Music Matters: An empirical study on the effects of adaptive music on experienced and perceived player affect

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***Abstract*—Music is an important affective aspect of video games. We present the findings of an empirical study on the affective effects of adaptive uses of music in games. We find that adaptive music can significantly increase a players reported experienced feeling of tension, that players recognize and value music, and that player recognize and value adaptive music over linear music.**

***Index Terms*—Music, games, game music, affect, tension, audio**

I. Introduction and Motivation

A. *Music for video games and other media*

Music is an integral part of video games, and almost every video game has music [1]. Most music for games is linear, and is not affected by the actions of the game [2]. Adaptive music is music that changes based on the state of the game, and has many theoretical benefits [3]. In film, music that more closely aligns with the actions of a movie significantly increase the viewer's emotional response and enjoyment of the media [4]. This phenomenon is previously assumed to exist for video game music as well [3].

Despite the potential advantages of adaptive music, most game music plays linear music during an associated level or game state [2]. One reason that adaptive music is not used across all games is that it entails a higher production cost and can reduce the expressive range of the music [5]. Another reason for the lack of adoption of adaptive music in the industry may be that it has uncertain benefit without empirical support.

The research that targets music in games is almost all concerned primarily with immersion [1], player performance [6], or other non-affective measures [7]. Research into affective effects of music in games is often overly broad or narrow. Previous studies have only manipulated the presence of music, not the content [8]. Studies done in Virtual Reality have not also investigated non-VR interaction [9]. We found two studies that found significant affective effects from adaptive music in games [2], [10]. However, neither study engages with game design literature, and both studies test the output of multifaceted music generation systems rather than isolating the adaptivity of music.

Understanding the affective impact of adaptive game music has a wide array of benefits for game development. In linear media, music is a powerful tool for manipulating an audience's experienced affect, in part due to empirical study of linear multimedia music [11]. Greater understanding of adaptive music in games leads to more impactful and better games.

In addition to improving games, this knowledge can influence the design of generative music systems. Currently, research in this area has many objectives, including musical style imitation [12], and generation of musical ambience [13]. As far as we are aware, only three systems follows an affect-based approach: *MetaCompose* [10], Prechtl's unnamed system [2], and *Melodrive* [14]. Our research helps the design and evaluation of generative music systems for games.

We present a study on the effect that adaptive music has on a player's experienced and perceived affect. Specifically, we isolate the affective dimension of tension. Our hypothesis is that music that adapts to and matches the tension curve of a game will strengthen a player's experienced tension. We created a game, titled *Galactic Escape (GE)* to study adaptive music. *GE* is detailed in Section IV. Our Independant Variable (IV) is the music that accompanies the game. There are four levels of the IV: No music, neutral music, music that adapts in inverse of game tension, and adaptive music that matches game tension. Our Dependent Variable (DV) is the player's reported affective response to the game.

We find that adaptive music has a significant effect on the player's experienced and perceived affect. We find that in a game with a rising tension curve, the player's experienced tension is significantly increased when adaptive music is added over linear music, even if the adaptive music is mapped inversely to game tension. We also find that players are aware of the presence of adaptive music and feel that adaptive music significantly adds to the experience of playing a game.

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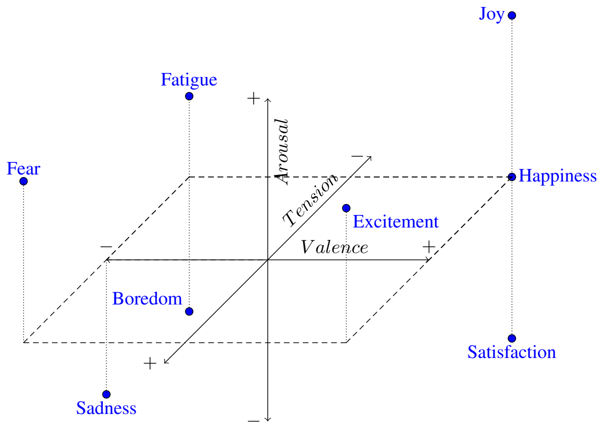

