strong ludic incentives were found to eclipse musically creative processes (7.2.3.1; 7.3.1.2), exemplifying a tension that I have described as *ludocompositional dissonance* (2.2.4.5). These findings highlighted the diverse challenges and potentials faced by different approaches to competitive composition games, which lead to a series of design recommendations that concluded the second phase investigation (7.4).

8.2 Summary of Findings

This research has unearthed a complex interplay between accessible music composition and competitive gameplay interactions. To articulate these findings, I first address the research questions (8.2.1) before positing a series of design recommendations for competitive composition games (8.2.2).

8.2.1 Responding to the Research Questions

8.2.1.1 What are the aesthetic assumptions and design challenges underpinning interactive composition in competitive game settings?

There are two prevailing literature presumptions concerning the prospect of designing competitive composition games:

1) An *aesthetic* presumption that the experience of competitive gameplay precludes or is unconducive to the experience of musical creativity (2.3.4.1) – this was not supported by the player experience (5.3.2; 7.3.2).

2) A *mechanical* presumption that competitive elements, such as ludic goals or victory, detract from a focus on compositional interactions (2.3.4.2) – this was strongly supported by the player experience (5.3.2; 7.3.2).
Competitive composition games also face a complex network of design challenges and conceptual tensions to be negotiated by designers. These principally include:

- **Musical control**, musical accessibility, and competitive gameplay exist in an interconnected design tension where approaching one may detract from the others (4.4.1.2; 6.4.1.2; 7.3.3).
- Strong ludic incentives, such as combat or victory, distract from a focus on compositional decision-making (7.2.3.1), but strengthen the gameplay experience (7.2.2.3.3) and are often expected in gameful contexts (7.3.1.2).
- Players have diverse expectations for compositional and ludic experiences that influence their perceptions of each (5.3.1; 7.3.1.1).

8.2.1.2 How can musical creativity and competitive gameplay be reconciled in a digital game while maintaining a focus on accessible sound composition?

As *EvoMusic* exemplified, to successfully reconcile musical creativity and competitive gameplay may require eschewing traditional ludic outcomes (7.3.1.3). Extramusical incentives, such as avoiding defeat, supported a more engaging gameplay experience in *Chase* and *Idea*, but eclipsed the player’s compositional considerations (7.3.1.2). It can thus be understood that strong ludic frameworks may preclude the integration of music-making as a core component (2.2.4.4; 3.2.1) of the gameplay experience.

In *EvoMusic*, the environment’s interactive affordances and musical behaviours were designed to introduce a dynamic of contest into the co-creative dialogue between player and system. Interaction within this minimally ludic framework (4.1.4) was characterised as being both musically creative and competitive by 60% of the 30 participants (7.3.1.3). *EvoMusic* was also rated as satisfactorily usable and accessible to musical novices in both studies (5.3.4.2; 7.4.2). This demonstrates that accessible composition and competitive gameplay can be reconciled within single-player digital games despite their many conceptual tensions.

As proposed (3.2.1), then, establishing a player-system contest for authorial control offers one means of circumventing the need to competitively rate compositional interactions (2.2.4) while also preventing ludocompositional dissonance – so long as strong ludic incentives are not introduced (7.3.1.2). The design dimensions by which *EvoMusic* realised this approach were outlined prior (4.3). Alternative conceptual approaches to establishing this dialogue are considered further in (8.4.4).
In summary: musical creativity and competitive gameplay were not reconciled within traditional competitive frameworks, but by fostering a competitively co-creative dialogue between the player and system.

8.2.1.3 How do competitive game settings shape player perceptions of musical control, creativity, and ownership?

The reported influence of competitive game settings on the player’s compositional experience can be summarised as follows:

- Strong ludic frameworks distract from musically creative interaction (7.3.1.2), shaping perceptions of musical control (7.2.2.1.3), creativity (7.2.2.2.1), ownership (7.2.2.2.2), compositional contest (7.2.2.3.2), and overall value as a compositional experience (7.2.2.2.3):
  - More broadly, tensions between a game’s ludic and compositional incentives (2.2.4.5) detract from the compositional experience.

- Individual ludic elements each have a diverse influence on the compositional experience (7.4.3; Table 31) as dependent upon player tastes and expectations; notable examples include:
  - Challenge may hinder musical control (5.2.3.2; 7.2.3.3) but help creativity (5.2.2.2);
  - Stochastic gameplay may hinder control (5.2.2.1.3), help creativity (5.2.2.2), and help or hinder ownership (5.2.2.4).

