

# Evaluating Digital Games for Competitive Music Composition

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**Digital games are a fertile ground for exploring novel computer music applications. While the lineage of game-based compositional praxis long precedes the advent of digital computers, it flourishes now in a rich landscape of music-making apps, sound toys and playful installations that provide access to music creation through game-like interaction. Characterising these systems is the pervasive avoidance of a competitive game framework, reflecting an underlying assumption that notions of conflict and challenge are somewhat antithetical to musical creativity. As a result, the interplay between competitive gameplay and musical creativity is seldom explored. This article reports on a comparative user evaluation of two original games that frame interactive music composition as a human–computer competition. The games employ contrasting designs so that their juxtaposition can address the following research question: how are player perceptions of musical creativity shaped in competitive game environments? Significant differences were found in system usability, and also creativity and ownership of musical outcomes. The user study indicates that a high degree of musical control is widely preferred despite an apparent cost to general usability. It further reveals that players have diverse criteria for ‘games’ which can dramatically influence their perceptions of musical creativity, control and ownership. These findings offer new insights for the design of future game-based composition systems, and reflect more broadly on the complex relationship between musical creativity, games and competition.**

## 1. INTRODUCTION

Recent years have shown an increasing interest in digital games as a novel platform for computer music practice. Exemplifying this trend is the growing number of researchers investigating the automatic generation of game music (Prechtl 2016; Scirea, Togelius, Eklund and Risi 2016; Gillespie and Bown 2017), or the emerging application of musical computer games to wider contexts such as education (Roesner, Paisley and Cassidy 2016; Chung and Wu 2017). Such diverse activity is emblematic of the considerable breadth with which digital games and playful media now permeate the cultural lexicon. Similarly, 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. Precedents are apparent in Danckerts’ sixteenth-century chessboard canon (Moseley 2016), the eighteenth-century musical dice games (Hedges 1978), and the twentieth-century game pieces of Zorn and Xenakis (Sluchin and Malt 2011). With digital games, however, participation in interactive music composition has attained an unprecedented level of access. A rich landscape of ‘sound toys’ (Dolphin 2014), physical game installations (Cera 2013; Bown and Ferguson 2016) and music-making apps (Kassabian and Jarman 2016) now contribute to a growing participatory culture of playful, computer-assisted music creation. For the user, this access is often predicated upon symbolic game-based interaction with the real-time output of a music generation system.

Characterising these playful, musically creative media is their broad avoidance of a competitive game framework. This aversion is seemingly informed by an underlying assumption that notions of challenge and conflict are antithetical to musical creativity – or, at the least, to the casual and exploratory aesthetic often pursued by such media (Dolphin 2014; Kassabian and Jarman 2016). As a result, the interplay between competitive gameplay and musical creativity is seldom explored at a time when digital games are near ubiquitous and generative composition tools are more democratised than ever before. At this juncture lies an opportunity to investigate new forms of human–computer co-creation.

This article presents practice-based research by the authors which explores the nexus of interactive composition and competitive gameplay. Through the design and evaluation of two original games – *EvoMusic* and *Chase* – the research addresses the question: how are player perceptions of musical creativity shaped in competitive game environments? Both games position the player in creative contest with the system over a shared musical output, but each work employs contrasting implementations of musical control and

game-based challenge. This allows their juxtaposition in a comparative user study to reveal new insights regarding player perceptions of musical creativity, control and ownership in competitive game settings.

The context surrounding game-based composition is first outlined, addressing prevailing cultural assumptions and providing an overview of related work. The game and music systems of the two original works are then detailed, revealing their conceptual intentions and research purpose. The results of a comparative user evaluation are discussed, and implications of several qualitative insights gleaned from the juxtaposition of the games are drawn. The user study reveals two key insights: 1) that deep musical control is preferred even at the expense of general usability; and 2) that players' diverse criteria for games can dramatically shape their overall enjoyment and perceptions of musical creativity, control and ownership. These findings help to illuminate the complex relationship between musical creativity, games and competition.

## 2. GAMES, PLAY, AND COMPOSITION

In building a conception of game-based composition, it is necessary to address the inherent conceptual difficulties that emerge at the nexus of musical creativity and competitive game design. There are many categories of game in the prototypical sense. Game designer Chris Crawford (1984) identifies board games, card games, athletic games (e.g., sports), children's games (e.g., 'tag', 'hide and seek') and, of course, computer games. There has also been historical contention over the boundaries of 'game' as an ontological object, with modern game scholars adopting the Wittgensteinian (1953) position that any attempted definition would encircle only a subset of all phenomena described as games (Arjoranta 2014; Aarseth and Calleja 2015). Nonetheless, efforts to formalise the constituent elements of games (Salen and Zimmerman 2003; Juul 2005) have solidified a prevailing assertion that games are fundamentally predicated upon a contest between powers – or simply, conflict. All categories of games exhibit this contest, whether between opposing human players or against a computer system (Crawford 1984), and each contest typically results in a quantifiable outcome; that is, a victor or numerical score (Salen and Zimmerman 2003).