Fig. 1. 3-Dimensional Model of Affect

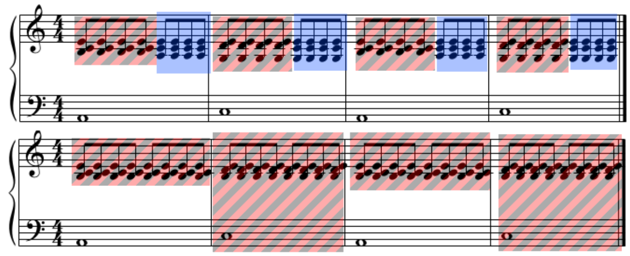

Fig. 2. Top (a): Resolved dissonances. Bottom (b): Non-resolved dissonances

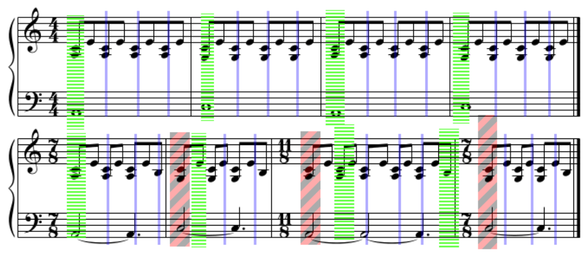

Fig. 3. Top (a): Balanced resolved rhythm. Bottom (b): Unbalanced tense rhythm

II. Background

A. Affect

We use a 3-dimensional model of affect shown in Figure 1, with dimensions of Valence, Tension, and Arousal. This is based on a model with dimensions of Valence, Tense Arousal, and Energy Arousal [15], modified for simplicity, parity, and to bring the language into line with common terminology from the field of ludology [3]. This model is useful in both music and games, due to the importance of tension in both [4], [16].

Tension can be understood through the lens of cognitive dissonance [17], and is a strained emotional state resulting from conflict between contradictory elements [18]. While tension is often associated with increased arousal and decreased valence, it is a distinct dimension [19]. The opposite of tension is a feeling of resolution [20], or consonance. Mental consonance, or cognitive coherence [18] occurs when cognitive elements are not in conflict with each other. Tension is a temporal emotion that arises from a lack of resolution over time. We focus on tension as our IV due to its importance across media disciplines [16], [21].

B. Affect in Music

The relationship between music and emotion is complicated [4], though it is agreed that music has an affective impact on its listener. While some contend that listeners may only perceive emotion in music [22], biofeedback technologies show a neurological and physiological affective response to music [23], [24]. This demonstrates that the affective impact of music is also felt and experienced.

A listener's physiological response to music is stronger when paired with film [25], and, affective responses to film are stronger when paired with music [26], [27]. In addition to affective considerations, viewer ratings of films increase when the music is emotionally congruent with the film [28].

III. Generating Tension in Music and Games

A. Tension in Music

The rise and fall of tension, or ”tension curve”, is a feature across many media types. Musical tension emerges when the listener has an expectation of musical movement that does not occur, or that occurs in a way that creates a new expectation of movement [20].

In musical harmony, dissonances can create tension. While there are many ways to create dissonance [29], we use the standard western 12-tone theory definition of dissonance to prevent confounds arising from unfamiliarity or novelty of harmonics and timbre. A dissonance is a chord, interval, or note that implies a future resolution to consonance [30]. The implication of future resolution is what causes tension in dissonances.

Figure 2 shows two similar musical excerpts. 2a resolves its dissonance, but 2b does not, creating tension. The dashed red highlights indicate dissonant intervals, and the solid blue highlights indicate consonant chords. Audio of these examples, and the examples in Figure 3, are available at *https://bit.ly/2QBwV1a* [31].