- Musical control is the most significant dimension shaping players’ compositional perceptions and expectations (5.3.1; 7.2.2.2.3; 7.3.1.1).

8.2.2 Design Recommendations

The paramount design consideration for competitive composition games is that players bring diverse tastes, values, and expectations to their experience. These dispositions, such as a taste for challenge, not only influence players’ overall engagement and design preference, but critically shape their compositional perceptions. As such, any potential designers should first delineate the following:

1) Their aims with introducing competitive dynamics into compositional interactions; and
2) The intended roles of both competitive and compositional interactions within the overall experience.

With this as a starting point, my research has suggested that two broad relationships between composition and competition might be pursued in a single-player context:

a) A primarily ludic engagement with compositional affordances as a novel mechanic or identity:
   - Player actions may be musicalised and free creation may be supported, but the focus is on satisfying a structure of ludic goals.
   - Examples include Fract OSC (2.5.3.2) and Chiptune Runner (2.5.4.1)

b) Composition as competitive gameplay, as a ludic co-creative dialogue between the player and system:
   - Player actions compete with the system’s musical gestures for control over a shared musical output; ludic elements may be present, but the focus is on the compositional outcomes.
   - EvoMusic (4.1) exemplified this relationship.

It is the latter (type “b”) that I have predominantly explored through this research, and in which I find the more exciting potential for new compositional experiences. To this end, I recommend the following as design heuristics for those pursuing a competitive compositional dialogue between a single novice player and game system:

1) Prioritise a depth and diversity of musical control:
   - Musical control is the most significant dimension informing players’ compositional perceptions and expectations (5.3.1; 7.2.2.2.3; 7.3.1.1).
   - It can be prioritised even at a reasonable cost to usability or the traditional competitive framework (5.3.1).

2) Minimise ludic elements that invite strong extramusical incentives:
   - Win-loss conditions, ludic goals, and combat each distract from compositional interaction (7.3.1.2).
   - These elements are not required to cultivate a competitively co-creative dialogue between player and system (7.3.1.3; 7.4.2).

3) The system should attain at least proactivity (Eigenfeldt et al., 2013) in its musical behaviour (2.6.1-2.6.2):

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212 The potential for alternate approaches to this dialogue is outlined in section 8.4.4.
• Considered as a musically metacreative system (2.6), the game must be capable of initiating its own musical gestures if a co-creative contest is to emerge (2.6.2).

Again, it is paramount that designers temper these heuristics with attention to the specific tastes and expectations of their intended player audience. The above are simply useful in guiding design decisions towards the realisation of a human-computer dialogue that a majority of players have characterised as both musically creative and competitive.

Conversely, for designers instead seeking to introduce compositional interactions into a primarily ludic experience (see type “a” above), my research suggests the following design recommendations:

1) Incorporate traditional game elements such as combat, progression, ludic goals, and quantifiable outcomes:
   • These are expected in gameful contexts and support more engaging competitive gameplay experiences (7.3.1.2).

2) Endeavour to imbue each competitive action (or “move” within the ludic structure) with compositional outcomes and affordances:
   • Players prefer musical creation as a closely integrated component of competitive gameplay than as a peripheral feature (7.2.3.2).
   • Although players are still likely to prioritise ludic incentives, this will help to integrate composition into the core competitive experience.

3) System musical autonomy is less crucial in this context:
   • The system could exhibit any degree of musical metacreativity (2.6.1) and remain an engaging ludic experience.
   • Attaining at least generativity213 (Eigenfeldt et al., 2013) is likely to aid musical novices in exploring compositional outcomes.

No matter the approach pursued, striking a context-appropriate balance between musical control, musical accessibility, and competitive engagement remains a key question for any competitive composition game. I would reiterate that designers should carefully

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213 Generativity describes the generation of substantial musical gestures in reaction to player input, even if never independently initiated by the system (2.6.1).
consider the ludic and compositional expectations of their target audience in guiding any efforts to negotiate these conceptual challenges.