From this essentialist viewpoint, competitive gameplay is somewhat incompatible with the idea of composition. As a subjective process, composition cannot easily be scored or quantified by a game system in the way that performative criteria such as rhythmic accuracy are assessed in *Guitar Hero* (Harmonix 2005). This is not to suggest that creativity is absent from competitive games: to play any game from Chess to *Fortnite Battle Royale* (Epic Games 2017)

requires that players create their 'own solutions' to each scenario (Crawford 1984), and the very act of gameplay itself has been described as 'creativity within given rules' or 'boundaries' (Summers 2016: 201). The incongruity lies specifically with musical creativity; with the difficulty of designing computer systems capable of assigning quantitative value to compositional decisions. The result is a widespread tendency for playful music-making media to reject conflict altogether, complicating their conception as musical 'games' (Collins 2009; Blickhan 2016).

This tension is more broadly underpinned by the relationship between play and game – or rather, how they have been mapped to musical activity. Roger Caillois's (1958) seminal notions of *paidia* and *ludus* are central to this discourse. *Paidia*<sup>1</sup> denotes unstructured play that is free and exploratory, while *ludus*<sup>2</sup> embodies the willing submission to structured activities with explicit rules, objectives and contest. In their discussion of playful musical media, Kassabian and Jarman (2016) align *paidia* and *ludus* with two cultural representations of musical practice: music as a liberatory experience (*paidia*), and music as a disciplinary pursuit (*ludus*). They then dichotomise the performance and creation of music as such: musical performance is *ludus*, an achievable task to be practised until the rule structure is mastered, while musical creation is *paidia*, engendering free exploration and discovery. This strong cultural association of musical creativity with *paidia* and play – in contrast to *ludus* and games – underscores the rejection of competitive game frameworks by designers of interactive composition experiences.

Dolphin's (2014) discussion of 'sound toys' reinforces the sentiment of an incongruity between musical creativity and competitive game design. He describes sound toys as interactive, sonic-centric systems that allow novice users to playfully generate sound as a means of providing access to composition. With this framework, he casts a wide net over musically creative media ranging from Brian Eno's generative music app *Bloom* (Eno and Chilvers 2008) to Björk's interactive app-album *Biophilia* (Björk 2011). Dolphin then asserts that such designs avoid competitive or challenging game elements for the purpose of ensuring that the user experience remains casual, exploratory and explicitly focused on sound composition. In light of wider assertions that challenge is 'characteristic of all good games' (Hurka and Tasioulas 2006: 221) and psychologically significant to 'enjoyable gaming experiences' (Corcos

<sup>1</sup>*Paidia*: borrowed from Ancient Greek παιδιά (paidiá, 'childish play, amusement'), from παῖς (país, 'child').

<sup>2</sup>*Ludus*: borrowed from Latin *lūdus* ('game') and *lūdō* ('I play'), either from Proto-Indo-European *loydos* < *leyd-* ('to play') or from Etruscan.

2018), this again illustrates music creation as somewhat antithetical to competitive gameplay.

Of course, there are several cases in which competitive game structures have been deployed as compositional procedures. Iannis Xenakis's *Duel* (1958) and *Stratégie* (1962) facilitate a scored combat between orchestras with points and a victor awarded using predetermined payoff matrices (Sluchin and Malt 2011). In contemporary work, *Sound Games 1 & 2* (Gimenes 2018) present musically metacreative performances for multiple participants which similarly incorporate elements of competition and scoring. The recent Gamified Audiovisual Performance and Performance Practice project (GAPPP) is also notable for producing works which explicitly explore the effects of competitive game elements on compositional decision-making (Lüneburg 2018). A key distinction, it seems, is the intended context of these works.

Unlike sound toys, these modern game pieces do not target casual engagement by a single user, but are rather predicated upon the contest of multiple human agents in a formal performance setting. To imagine a comparable contest in the single-user systems described by Dolphin (2014) would suggest a compositional conflict between the player and computer, yet there is an apparent lack of systems allowing for such a dialogue. This shows that competitive game frameworks are not avoided by interactive composition experiences in general, but by systems targeting creative human–computer interactions for a single player. In this way, the rejection of contest by digital composition games is not simply a matter of latent tensions between representations of creativity as *paidia* and competition as *ludus*, but a reflection of the specific human–computer dialogues pursued by these media.

In most playful music apps, the computer relates to the human as a passive compositional assistant; the player interacts with the system as a ‘tool’ for exploring audiovisual possibilities (Kassabian and Jarman 2016). This is deeply connected to the aesthetic goal of providing access to composition, as evidenced by the constrained sound worlds and static musical behaviour of these media. In the mobile apps *Soundrop* (Develoe 2010) and *Pulsate* (Audiotool 2012), players generate deterministic music by creating simple arrays of two-dimensional shapes. In Toshio Iwai's *Electroplankton* (Indieszero 2005), players launch organisms at a moveable musical plant structure to manipulate pitch, rhythm and timbre.<sup>3</sup> These easily decodable interactions produce strictly diatonic, timbrally unobtrusive music to uphold an aesthetic of accessibility. More crucially, the computer only

affects musical change in direct response to player input; if the player idles, the game's musical state either perpetuates in stasis or gradually recedes. What emerges is a disarming, carefully non-competitive dialogue between the player as empowered creator and the computer as artistic tool.