Rhythm is temporal in nature, and rhythmic tension may be created by introducing unbalanced and changing time signatures. The time signature of music indicates how the music is organized in time. Most western music occurs in time signatures with an even number of eighth notes in each measure. Disrupting this even division of time creates a dissonance between the expected timing of a note and its actual timing [32]. However, this effect is unstable, and if the unbalance continues long enough for the listener to adjust their expectations, the tension can be lost or resolved. Figure 3 shows two similar musical excerpts. In 3a, the rhythm is evenly distributed. In 3b, rhythms are unbalanced and changing, creating tension. The striped green highlights indicate expected strong beats. The solid blue lines indicate the expected weak beats. The dashed red highlights indicate unexpected strong beats.

B. Tension in Games

In games, tension is generated through conflict: the placing of two opposing objectives against each other. Conflict is a necessary component part of games [33]. The most common form of conflict in games is a violent conflict - Chess abstracts war. Conflict can also be non-violent, as in the card-scoring mechanics of Poker. Games can also have both violent and non-violent conflict. The opposition of objectives that defines conflict is a dissonance. The interactivity of games means that the player is responsible for resolving the conflict, which increases tension. This is similar to non-game interaction, where cognitive dissonance can occur when a person acts in opposition to a private opinion [34].

Conflict in games can almost universally be abstracted to a conflict of the player against timers. A timer is any game mechanic whose expiry causes the player to experience some loss [16], [21]. This potential loss, and the player attempting to avoid it, is a core source of tension in games [35]. Importantly, a timer does not need to display a number on a screen, but may take many forms. A fixed timer depletes at a set rate over time. A variable timer drains with game conditions. A health bar is an example of a variable timer, as it decreases with actions instead of time. Variable timers still function as timers because the average player can be expected to deplete the timer at a consistent rate.

Atari's *Centipede* is an often given example of a variable timer used to create a constantly rising tension curve [21], [33]. In Centipede, the player avatar is at the bottom of the screen. The eponymous centipede begins at the top of the screen. It moves horizontally until it hits either a mushroom or the edge of the screen, which causes it to move down one level and reverse direction. Mushrooms will appear both from player actions and enemy actions [33].

There are three timers in *Centipede*. As mushrooms appear, the player loses control of the environment and the centipede moves faster. As the centipede nears the bottom, the player is closer to losing a life. As the player loses lives, they are closer to losing all progress. These are all examples of timers creating an escalating tension curve [36].

This abstraction of game resources as timers can be applied to any game. Another example can be seen in a rising stack of tetrominos in *Tetris* [37]. Tension is reduced in games when timers complete and the player receives a loss, the player completes their objectives before the timer expires, or the timer is removed by some other means.

IV. Galactic Escape

We created a game titled *Galactic Escape (GE)* for this study. *GE* has a rising tension curve caused by a variable timer. *GE* is designed to be easy to play without in-depth knowledge or familiarity with games. A video that fully explains the gameplay and mechanics of *Galactic Escape* is available at *https://youtu.be/3vxXbMeJGkw* [38].

The mechanics in *Galactic Escape* are similar to wager-based games of chance such as craps or roulette [16], [39], and are inspired by *Blades in the Dark* [40]. The player does not have direct control over whether they succeed or fail each challenge, but instead controls the ramifications of their success or failure.

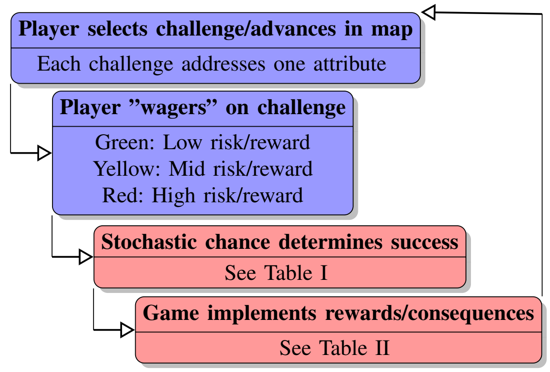

Fig. 4. Gameplay loop of *Galactic Escape*. Blue nodes indicate player action, red nodes indicate game actions.