### 8.3 Research Contributions

My creative practice has driven a cyclical, mixed methods investigation into the challenges and potentials of accessible composition through competitive gameplay interaction. This process has generated the following research outcomes:

1. Theoretical insights consolidated from literature, practitioner, and player perspectives (8.2.1).
2. Design recommendations drawn from these insights (8.2.2).
3. A body of original creative works as:
   a. Evidence of the inquiry generating the insights (1); and
   b. Demonstrative cases for the design recommendations (2).

Through these outcomes, my research has contributed the following:

- Surveyed the lineage and contemporary context for game-based compositional praxis (1.6).
- Distilled and explored extant *literature* perceptions of competitive composition games (5.3.2; 7.3.2), which as yet lacked a practical, player-based investigation.
- Commenced a charting of the design space for competitive composition games via existing works (1.6.1; 2.5) and three original designs (4.3; 6.3).
- Explored the design challenges facing practitioners in the context of single-player, competitive games for accessible composition (4.4; 6.4).
- Constructed an accounting of the player experience of composing through competitive gameplay and its underlying expectations (5.3.1; 7.3.1).
- Consolidated an understanding of how competitive game settings shape compositional perceptions (5.3.4.3; 7.4.3).
- Explicated “ludocompositional dissonance” (2.2.4.5) as a key theoretical concept in understanding the interplay of composition and the traditional game framework.
- Explored how musically metacreative perspectives apply to competitive composition games in theory and practice (2.6; 4.3.2.6; 6.3.2.6; 8.2.2).
• Articulated a novel approach to reconciling musical creativity and competitive gameplay for single, novice users (3.2.1; 4.1; 8.2.1.2).

8.3.1 Wider Applications

This research is transferable to wider contexts. Foremost, it has demonstrated the potential for a new creative partnership in human-computer composition: metacreative systems that both challenge and collaborate in a co-creative contest with the user. Though only a preliminary exploration of this concept, EvoMusic has exemplified that a single-player system can at once be creatively stimulating and competitively engaging in a gameful sense. This invites further exploration within the wider practice of interactive composition and musical metacreation, as discussed shortly (8.4.4).

Second, the design insights revealed herein can inform wider musical applications of gamification (1.5), such as within education. As Lesser (2019) has outlined, quantifiable ludic elements such as scoring systems, specific objectives, or reward structures are key to the motivational and engaging benefits of gamified music education strategies. My research found these strong ludic elements to detract from the compositional experience in Idea, suggesting a tension with translating such strategies into a musically creative context. EvoMusic, on the other hand, was framed as having pedagogical value (5.2.2.1.2) despite its lack of extramusical scores, rewards, or outcomes. While further investigation is warranted, this perhaps indicates that any educational gamification of musical creativity would require a distinct approach to the more quantifiable musical disciplines. Regarding gamification more broadly, my research also demonstrated that the challenge, engagement, and “fun” of ludic interaction (1.4.3; 2.2.3.3) could be achieved – if to a lesser extent (7.3.1.2) – without introducing traditionally quantifiable game elements. This opens new pathways for designers in gameful music-making contexts to harness competitive dynamics without jeopardising the compositional experience.

Finally, my findings offer new insights regarding psychological investigations into creativity and competition. There is limited empirical work investigating the relationship between musical creativity and competition (2.4.3), though a substantial canon in broader psychology suggests that competitive environments are unconducive to creative behaviours (2.4.2). It is notable, then, that the user studies revealed such
scarce *aesthetic* objection\(^{214}\) to the experience of composing within competitive game environments (7.3.2.1). Even from a *mechanical* perspective, the player response to *Idea* clarified that it was particular ludic elements such as victory and combat that interfered with compositional interaction, not a competitive dynamic in general; otherwise, *EvoMusic* would not have been framed as both creative and competitive. These findings make no explicit case that competitive environments could *improve* musically creative output, as Eisenberg and Thompson (2011) have found (2.4.3). They simply suggest that competing and composing are not inherently incongruous, lending crucial insight into the complex relationship between creativity and competition at large.

### 8.4 Potentials for Future Research

This research was by no means an exhaustive accounting of competitive, game-based composition. There are many further avenues to be pursued before a more complete understanding of its challenges and potentials can be approached: new platforms, contexts, design dimensions, theoretical perspectives, and conceptual strategies. I outline a selection of these potentials here.

