

Jump'n'Rhythm: A Video Game for Training Timing Skills

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Abstract

Developing a sense of rhythm is a central but difficult task in music education. Even otherwise enthusiastic music students might avoid the training of their rhythm skills due to the tedious and repetitive nature of exercises. In this work we explore how a gamification approach to rhythm learning can improve the capacity of entrainment in players. Based on insights from music didactics and neuroscience we developed *Jump'n'Rhythm*, a serious game for training rhythmical timing skills.

1 Introduction

A sense of rhythm is a central quality of any musician, but it needs to be trained. The methods used in musical education are tedious and provide little motivation to the students. Even otherwise enthusiastic music beginners might avoid the training of their rhythm skills due to the tedious and repetitive nature of the exercises. Digital music learning applications like *Yousician* or *Jamstik* aim at motivating students by enriching the interactive experience. Often they will use game-like elements like scores and badges to increase students' motivation. Yet this falls short of providing an experience close to the flow-like state of playing a well-designed video game. Music learning applications thus only gamify the learning experience. In this paper we present an alternative approach: adding purpose to a game. We present *Jump'n'Rhythm*, a game designed to improve the sense of rhythm of the players. It references the side-scroller game genre with controls and level maps designed so that players must perform a rhythm in order to succeed. Our research question is how a game can improve the ability to learn and embody musical rhythms. This paper describes the approach and game prototype of ongoing research.

2 Related Work

Pichlmair & Kayali categorize games in which music is a central part of the game mechanics and introduce the term *rhythm games*, where the player has to perform a rhythm provided by the game. The player's success is measured by the quality of her actions with respect to the rhythm (Pichlmair & Kayali, 2007). In such games one of the most common visualization approaches is the time ribbon metaphor, which is based on traditional musical notation. Note ticks or cues are displayed in succession and are either browsed by a playhead (e.g. *Singstar*) or scrolled through the screen (e.g. *Guitar Hero*). Here, a successful traversal of the level already has a fixed rhythm. Many music games can also be applied as learning tools (De Castell & Jenson, 2003; Prensky, 2004). Rhythm games can support students to improve their musical skills, which transfers to playing a real musical instrument (De Castell & Jenson, 2003). This is achieved by designing games so that they require the player to embody a rhythm. The use of embodied metaphors in music learning improves the understanding of musical concepts such as tempo, volume and pitch (Antle, Droumeva, & Corness, 2008).

Cognitive science increasingly emphasizes the role of embodiment in the process of learning. Embodied music cognition is the relationship between the subject and the environment (musical mind/matter) mediated by the human body. In this way, the technology-based mediation can be seen as an extension of the human body, thus allowing a more flexible access to music through interaction (Leman, 2008). Musical involvement is linked to the audio motor recognition network, so that the humans motor system can react automatically and unconsciously when listening to music (Lahav, Saltzman, & Schlaug, 2007). One of the concepts Leman propose, is the synchronization based on the corporeal imitation. People tend to move in synchrony with auditory rhythms; for example, tapping to beat while listening music. Jenson & de Castell and Leman speak of imitation as a way of learning, which builds on repetition and mimicry.

With the aim to improve student's rhythmical skills, these concepts were applied to the game design of *Jump'n'Rhythm*.

3 Game Design

Jump'n'Rhythm is a rhythm based 2D side-scroller jump-and-run, where each challenge is a specific rhythmical pattern. The player controls the character's jump action while the avatar is moving forward in sync with the background music. Thus all interaction in *Jump'n'Rhythm* is driven by the underlying game music. The platforms and gaps are arranged so that in order to master the level, the avatar must jump to the exact timing of the rhythm. A successfully performed exercise is rewarded with score points. For a game session, the player has 3 lives. If the player does not perform well (jumps too early or too late) the character falls into the gap and the player loses a life. As long as lives are left, the player can repeat the exercise again. To this end, inbuilt rehearsal stretches precede each challenge in the level. This is a dry-run stretch with visual and audio cues that allow the player to listen to and internalize the rhythm (Figure 1). Shortly after this, the actual

challenge is presented with a starting cue. This call and response method is the basis of *Jump'n'Rhythm* gameplay. The game is played with a single discrete non-spatial input such as clicking the mouse button, hitting a key or tapping a touchscreen. *Jump'n'Rhythm* is designed towards imitation, allowing the player to observe the environment, which is connected to action prediction and followed by the action – in this case tapping on the screen to perform a jump.