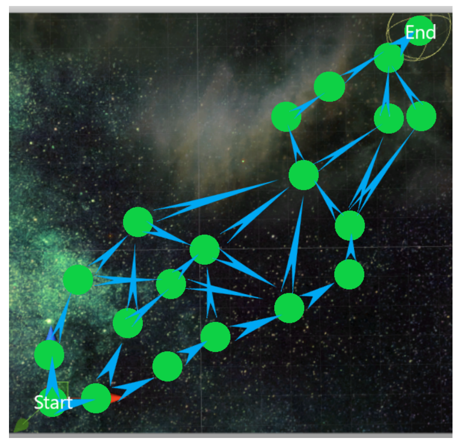

Fig. 5. Layout of map that player navigates. The player does not see this map

At the beginning of the game, the player is given a very light text introduction, inspired by *House of the Dying Sun* [41], that uses common tropes to quickly let the player know that they are being pursued and must escape. The player then begins gameplay, navigating space in a small spaceship. The gameplay loop of Galactic Escape is shown in Figure 4. To win the game, the player must navigate the map shown in Figure 5 and complete a challenge at each point before a pursuing ship catches them.

The player begins by selecting a destination as seen in Figure 6. At each destination, the player must overcome a challenge. Before the challenge is resolved, the player places their wager by selecting one of three colour-coded levels of risk/reward: Green (low), Yellow (medium), or Red (high).

To determine success or failure, the player character has four attributes. Each challenge addresses one of the attributes, and can result in an outcome of failure, partial success, or success. The chance of each outcome is shown in Table I. Attributes start at level 2, and can be modified based on the consequences of the roll.

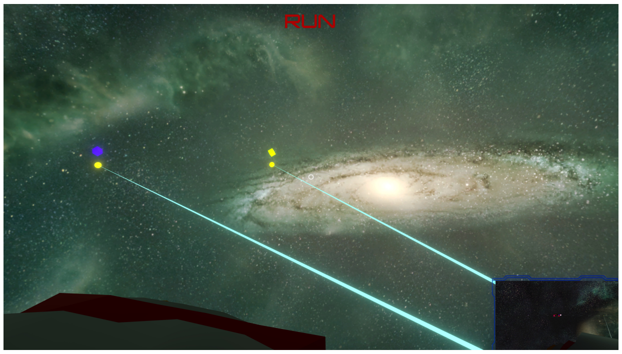

Fig. 6. The player selects a destination

TABLE I
PERCENT CHANCE OF OUTCOMES BASED ON ATTRIBUTE LEVEL

Attribute level	Success	Partial Success	Failure
0	3	22	75
1	17	33	50
2	31	44	25
3	42	45	13
4	52	42	6

TABLE II
CONSEQUENCES OF DIE ROLLS BASED ON ROLL RESULT

	Success (6)	Partial Success (4-5)	Failure (1-3)
	Consequences affect *current challenge*		
Green 5 seconds	None	Time Penalty (2.5 Seconds)	Repeat Challenge
	Consequences affect *next roll*		
Yellow 3.5 seconds	+1 Die on Next Roll	-1 Die on Next Roll	-1 Die on Next Roll Repeat Challenge
	Consequences affect attribute permanently		
Red 2.5 seconds	+1 Die to Attribute	-1 Die to Attribute	-1 Die to Attribute Repeat Challenge

Once the game has rolled the dice, it implements the rewards and/or consequences. Regardless of the outcome, the player must also wait a short time that is determined by their wager. The rewards and consequences, based on the roll result and player wager, are shown in Table II.

The risk/reward levels of the player wagers are balanced by a pursuing enemy. If the player does not take risky actions the enemy will catch them, but the consequences for risky failures negatively affect future rolls as well. This creates a negative feedback loop that further incentivizes further risky actions [33].

A. Gameplay Tension in Galactic Escape

Tension in *GE* is created primarily with two timers: one fixed and one variable. The first timer is fixed and lasts 30 seconds, during which the player is alone on the map and can begin completing challenges. This timer is presented to the player as an on-screen number with the remaining time. When the first timer expires, the second timer begins. The second timer is a variable timer that is represented by a pursuing enemy ship. The player may look around during gameplay, and can see the pursuing ship. The pursuing ship appears at the player's initial position, and follows the same path that the player takes. The pursuing ship moves slightly slower than the player's ship, but does not need to clear challenges. This timer is represented by the distance between the player ship and pursuing ship. If the pursuing ship catches the player, the player loses. The player attempts to reach the final challenge before this timer expires.