With this, the aesthetic ideals underpinning the current landscape of digital composition games become clear. The broad aim is to engender participation in music-making through the disarming qualities of digital games (Wang 2016), but to reject competitive human–computer dialogues in favour of casual, exploratory experiences that lower inhibition and better align with cultural conceptions of creation as *paidia* – or play. While this initiative is undoubtedly significant in advancing a culture of participatory computer music creation, there is a lack of research or practice interrogating the underlying assumptions. For instance, how would players respond to the repositioning of the computer as a compositional opponent? In what ways would this competitive dialogue influence compositional decision-making, or perceptions of control, creativity and ownership? More immediately, how might we approach such a design? This interplay between musical creativity and competitive gameplay is seldom explored, presenting a point of departure for the original works and research presented here.

### 3. ORIGINAL WORKS

This section introduces two original games – *EvoMusic* and *Chase* – as creative research. Earlier iterations of these games are detailed in the authors' prior work (Studley, Drummond, Scott and Nesbitt 2018), though their design warrants summary here to contextualise the user study results reported in section 5. First, the games are described as interactive music systems and their conceptual intentions are addressed. The contrasting rules, mechanics and musical constraints employed by each game are then detailed before discussing how these elements contribute to the cultivation of a compositional contest between player and system.

#### 3.1. System design

In both works, the total composition game as experienced by the player comprises a separate game and music system communicating on a single device. 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 player actions as control inputs. The game systems were built with *Unity*, a flexible game engine which allows for the easy

<sup>3</sup>This refers specifically to ‘Hananbow’, one of ten musical mini-games available in *Electroplankton* (Indieszero 2005).

mapping of sonic parameters to physics and game-world data (Unity Technologies, version 2017.3.1f1).

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 player's compositional decisions. MIDI data is first generated using basic stochastic strategies (e.g., first order markov chains, 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, with timbre chosen directly by the player using a pre-game settings menu. In both games, this output can be captured as a WAV file so that players can preserve permanent artefacts of their creativity. Soundscape elements do not factor into composition, save for a subtle and persistently looping environmental ambience (e.g., wind, water) 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 (OSC) and a C# script from Thomas Frederick's *UnityOSC* project.<sup>4</sup> This communication is bidirectional: while the game state determines the broad 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. Further details of this implementation are addressed in the authors' prior work (Studley et al. 2018).

### 3.2. Conceptual approach

*EvoMusic* and *Chase* are conceived as compositional contests between the player and game system. The player and game do not compose discrete music, but rather compete for creative control over the direction of a single, shared musical output. This competitive co-creative dialogue is suggested to emerge from designing the game rules and mechanics in such a way that the music generation moves inexorably towards some broad aesthetic outcome (e.g., harmonic cacophony) over the course of a game session. The player then contests this designed musical trajectory using in-game interactions in a persistent effort to align the generated music with their own aesthetic goals. Considered as interactive music systems, the games expand Rowe's (1993) notion of the 'player paradigm' – wherein systems construct an artificial player as a musical presence – to encompass representations of the computer as both musical partner and

**Table 1.** Summary of the cell types in *EvoMusic* and their sonic characteristics.

Cell Type	Colour	Sonic Event Class
Melody	Yellow	Short, pitched tones
Harmony	Magenta	Long, pitched tones
Bass	Red	Low-register, pitched tones
Percussion	Green	Percussive layers
SFX	Cyan	Miscellaneous SFX samples
Destructive	Black	Dissonant synthesiser

game opponent. Like the sound toys described in section 2, the games are also designed to be accessible to users of any musical literacy and digital game proficiency. The implementation of these aims differs for each work, as outlined in the following sections.

### 3.3. *EvoMusic*

*EvoMusic*<sup>5</sup> is a two-dimensional, point-and-click game inspired by the principles of mitosis and evolution. It allows players to exercise musical creativity by curating the growth of an evolving population of musical 'cells'. Each cell is assigned a discrete sonic event (e.g., a pitch, a percussion hit, a sound effect) which the music system then organises into an open and evolving composition. Cells also grow over time, intermittently sounding their musical event until they grow large enough to divide into two new cells; one inherits the sonic event of the parent while the other is assigned a new event through stochastic processes. This provides novice users 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.

There are six cell 'types' in *EvoMusic*. A cell's type determines both its in-game behaviour and the class of sonic event that it produces (see Table 1). Whenever a new cell is created, the music system assigns it an unused sonic event of the appropriate class from a player-defined constraint (e.g., a mode and key). These constraints are chosen in a pre-game menu where the player can also configure tempo, metre, cell types used, and the speed of cell growth (analogous to 'game difficulty'). The new sonic event is subsequently added to a pool of currently active events, which *Max* then treats as the parameters for music generation by performing the events with stochastically determined order, timing and duration. Importantly, cells also flash whenever their assigned musical event is produced; this allows players to quickly decode the sonic identity of each cell and thus

<sup>4</sup>Available at: <http://thomasfredericks.github.io/UnityOSC/> (accessed 12 November 2019).

<sup>5</sup>A video demonstration is available at: <https://youtu.be/pS-xG6bI8N8> (accessed 12 November 2019).