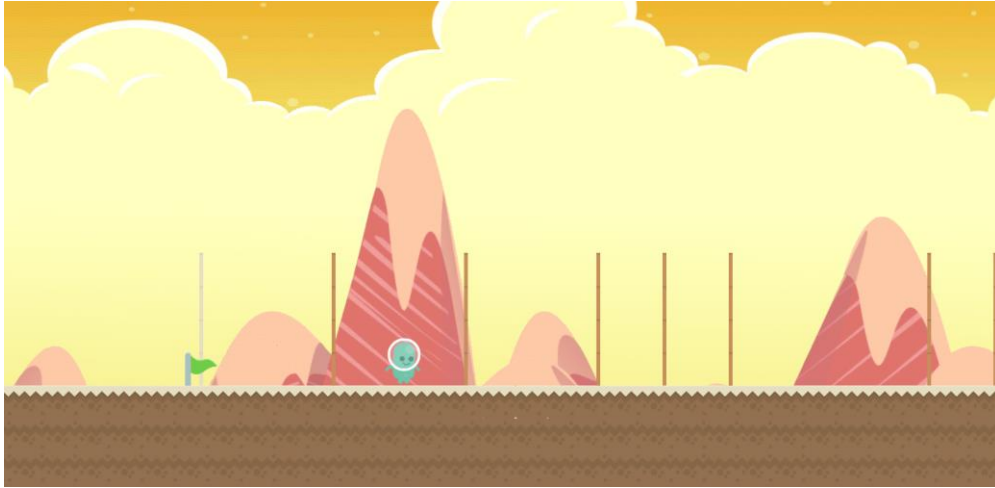


Figure 1: The call phase of an exercise. The green flag is a spawn point. The bamboo poles give a visual representation of the upcoming rhythm pattern. The lighter colored bamboo marks the starting cue of the rhythm.

The design space of *Jump'n'Rhythm* can be summarized in nine aspects of control and level design that shape the game experience:

- *Notes*: The bandwidth of notes available, equaling the amount of controls. In the current implementation this is a single pitchless beat sound, mapped to a tap, click or keystroke input.
- *Length*: The length of a rhythmic sequence to be performed. The rhythms have a length of no longer than 8 beats, consisting of quarter, eighth and triplet notes, depending on the difficulty level.
- *Tempo*: Besides the complexity of a rhythm, the tempo is a degree of freedom to change the difficulty of the game. We currently use a moderate tempo of 90 bpm.
- *Feedforward*: Visual guides to anticipate the next note or beat. In call sequences, vertical bars (“bamboo poles”) coincide with playing a beat when the avatar passes; in response, platform layout provides a certain visual cue. However, unlike standard variations of this game genre, *Jump'n'Rhythm* cannot be played using visual anticipation alone. Rather, the player needs to internalize the rhythm of the control sequence.
- *Feedback*: Next to avatar motion audio beats are played when the avatar jumps, plus a score counter increases.

- *Calls*: Currently a single playthrough of each call is given. This could be extended by 1-2 repetitions in order to aid embodying the rhythm.
- *Responses*: Matching the single call, only a single response is required. Again, repetitions could be used for improved rhythm learning, or just for varying the level design.
- *Tolerance*: The delta T error tolerance at which notes are still accepted. This is statically given by the platform width and is currently set to 1/32th of a beat.
- *Failure*: The result of missing the beat beyond the tolerance threshold. Currently failure results in repetition from the last call. These checkpoints also may be adapted in further design iterations.

3.1 Development

Jump'n'Rhythm was implemented with the *Unity3D* engine. The levels are constructed as tile maps. Therefore an additional *Tile Editor* plugin was used. This grid-based level structure supports the synchronization of the character's movement with the music and makes the design process for the exercises easier, since each exercise can be designed separately. 5 levels with increasing level of rhythm complexity were created. Each level consists of 12 rhythms with same rhythm difficulty class.