#### 8.4.1 New Methods and Measurements

In exploring and evaluating my creative works, I have relied on the player’s experiential insights to construct an understanding of the relationship between accessible composition and competitive gameplay. Alternative evaluation methods are likely to yield additional insights. For instance, psychophysiological measures\(^{215}\) of the player’s emotional state during gameplay (Kivikangas et al., 2011) may afford rich comparisons to their reported creative experience, particularly concerning the influence of stress and pressure. Expert evaluations of musical *output* or system *behaviour* (3.3.1.1) in competitive composition games could also support further understanding of their creative affordances. Finally, evaluations might incorporate wider conceptions of the gameplay experience, such as GameFlow (Sweetser & Wyeth, 2005) or even game

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\(^{214}\) Only one of the 30 total participants (3%) suggested that competitive dynamics, such as being chased by hostiles, were undesirable for creative contexts – and in only one response.

\(^{215}\) This includes measures like skin conductance, heart rate variability, or facial muscle tension. The data is collected during gameplay in real-time and correlated with concepts like emotional arousal.
musical immersion\(^\text{216}\) (van Elferen, 2016), to build a more holistic accounting of player perceptions.

### 8.4.2 New Platforms, Interfaces, and Contexts

My findings and design recommendations have been grounded in the context of desktop interaction. However, my conceptual approach (3.2.1) is equally applicable to other control interfaces and platforms (3.2.3.1), which may each harbour novel insights or unique design potentials regarding competitive game-based composition:

- **Mobile Platforms** – key to the democratisation of interactive composition (1.6.2.1). Their cultural pervasion and ease of access could be harnessed by competitive composition games to advance wider participation in new forms of human-computer co-creation. Their capacity for gestural interaction via gyroscopes and accelerometers also bears exploration in the context of single-user competitive composition.

- **Web Platforms** – web apps have similarly advanced participation through their ease of use and distribution. Browsers are now an active platform for democratised computer music tools (1.6.2.2) and playful sound toys,\(^\text{217}\) though are as yet untapped by competitive composition games. The potentials for co-creative experiences extend to the gameful sonification of web data, for which projects such as *Listen to Wikipedia*\(^\text{218}\) are notable forerunners.

- **Virtual Reality** – the platform’s embodied interaction and engrossment of sensory input may reveal new understandings of the interplay between composition and competition, particularly with regard to how the immersive modality influences player perceptions. *Soundlites*\(^\text{219}\) (ICON Interactive, 2017) demonstrates the platform’s compositional potentials using similar interaction metaphors to *Idea*, albeit lacking a competitive dialogue.

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\(^{216}\) The ALI Model (van Elferen 2016) considers how musical *affect*, musical *literacy*, and musical *interaction* each contribute to a music-specific immersion into games and “sound play” (p. 33).

\(^{217}\) For instance, see Google’s “Chrome Music Lab”, a suite of playful web apps for accessible music-making with quasi-educational aims. Available at: https://musiclab.chromeexperiments.com/Experiments (retrieved 3 June, 2020)


\(^{219}\) A promotional demonstration is available at: https://www.youtube.com/watch?v=FjdmfDd_Is (retrieved 3 June, 2020).
- **Augmented Reality** – explored for accessible composition in several tabletop designs (1.6.1.4), though without competitive dialogues, and more recently in location-based mobile audio games (Rovithis et al., 2019), though scarcely with creative affordances. There is potential to reconcile the two: to harness the gestural interaction and location data afforded by mobile AR experiences, but towards the design of accessible, composition game interactions.

- **Installations and Sound Art** – several works afford accessible and even competitive composition within installation and sound art contexts (1.6.1.7), though few engage single users in a competitive co-creative dialogue. Translating these concepts into the public space presents novel design challenges, and may reveal new insights regarding the perceived interplay of competition and creativity in human-computer interaction.

How are experiences of play, creation, and competition mediated by these diverse modes of interaction? Are there meaningful divergences in how each influences the compositional and ludic perceptions of players and audiences? Through such lines of inquiry, future research may continue to unravel the complex interrelationship between musical creativity and competitive gameplay.

### 8.4.3 Alternate Game Modalities and Design Dimensions

Digital games are an intensely multimodal medium. I have neglected many of these modalities to allow a focused investigation of the interplay between accessible composition and the competitive game framework (3.4). Having attained a first accounting of player experience (7.3.1; 8.2.1.3), it becomes pertinent to consider the influence and affordances of wider game design dimensions so that a more holistic understanding of competitive composition games may be approached:

- **Visuality** – visual aesthetics are integral to digital gameplay experiences. With no prompting, several user study participants commented on the graphical fidelity or visual stylings of the creative works, suggesting an undiscovered role in shaping player perceptions of ludocompositional interactions.