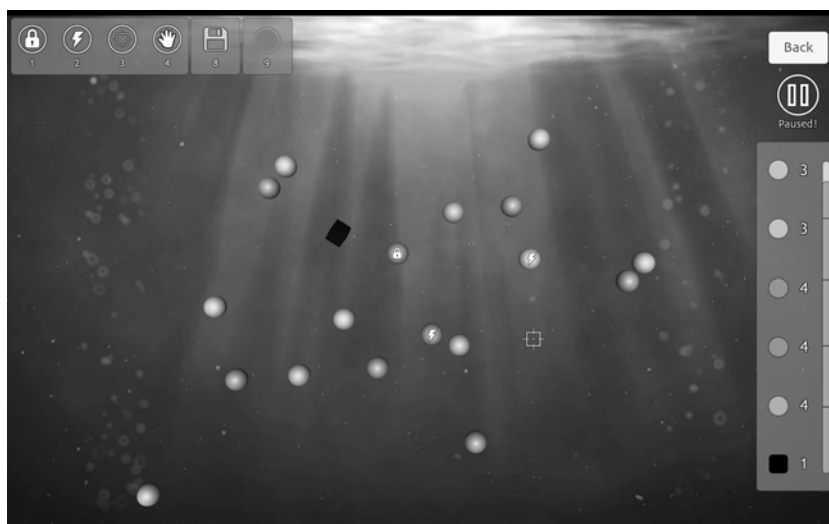


Figure 1. Screen capture of the interface for *EvoMusic* during gameplay.

affect discernible sonic results (e.g., removing an unwanted sound).

The competitive framework in *EvoMusic* is multifaceted. First, population growth is tied to an increasing chance that new sonic events will not conform to the player's initially chosen harmonic constraints. Given that the population bifurcates exponentially, the system exhibits an innate pull towards cacophony which the player must actively contest. They can 'lock' cells to slow growth and preserve favoured sonic content, 'mutate' cells to hasten growth and promote sonic variety, or outright remove cells to suppress unwanted content as a staple of gameplay. By responding promptly to new sonic events, the player can keep the population to a manageable size while pursuing a desired musical state. The difficulty of this mechanic can be adjusted prior to gameplay by altering the speed of cell growth, allowing more time to respond to musical changes.

Critically, population growth in *EvoMusic* is also the mechanism by which the player is offered new sonic material to preserve or discard at their discretion, ensuring that the competitive dynamic is conceptually integrated into the core compositional loop. The intention is to facilitate a co-creative dialogue between player and system that resides in a liminal space between collaboration and competition. *EvoMusic* also incorporates traditional game elements that are more distinctly adversarial. For one, each cell division risks the creation of 'destructive' cells, which destroy 'non-locked' musical cells upon collision and so can disrupt the music if the player fails to promptly remove them. Additionally, all actions taken by the player consume 'energy' – displayed as a bar to the right of the interface (see Figure 1) – which is only

replenished by generating further music. This balancing mechanic aims to better cultivate the perception of an equal, gamified dialogue between compositional wills that variably collide or comply with one another.

### 3.4. Chase

*Chase*<sup>6</sup> presents a clear departure from *EvoMusic* in the treatment of its game framework and compositional controls. The player is perpetually pursued by a red humanoid agent (see Figure 2) over a three-dimensional gameworld comprising four interconnected environments. The proximity of this 'Red Man' to the player is scaled by the music system and mapped to the tempo, velocity and rhythmic density of stochastically generated musical events. The metre and harmonic treatment of this music is determined by the Red Man's current environment (see Table 2). Having decoded this sonic relationship, the player strategically navigates the gameworld to manipulate the Red Man's position and exert compositional control.

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 are withdrawn if the player restores health by collecting heart-shaped tokens distributed throughout the gameworld. The result is a risk-reward dynamic where the music grows more interesting in proportion to the danger of losing. The player also loses 'stamina' as they sprint; this can only be recuperated by slowing down, which in turn risks capture and a ceding of control to the game's natural musical

<sup>6</sup>A video demonstration is available at: <https://youtu.be/TjjKuzusUc> (accessed 12 November 2019).



**Figure 2.** Screen capture of the interface for *Chase* during gameplay.

**Table 2.** Summary of the musical treatment of environments in *Chase*.

Environment	Metre	Harmonic Treatment
Forest	4/4	Major
City	4/4	Harmonic Minor
Desert	3/4	Lydian-Dominant
Snow	3/4	Phrygian-Dominant

trajectory of increasing rhythmic saturation. This provides a comparable balancing mechanism to the energy bar in *EvoMusic*, ensuring that the player does not command complete compositional control over the system in the manner of a tool.

The nature of the compositional contest in *Chase* is conceptually similar to *EvoMusic*. The Red Man's unrelenting pursuit of the player pulls the music inexorably towards rhythmic saturation, which the player must variably resist or embrace to explore sonic outcomes. Several design elements aid the player in this engagement, such as a numerical indication of the Red Man's proximity and the option to enable a rear-view mirror display. The generated music also pans in accordance with the Red Man's position, serving a dual purpose as both an aid to auditory information display (i.e., for locating the Red Man) and a creative parameter. The sound world of *Chase* is rather constrained: rhythmic treatment is benign and quantised, harmonic treatment is strictly confined to the environment's mode (see Table 2), and the timbral palette comprises familiar sonic identities enshrined in the Western musical tradition (e.g., piano, harp, flute). This polite sonic treatment compounds with the easily apprehended game controls

to ensure that *Chase* presents as both compositionally and mechanically accessible.