The central concept of *Jump'n'Rhythm* – that actions, music and level design are in perfect synchrony – posed a challenge to the implementation. The problem is that the frame rate at which the game updates is not constant. So the time between two frames may vary, while the rate at which the audio is played remains constant. A simple update of the player's position in the update loop will lead to an accumulating synchronization error. So the calculation of the character's movement has to be dictated by the music. Luckily the tiling approach makes synchronizing the movement of the character with the music easy. Taking the sample rate, as well as the bpm value of the music into account, the duration of the movement on a single tile (pixel/sec = tiles/beat) is computed. 4 tiles/beat (= 16th note/tile) for binary rhythms and 3 tiles/beat (= triplet 8th note) for ternary rhythms seemed to be reasonable values. On each frame the time delta of the audio since the last update is computed and with respect to the duration per tile, the player's position is updated.

Another design issue was the jumping action of the character. In order to execute the tasks precisely, the jumps of the character have to be perfectly aligned to the beat. The first approach was to make the jump adaptive to the next "safe platform" by pre-calculating the jump width. But during the design process it became clear that the player might feel patronized by the game. So a jump with a constant width of one beat (4 tiles, 3 tiles for the triplets respectively) was chosen. This design decision comes with its own limitations. While gaps with a duration of one beat can be performed on the same height, gaps that represent fractions of a beat need to be placed at the highest point of the jump arc (Figure 2).

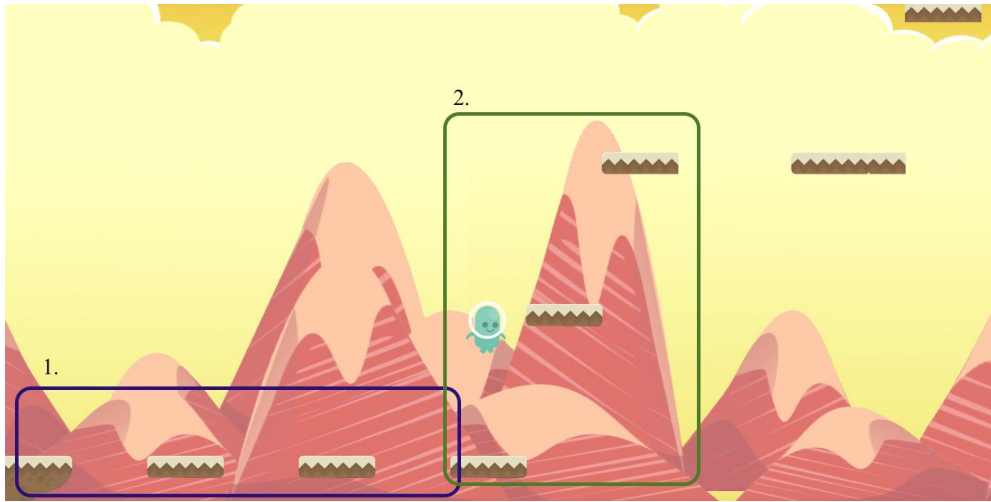


Figure 2: Platform layout in both dimensions models the jump pattern rhythm. Platforms on the same level (1.) indicate a full beat, while raised platforms (2.) indicate fractions of a beat – in this case eighth notes.

4 Limitations & Future Work

At the moment the game holds some limitations that need to be resolved in future design iterations. Due to the implementation of the jump action, sixteenth notes and smaller subdivisions have been avoided so far. A solution to this issue could be for example a wall-to-wall jump. Further, the game only supports a single action – the jump – this limits the level design and might lead to a not long lasting motivation to play. Additional actions like shooting enemies, ducking and further game elements from other jump-and-run games should be considered. It also might be beneficial to implement a more complex rewarding system, since supplementary rewards may engage the player to continue playing. Moreover, for player with a low skill level, the game might be frustrating. So an adaption of the tolerance threshold should be considered. Furthermore, the sound design should be revisited. Instead of a simple metronome pulse a well-designed music is needed in order to provide a deeper level of immersion to the player. Since the game design is not bound to classical input methods, it is considered to try out alternative input channels in the future. With a microphone, the players clapping or drumming on a surface can be used to control the game. Through that a stronger involvement of the player's body can be achieved. Also involving (full) body motions or tangible objects into gameplay can enrich player's embodiment and provide a deeper experience of the rhythm.

5 Conclusion

We presented *Jump'n'Rhythm*, a serious game to rhythm education. It is designed as a jump-and-run side-scroller at which players can only succeed when they embody rhythms presented to them. We discussed design considerations and technical challenges as well as solutions found for our game prototype. We are in the process of designing an experimental study in order to test the game-based rhythm learning approach under the perspective of motivation, fun, performance and learning outcome, with traditional rhythm exercises as the baseline.

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