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220 Rovithis et al. (2019) offer a comprehensive review of augmented reality audio games before presenting their own design, “Audio Legend”. The games often include audio-based combat, where players respond to sonic cues with physical gestures against virtual enemies, but there is no aspect of creatively manipulating or producing sound; the player merely reacts to sound as an information source.
• **User Interface** – I have addressed user interface design with regard to accessibility and the abstract representation of musical concepts (2.5.2.3; 4.3.2.5; 6.3.2.5). However, that *Idea* received both the lowest rating for usability and highest reception as a “game” warrants a deeper investigation into the specific challenges of designing musical user interfaces in this context.

• **Auditory Display** – in digital games, informative sound (Ng & Nesbitt, 2013) is a significant channel for communicating pertinent game information, such as impending danger or feedback on player performance. Auditory display thus faces novel challenges in the context of competitive composition games: principally, the tension of providing urgent ludic feedback without disrupting the compositional output cohabiting the same sensory channel.

• **Narrative** – external to the formal game framework (2.2) and neglected in compositional applications of gameful design, but nonetheless a substantial component of contemporary digital games and their culture. Whilst I presume that narrative elements might introduce another layer of tension to the already conflicting aims of creation, competition, and access (4.4.1.2; 6.4.1.2), there may be rich insights to uncover in exploring the interplay of game narrative with compositional interaction.

8.4.3.1 Opportunities in Audio Games

I would also draw particular attention to audio games (Friberg & Gärdenfors, 2004) as a novel context for compositional interactions. There are several digital game experiences accessible to the visually impaired, such as *Papa Sangre* (Somethin’ Else, 2013) and *The Vale* (Falling Squirrel, 2020), that rely only on auditory and tactile feedback. To my knowledge, this non-visual gameplay modality lacks any exploration of interactive composition for musical novices. Audio games present an opportunity for designers to take a more inclusive approach to gameful composition, unveiling new design challenges and advancing a culture of participatory music-making all the while.

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221 See the game’s website for information on gameplay mechanics, developer aims, and video demonstrations; available at: [https://www.fallingsquirrel.com/the-vale](https://www.fallingsquirrel.com/the-vale) (retrieved 4 June, 2020).
8.4.4 New Musical, Conceptual, and Metacreative Strategies

There are many alternative approaches to the design of competitive composition games than those pursued herein. First, one might consider music generation strategies beyond the rule-based and stochastic processes explored in my original works (3.2.3.2; 4.1.3; 4.2.3; 6.2.3). These include artificial life algorithms such as cellular automata or Boids, evolutionary approaches such as genetic algorithms, or neural networks. Players might also affect compositional interventions through non-algorithmic paradigms, such as the vertical and horizontal arrangement of pre-rendered loops and samples. A practical exploration of each strategy would yield a more complete charting of the design space, particularly if comparing their influence on player perceptions of musical control, creativity, ownership, co-creative competition, and the overall gameplay experience.

There are also alternate conceptions of the co-creative contest itself. My approach herein is based in synchronous interaction between the player and system, where both parties are always simultaneously affecting the shared musical output. We might instead conceive of a compositional contest founded on asynchronous musical gestures in the manner of a conversation – or perhaps, a “debate”. Interactive systems such as *Cypher* (Rowe, 1992) and *Voyager* (Lewis, 2000) have explored comparable human-computer relationships within a machine listening paradigm, though are not conceived as competitive dialogues and are inaccessible to musical novices. So how might an accessible, asynchronous compositional contest manifest? What are the design challenges of this alternate approach? Consider the following hypothetical design as a demonstrative case:

1) A “round” begins with the player creating a sonic motif or gesture via symbolic gameplay interactions.

2) The system generates a motif to compete with the player’s.

3) The player chooses which motif they prefer and carries it into a new “round”, discarding the other.

4) Rounds continue in this manner (steps 2-3) until the player is satisfied with the musical outcome.