#### 4. METHODOLOGY

The practice-based research presented here encompasses both the original games as creative artefacts and their evaluation in a comparative user study. As creative artefacts, *EvoMusic* and *Chase* explore practical approaches to the design of competitive, game-based composition for single, novice users. A user study was employed to provide a deeper understanding of how players interact with these settings, allowing broader reflection on the interplay between musical creativity and competitive game environments. Critical to the research is that the games have been designed as contrasting implementations of compositional control and competitive gameplay.

*EvoMusic* affords atomised command over musical content at a granular level, editing individual notes and sounds. The larger co-creative system resembles a gamified genetic strategy with the player's musical taste as the fitness function. In *Chase*, players harness a single control input (movement through the environment) to broadly affect high-level musical characteristics such as rhythmic density, harmonic treatment and general 'intensity' (e.g., tempo, velocity, ensemble size). Unlike *EvoMusic*, the compositional opponent is embodied as a literal hostile agent and the game can be definitively lost. The relationship between the works is as follows: *EvoMusic* allows for deeper and more diverse musical control than *Chase*, but *Chase* more closely approaches a traditional competitive game framework. By presenting participants with two contrasting designs to be evaluated, their juxtaposition

**Table 3.** Summary of questions 1–6 of the user study.

Question #	Question
1 (balance)	How would you describe your level of creative control over the music in <i>EvoMusic/Chase</i> ?
2 (control)	It was easy to direct the music towards a result that I desired in <i>EvoMusic/Chase</i> .
3 (challenge)	I felt a sense of challenge while creating music in <i>EvoMusic/Chase</i> .
4 (creativity)	I found that <i>EvoMusic/Chase</i> helped me to be musically creative.
5 (contest)	I felt that I had to compete against <i>EvoMusic/Chase</i> for creative control of the music.
6 (ownership)	I felt a sense of ownership over the music created during my time playing <i>EvoMusic/Chase</i> .

Note: Likert-scale responses to question 1 are as follows: 1 = Game had total control; 2 = Game had most control; 3 = Balance between me and game; 4 = I had most control; 5 = I had total control.

can reveal the more successful design approach while also illuminating the implicit player values underpinning musically creative play in competitive game settings.

#### 4.1. User study design

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. A total of 24 anonymous participants were recruited from the undergraduate student cohort at the University of Newcastle, Australia. The only demographics collected from participants were indications of their existing musical knowledge and proficiency with digital games for the purpose of contextualising results. All 24 participants identified as gamers, while four also identified as musicians.

The user study was conducted in single supervised sessions for each participant. After providing written consent, participants were asked to play each game for approximately 20 minutes before completing a survey pertaining to their experience. The order in which they played the games was randomly assigned as a control, and participants responded to an identical set of questions for both games. Participants were introduced to the broad aims of the research beforehand, but no specific information about the games or survey questions were given to avoid influencing their responses.

In evaluating each game, participants first completed ten Likert-scale questions derived from the System Usability Scale (Brooke 1996), an effective standardised instrument for subjective assessments of system usability (Bangor, Kortum and Miller 2008). The scale yields a score between zero and one hundred, providing a high-level overview of usability in *EvoMusic* and *Chase* both individually and as a direct comparison. Participants then responded to six primary questions (see Table 3) 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 of each inquired category while also allowing latent qualitative trends to emerge. Participants were next

given the opportunity to indicate which features they most enjoyed, or would like to see improved, in free-form responses. The survey concludes with a direct, open-ended comparison between *EvoMusic* and *Chase* where users can specify a preferred game and articulate their reasoning at length. A list of survey questions are available in the Appendix.

#### 4.2. Analytical methods

Data collected from the System Usability Survey (SUS herein) were used to produce mean scores for each game. The mean scores were then compared to a global SUS benchmark of ‘around seventy’ (Bangor, Kortum and Miller 2009) and a paired-samples t-test was conducted to test for significance ( $p < 0.05$ ) 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 3) to test for significance between games in primary categories (e.g., compositional control). The frequency distribution of participant responses were also compared to provide further perspective on the spread of player perceptions (Sullivan and Artino 2013).

The qualitative data were categorised by user, by question and by conceptual category (e.g., contest, ownership) to facilitate cross-examination and construct a more detailed representation of player perceptions. The two free-form responses (i.e., most enjoyed features, suggested improvements) 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; a participant might rate *Chase* as a more usable system and more enjoyable game, but still ultimately prefer *EvoMusic* as a composition experience. This ensures that any conclusions extracted from participant responses are interpreted in relation to their explicitly stated preference.

No meaningful comparison can be drawn between the two participant categories (i.e., gamers and

**Table 4.** Statistical comparisons between *EvoMusic* and *Chase* for questions 1–6.

Question	<i>EvoMusic</i>		<i>Chase</i>		N	Paired t-test	
	M	SD	M	SD		t	p-value
1 (balance)	3.08	0.88	2.83	0.92	24	1.1867	0.247
2 (control)	3.29	1.27	3.21	1.22	24	0.2490	0.806
3 (challenge)	3.08	1.02	2.79	1.18	24	0.2713	0.271
4 (creativity)	3.96	0.95	2.83	1.13	24	5.1224	< <b>0.0001</b> ****
5 (contest)	3.29	1.00	3.00	1.10	24	1.0707	0.295
6 (ownership)	3.09	1.04	2.13	1.26	23	3.7607	<b>0.001</b> ***

Note: one participant failed to answer question 6.

musician-gamers) due to the small sample size of musicians ( $n = 4$ ) and the fact that all musicians were also gamers. A bias is also present given that all participants described themselves as proficient gamers. This is not considered problematic because 1) gamers are the primary target audience for the original works, and 2) gamers are presumed to have a richer set of implicit criteria for game-based systems than non-gamers.

## 5. RESULTS AND DISCUSSION

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 also to an intriguing variety of often conflicting perceptions revealed. To best articulate this, the discussion of results is structured as follows: the general reception of the games are outlined to provide context (section 5.1); participant perceptions pertaining to the primary categories of musical creativity, control, competition and ownership are compared between games (section 5.2); insights regarding the interplay between these categories and the traditional game framework are detailed (section 5.3); the results are summarised and the implications discussed (section 5.4).

### 5.1. General reception

*EvoMusic* is clearly preferred as an overall experience when detached from any specific criteria. In the final qualitative comparison, 15 participants (63%)<sup>7</sup> 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*). This is 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’.

<sup>7</sup>All percentages are rounded to the nearest whole integer due to the small sample size ( $n = 24$ ). Tables are rounded to one decimal place.

This dichotomy aligns with the design assumptions described in section 4: that *EvoMusic* affords deeper musical control, but *Chase* more closely approaches a competitive game framework. Six participants (25%) articulated this relationship in the final comparison, as exemplified by the following excerpts:

*Chase* was more fun, but as a music creation game *EvoMusic* gave me more variety of sound and more control. (Participant 1)

I preferred *Chase* on a gameplay standard and *EvoMusic* on a creativity and music standard. (Participant 3)

There is also strong support for each sentiment individually. In the final comparison, 19 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.

### 5.2. Primary categories

The primary categories of player perception examined during the user study were as follows: compositional control (5.2.1), musical creativity (5.2.2), compositional contest (5.2.3) and ownership (5.2.4). Quantitative data from the six hybrid questions concerning these categories are summarised in Table 4. Paired sample t-tests were conducted to compare these results for each category reported between *EvoMusic* and *Chase*. Overall, significant differences were found between *EvoMusic* and *Chase* in the categories of musical creativity and ownership, with *EvoMusic* scoring significantly higher in both cases (see Table 4). The qualitative responses offer further insights, as discussed in the following sections.

#### 5.2.1. Compositional control

A paired-samples t-test was conducted to compare the balance of compositional control between the player and system (Table 4: Question 1) for *EvoMusic*



**Table 5.** Compared frequency distributions of responses to question 2: ‘It was easy to direct the music towards a result that I desired.’ Note: percentages in all tables are rounded to one decimal place.

Responses (n = 24)	Distribution ( <i>EvoMusic</i> )	% ( <i>EvoMusic</i> )	Distribution ( <i>Chase</i> )	% ( <i>Chase</i> )
Strongly disagree	2	8.3	2	8.3
Tend to disagree	6	25	6	25
Neither agree nor disagree	3	12.5	4	16.7
Tend to agree	9	37.5	9	37.5
Strongly agree	4	16.7	3	12.5

and *Chase*. There was no significant difference in the balance scores for the *EvoMusic* ( $M = 3.08$ ,  $SD = 0.88$ ) and *Chase* ( $M = 2.83$ ,  $SD = 0.92$ ) conditions;  $t(23) = 1.1867$ ,  $p = 0.247$ . Similarly, a paired-samples t-test to compare the ease of creative control (Table 4: Question 2) found no significant difference for the *EvoMusic* ( $M = 3.29$ ,  $SD = 1.27$ ) and *Chase* ( $M = 3.21$ ,  $SD = 1.22$ ) conditions;  $t(23) = 0.2490$ ,  $p = 0.806$ . Considering the frequency of responses, there was a wide variation (see Table 5), indicating that general perceptions on creative control were somewhat divided.

Both games achieved an acceptable usability rating, meeting the established SUS benchmark of ‘around seventy’ (Bangor et al. 2009). However, a paired-samples t-test comparing the SUS scores found a significant difference between *EvoMusic* ( $M = 70.94$ ,  $SD = 15.76$ ) and *Chase* ( $M = 80.0$ ,  $SD = 13.85$ );  $t(23) = 2.1594$ ,  $p = 0.0415$ . Overall this suggests *Chase* as an easier game to understand and operate, though the qualitative responses offer further insight. Eighteen participants (75%) described *Chase* 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 with the cost of more complex operation, as indicated in 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 17 participants (71%) awarded superior musical control to *EvoMusic* in the final comparison, the implication is that players value deep and diverse compositional control even at the expense of general usability (i.e., the operational ‘ease’ of exerting this control). Exemplifying this is participant 15, who scored *EvoMusic* as low as 30 on the SUS (compared to *Chase* at 75) while 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 final note, the stochastic nature of the music generation and gameplay in *EvoMusic* was framed as a hindrance to creative 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’ in *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. Musical creativity

A paired-samples t-test comparing the level of musical creativity experienced by players (Table 4: Question 4) found a significant difference between *EvoMusic* ( $M = 3.96$ ,  $SD = 0.95$ ) and *Chase* ( $M = 2.83$ ,  $SD = 1.13$ );  $t(23) = 5.1224$ ,  $p < 0.0001$ . It is notable that 19 participants (79%), including all four musicians, either ‘agreed’ or ‘strongly agreed’ that *EvoMusic* helped them to be musically creative (see Table 6). This not only supports the representation of *EvoMusic* as the superior compositional experience, but offers a vital contextualisation of wider responses.