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222 This involves a computer system analysing live musical input from a human performer and generating appropriate compositional responses.
223 This could variably resemble the abstract representations of *EvoMusic* (4.1) or the explicit musical interface of *Idea* (6.2).
Like *EvoMusic*, this design does not rely on quantifiable ratings or game outcomes such as victory – so would the player perceive it as competitively engaging? Or competitive at all? Alternatively, were one to award “points” to the victor of each round, would the player engage in a fair compositional contest as an unbiased judge? Or deprioritise the musical outcome to inflate their own score and so win the “game”? These remain key questions for any new approaches to competitive co-creation, particularly regarding the outcomes of introducing strong ludic elements into human-computer creative partnerships. Exploring such approaches seems likely to offer a deeper understanding of the interplay between interactive composition and competitive gameplay.

Finally, there is great scope for exploring gamified co-creation within the context of higher metacreative behaviours. Brown, Gifford, and Voltz (2016) have found that even simple metacreative systems can stimulate creativity, which the success of *EvoMusic* shows as translating to gameful settings. Still, my systems do not learn from the player’s compositional interactions, nor reflect upon their own output, and so would not be deemed to exhibit true metacreative behaviour by more discerning perspectives (Agres, Forth, & Wiggins, 2016). Such behaviours are key to realising the full potentials of a human-computer compositional contest, and existing game design techniques may offer a theoretical lens for their ludically meaningful implementation. One such example is Dynamic Difficulty Adjustment (Hunicke, 2005), where system-based evaluations of the player’s ludic performance are used to adjust the difficulty of gameplay in real-time.²²⁴ A system capable of evaluating the player’s compositional “proficiency” in this way could dynamically shift the balance of its dual role as collaborator and competitor. It could creatively aid a struggling novice as much as it challenges an expert composer, providing a proportionately challenging Flow experience (1.4.3.1) for each individual. Of course, to ground such an approach in the player’s creative proficiency rather than their objective ludic performance raises critical questions: when is a player compositionally “struggling” as opposed to simply exploring sonic outcomes? Could a system intentionally aid or challenge the player without understanding their compositional goals? How might it come to understand them? In embracing such challenges, we might unearth the full compositional potentials of competitive gameplay.

²²⁴ Common metrics for system-based evaluations of the player’s ludic performance include task-completion rate, number of deaths, or current game score.
8.5 Conclusion

I began this research with the question: What can digital gameplay bring to interactive composition? Gameful designs, technologies, and identities have contributed much to accessible music-making (1.6), advancing a culture of playful participation in music that now reaches across the arts, entertainment, health, and education. And yet, the spirit of contest and challenge that lies at the heart of so many gameplay experiences has been neglected in explorations of their compositional potentials. It is this gap in understanding that my works and research have sought to address: to chart the new challenges and opportunities that arise from taking competitive gameplay as a platform for interactive composition.

In many regards, this research has shown that competitive gameplay and accessible music creation are themselves competing forces. I have revealed inherent mechanical tensions that emerge once the two coinhabit an interactive space, looming large from the designer’s first conceptualisation to the player’s live game session. And yet, despite these tensions, I have demonstrated a novel potential in the prospect of competitive composition games. EvoMusic has shown that competitive dialogues between a player and game system can support accessible, creatively stimulating compositional experiences. Players did not reject the aesthetic experiences of competitive gameplay when introduced into music creation contexts, countering the widespread intuition that the two are aesthetically incongruous. At the least, these findings reveal a more complex interplay between competitive gameplay and composition than previously assumed; beyond, they promise new opportunities for human-computer co-creation.

There is great potential in reimagining competitive dialogues not as an obstacle to interactive composition, but as a novel context for its continued exploration. In pursuing musical systems that act as both collaborator and playful opponent, we may come to realise computer partnerships that can nurture, inspire, and extend our creativity whilst still challenging, pushing, and engaging us in creative contest. This framing of human-computer co-creation as a game between player and system opens new approaches to interactive composition. It allows designers to harness the models and mindsets of gameplay to foster novel co-creative experiences for novices and experts alike, in music and beyond. The challenge, as with much of interactive composition, lies in striking an appropriate balance: in negotiating a compromise between the competing aims of creative control, musical accessibility, and gameplay engagement, which for the
designer becomes a “game” in itself. While these and other critical questions remain (8.4), I have shown herein that there are paths forward for the design of competitively engaging creative experiences, and for creatively stimulating ludic experiences. There are further compositional potentials in games that we may yet unlock, should we embrace the challenge.
References


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Appendix A: User Study Questions

Following are the questions provided to participants in the comparative user studies (Chapters 5 and 7). Section 1 was completed prior to playing the games. Participants then played the first game and immediately completed Sections 2-4, repeating this for the second game in Sections 5-7 before concluding with Section 8.