Qualitative responses revealed that player perceptions of creativity are influenced by multiple factors. For one, a lacking sense of creativity in *Chase* was explicitly attributed to the absence of fine musical control by 11 participants (46%), reiterating the importance of creative control as a player value. Further, the stochastic nature of *EvoMusic* was actually 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)

**Table 6.** Compared frequency distributions of responses to Question 4: ‘I found that *EvoMusic/Chase* helped me to be musically creative’.

Responses (n = 24)	Distribution ( <i>EvoMusic</i> )	% ( <i>EvoMusic</i> )	Distribution ( <i>Chase</i> )	% ( <i>Chase</i> )
Strongly disagree	0	0	3	12.5
Tend to disagree	3	12.5	8	33.3
Neither agree nor disagree	2	8.3	3	12.5
Tend to agree	12	50	10	41.7
Strongly agree	7	29.2	0	0

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 (section 5.2.1); in fact, two participants (8%) expressed both sentiments between separate responses. Additional factors influencing creativity pertain to broader conceptions of the traditional game framework (section 5.3).

### 5.2.3. Compositional contest

The player’s perception of a compositional contest with the game system is of critical interest to this research. A paired-samples t-test comparing the level of compositional contest (Table 4: Question 5) found no significant difference for the *EvoMusic* ( $M = 3.29$ ,  $SD = 1.00$ ) and *Chase* ( $M = 3.00$ ,  $SD = 1.10$ ) conditions;  $t(23) = 1.0707$ ,  $p = 0.295$ . However, the qualitative data reveals that this is a poor representation of participant perception. For instance, seven participants (29%) interpreted ‘competing against the game’ (see Table 3: Question 5) as referring to their reported struggles with the interface or poor musical controls rather than the nature of the 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 18 participants (75%) identified this sense in *EvoMusic*, compared to only 12 (50%) in *Chase*. Crucially, 16 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 (section 3.2). 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 (section 5.3).

### 5.2.4. Ownership

Both quantitative and qualitative data demonstrate unequivocally that *Chase* does 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 4: 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 ten participants (42%) ‘strongly disagreed’ with *Chase* engendering ownership (see Table 7) provides critical context to the game’s persistently cited lack of musical control, as revealed by the qualitative responses. 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 below. This further highlights 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 ownership:

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)

**Table 7.** Compared frequency distributions of responses to Question 6: ‘I felt a sense of ownership over the music created during my time playing *EvoMusic/Chase*’.

Responses (n = 23)	Distribution ( <i>EvoMusic</i> )	% ( <i>EvoMusic</i> )	Distribution ( <i>Chase</i> )	% ( <i>Chase</i> )
Strongly disagree	1	4.3	10	41.7
Tend to disagree	7	30.4	7	29.2
Neither agree nor disagree	5	21.7	2	8.3
Tend to agree	9	39.1	4	16.7
Strongly agree	1	4.3	1	4.2

Note: one participant failed to answer question 6.

### 5.3. Game framework

Elements of the broader game framework, such as challenge and goals, were a persisting theme in the qualitative responses. For instance, three of the six participants (50%) who nominated *Chase* as their preferred game explicitly attributed this to their perception of a clear game goal (i.e., avoiding the Red Man). While this supports the design assumption that *Chase* better approaches a traditional game framework, there is a wider and more complex interplay between goals and other musical perceptions. The responses of participant 13 exemplify this, suggesting that the lack of a comparable game 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 8, who suggested that the absence of goals in *EvoMusic* not only disqualifies 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 is that music creation is too ‘esoteric’ to serve as a goal in the traditional game sense. However, participants 12 and 22 offer the critical dissent that the absence of a game-based goal strengthened *EvoMusic* as a platform for composition, while the goals 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)

There was evidence of a similar complex interplay between musical control and game-based challenge, emerging from intrinsic differences in how players value challenge. The option to pause the Red Man in *Chase* exemplified this: nine participants (38%) stated that the pause function reduced or negated challenge in *Chase*, while eight participants (33%) – seven of which were the same – found it critical to creative control. Two participants (8%) even suggested removing the pause functionality to increase the level of challenge. These positions are 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 challenge and musical control have a close and near inverse relationship in the context of game-based composition, revealing an implicit tension whereby designing for one may detract from the other. Participant 3 articulates this tension in their primary suggestion for improving *EvoMusic*:

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

This recalls the aforementioned interplay between traditional game goals and the system's effectiveness as a platform for composition. That designing for challenge or game-based goals would detract from the compositional experience is emblematic of a deeper tension between interactive composition and competitive gameplay. Most notably, it lends credence to the underlying cultural assumption of a natural incongruity between musical creativity and the competitive game framework (section 2).

#### 5.4. Summary and implications

The results of the user study present clear and contrasting characterisations of each game. *EvoMusic* unequivocally presents the more successful composition experience – it engenders musical creativity, affords a higher level of compositional control and is the clearly preferred system for these reasons. *EvoMusic* is also more successful at eliciting a compositional contest between the player and computer, with 18 of 24 participants (75%) expressly identifying the intended dialogue. *Chase*, in comparison, is a more successful game in the traditional sense – it has more enjoyable gameplay, is easier to use and understand, and exhibits more defined goals. However, *Chase* is also decisively characterised as a weak compositional experience, affording only limited creative control and widely failing to evoke a sense of ownership in players. It is also less successful at inspiring a sense of human–computer contest, with only 12 participants (50%) identifying the intended compositional dialogue. To summarise their relationship: *EvoMusic* is preferred for music creation, *Chase* is preferred for gameplay.

An appropriate means of framing the implications of the user study results are as insights for potential designers of competitive, game-based composition experiences. What should they prioritise, and what do players value in such a context? First and foremost, the depth and diversity of musical control is by far the most influential factor shaping player reception – even at a cost to system usability or the clarity of the competitive game framework. While this may seem a redundant insight for designers of composition-based experiences, there are deeper conceptual tensions to navigate.

Critically, the qualitative data suggests that musical control seems aesthetically opposed to the design of game-based challenge and goals (section 5.3). This not only aligns with the prevailing characterisation of musical creativity as a *paidic* activity (Kassabian and Jarman 2016), but supports Dolphin's (2014) assertion that avoiding competitive elements enables a clear focus on composition. Despite this, six participants (25%) stated a desire for more challenge between the two games, with two outliers (8%) even suggesting that elements considered vital to musical control be removed to accommodate this. The implication is that a cohort of players, despite prioritising musical control foremost, still place significant value on formal game elements within musically creative contexts. As such, designers of competitive, game-based composition must carefully consider the underlying values of their target player-base (e.g., their penchant for challenge) to ensure an appropriate prioritisation of musical or gameplay elements.

These insights indicate that the cultural assumption of an incongruity between musical creativity and competitive gameplay (section 2) is perhaps well founded.

Nonetheless, the general success of *EvoMusic* should not be overlooked. Given that 75 per cent of participants clearly identified the compositional contest between player and system, the consensus that *EvoMusic* successfully engendered musical creativity (section 5.2.2) suggests that there is indeed latent potential for interactive composition in competitive, digital game environments.

#### 6. CONCLUSION

This article has reported on the design and evaluation of two digital games that explore the interplay of musical creativity with competitive gameplay in the context of a single, novice user. The practical and theoretical contexts surrounding game-based composition were first outlined, revealing an underlying cultural assumption that competitive gameplay is somewhat antithetical to musical creativity (section 2). Practice-based research interrogating this assumption is then presented. Two original games were described (*EvoMusic* and *Chase*), addressing both their design as interactive composition systems and their research purpose as contrasting implementations of competitive, game-based composition (section 3). The design of a comparative user study conducted with 24 participants to investigate player perceptions of musical creativity, control, contest and ownership within the two games is then detailed (section 4).

The results of the user study (section 5) indicate that *EvoMusic* is both a more effective compositional experience and more successful in eliciting the intended creative contest between player and computer, while *Chase* has more enjoyable gameplay and exhibits a more clearly defined game framework. Significant differences were found in usability, with *Chase* scoring more highly, and also musical creativity and ownership, with *EvoMusic* scoring more highly. The user study also reveals two key insights regarding the design of competitive composition games: 1) that deep musical control is preferred by players even at the expense of general usability or the clarity of the game framework; and 2) that players have diverse conceptions of 'games' which can influence their perceptions of musical creativity, control and ownership within the system. The research thus contributes a preliminary charting of the novel design space for competitive, game-based, human–computer co-creation while also providing a broader exploration of the complex interplay between musical creativity, games, and competition.

#### Acknowledgements

This work is supported through an Australian Government Research Training Programme Scholarship.



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## Appendix

Following are the questions provided to each participant during the comparative user study, excepting the standardised System Usability Survey (Brooke 1996). Questions 1–6 involved both a five-point Likert-scale rating and a short written justification. Questions 7–9 were open-ended, free-form responses.

- **Question 1** (Balance) – How would you describe your level of creative control over the music in *EvoMusic/Chase*? (1 = Game had total control; 2 = Game had most control; 3 = Balance between me and game; 4 = I had most control; 5 = I had total control).
- **Question 2** (Control) – It was easy to direct the music towards a result that I desired.
- **Question 3** (Challenge) – I felt a sense of challenge while creating music in *EvoMusic/Chase*.
- **Question 4** (Creativity) – I found that *EvoMusic/Chase* helped me to be musically creative.
- **Question 5** (Contest) – I felt that I had to compete against *EvoMusic/Chase* for creative control of the music.
- **Question 6** (Ownership) – I felt a sense of ownership over the music created during my time playing *EvoMusic/Chase*.
- **Question 7** – What did you like most about *EvoMusic/Chase*?
- **Question 8** – In what ways could *EvoMusic/Chase* be improved?
- **Question 9** – Which game, if any, did you prefer between *EvoMusic* and *Chase*, and why?