Note: Questions 7 and 8 of Section 3 (& 6) were only introduced for the second user study, as discussed prior (7.1.1).

SECTION 1 – Background Questions

1. Do you have any prior experience as a musician (e.g. play an instrument)?
   
   Yes  No

2. Do you have any prior experience with composing or creating music?

   Yes  No

3. How would you describe your understanding of music theory?

   None  Minimal  Basic  Developed  Expert

4. How often do you play digital games (including mobile games)?

   Once or twice a year (or less)  At least once a month  At least once a week  More than 3 times a week  Everyday

5. How would you rate your proficiency with digital games?

   None  Minimal  Basic  Developed  Expert
SECTION 2 (& 5) – System Usability

Questions derived from the System Usability Scale (Brooke, 1996). All questions offered the following Likert-scale responses:

<table>
<thead>
<tr>
<th>1. Strongly disagree</th>
<th>Tend to disagree</th>
<th>Neither agree nor disagree</th>
<th>Tend to agree</th>
<th>Strongly agree</th>
</tr>
</thead>
</table>
| 2. I think that I would like to use ____.
| 3. I found ____ unnecessarily complex.
| 4. I thought ____ was easy to use.
| 5. I think that I would need help to be able to use ____.
| 6. I found the various features in ____ were well integrated.
| 7. I thought there was too much inconsistency in ____.
| 8. I would imagine that most people would learn to use ____ very quickly.
| 9. I found ____ awkward to use.
| 10. I felt very confident using ____.

I needed to learn a lot of things before I could get going with ____.
SECTION 3 (& 6) – Compositional and Gameplay Experience

1. How would you describe your level of creative control over the music in ____?

<table>
<thead>
<tr>
<th>Game had total control</th>
<th>Game had most control</th>
<th>Balance between the game and I</th>
<th>I had most control</th>
<th>I had total control</th>
</tr>
</thead>
</table>

Please describe any aspects of your experience with ____ that gave you this impression.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

2. It was easy to direct the music towards a result that I desired.

   | Strongly disagree | Tend to disagree | Neither agree nor disagree | Tend to agree | Strongly agree |

Which aspects of ____ made it easy or difficult to influence the creation of the music?

________________________________________________________________________
________________________________________________________________________

3. I felt a sense of challenge while creating music in ____.

   | Strongly disagree | Tend to disagree | Neither agree nor disagree | Tend to agree | Strongly agree |

Which aspects of ____ do you think contributed to a sense of challenge, or might in other players?

________________________________________________________________________
________________________________________________________________________

4. I found that ____ helped me to be musically creative.

   | Strongly disagree | Tend to disagree | Neither agree nor disagree | Tend to agree | Strongly agree |

Please describe any aspects of ____ that you found particularly helpful or unhelpful towards your musical creativity?

________________________________________________________________________
________________________________________________________________________
5. I felt that I had to compete against ____ for creative control of the music.

- Strongly disagree
- Tend to disagree
- Neither agree nor disagree
- Tend to agree
- Strongly agree

Did anything in particular about ____ give you this impression?

________________________________________________________

________________________________________________________

________________________________________________________

6. I felt a sense of ownership over the music created during my time playing ____.

- Strongly disagree
- Tend to disagree
- Neither agree nor disagree
- Tend to agree
- Strongly agree

Please explain why you did or did not feel a sense of ownership over the music created during your time playing ____.

________________________________________________________

________________________________________________________

________________________________________________________

7. How do you rate ____ as a music creation experience?

- Very Poor
- Poor
- Neither good nor poor
- Good
- Very Good

Please explain why you gave this rating and describe any specific features in ____ that contributed.

________________________________________________________

________________________________________________________

________________________________________________________

8. How do you rate ____ as a game?

- Very Poor
- Poor
- Neither good nor poor
- Good
- Very Good

Please explain why you gave this rating and describe any specific features in ____ that contributed.

________________________________________________________

________________________________________________________

________________________________________________________
SECTION 4 (& 7) – Further Comments

1. What did you like most about ____?
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________

2. In what ways could ____ be improved?
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________

SECTION 8 – Final Comparison

1. Which game, if any, did you prefer between ____ and ____, and why?
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________
   
   __________________________________________________________