Gameplay tension is measured by a variable *tense*, which has a value between 0-100 and represents how close the timers are to expiry. During the first timer, *tense* rises at a fixed linear rate from 0-25 over the 30 second timer. Once the second timer begins, *tense* takes its value from the Euclidian distance between the pursuing ship and the player ship. As the distance between the two approaches 0, *tense* approaches 100.

TABLE III
EXPERIMENTAL CONDITIONS

Condition	Musical response to game
None	No Music
Neutral	Neutral tension music, doesn't change with game tension
Inverse Tension	Music decreases in tension as game tension increases
Tension	Music increases in tension as game tension increases

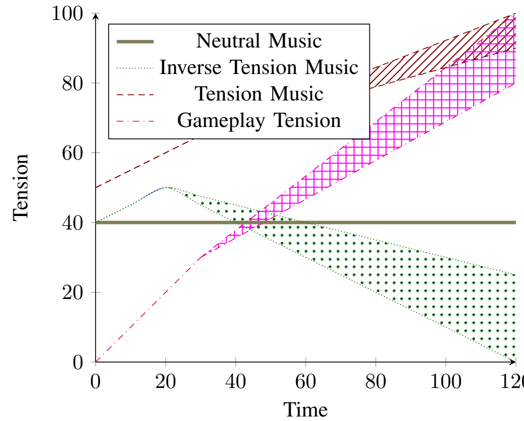

Fig. 7. Mapping of gameplay tension, and musical tension for each condition, by time

B. Musical Tension in Galactic Escape

Musical tension is the independent variable for this study. There are four different musical conditions, which are summarized in the Table III.

FMOD Studio [42] is used to adaptively map the musical tension to the gameplay tension. The music changes based on the value of *tense*. The mappings of the ranges of gameplay tension across time as represented by *tense*, as well as the mappings of the ranges of musical tension across time, based on the ranges of *tense*, are shown in Figure 7. A short clip of each piece with *tense* rising from 0-100 over one minute is available at *https://bit.ly/2FomQMF* [43].

The music for the Neutral condition does not change based on *tense*. It is ambiguous, and uses harmonies and notes which are shared between multiple modes. These notes could sound

TABLE IV
INVERSE TENSION MUSIC AS IT REACTS TO *tense*

tense	Musical behaviour
0	7ths and 2nds act as dissonances Polytonal fifth stacking on 2nd scale degree Higher spectra in timbre
1-25 *(Highest music tension)*	High-timbre bells More polytonal fifths
25-50	Timbral shifts in bells Bells resolve polytonality 7ths/2nds resolve to octaves/3rds
50-75	Timbral shifts in bass + synth Polytonal stacking resolves to one tonal centre
75-100 *(Lowest music tension)*	Bass line simplifies and resolves Drums enter with strong beats

consonant or dissonant if given more musical context. Rhythmically, the neutral music generally avoids strong accents.

The exact musical behaviour as it responds to the value of *tense* is described in Table IV. The music for the Inverse Tension condition is the most complex in its relationship to *tense*, because tension must first be present to decrease. The inverse tension music builds unstable and harsh sounds as *tense* is low, and resolves these instabilities as *tense* increases.

The music for the Tension condition adaptively matches musical tension to *tense*, adding dissonant tones, harsh timbres, and crowded harmonies as tense increases. Also the music is rhythmically unbalanced, which becomes increasingly pronounced as *tense* increases.

V. METHOD

A. Design

Our experiment follows a within-subject design. Our Independent Variable is the musical tension as it relates to game tension. Our Dependent Variable is the participant's affective response to the game. Data is gathered from a multi-question survey that participants complete after each condition.

B. Apparatus

GE was created using Unity 2017.3, with models made in 3ds Max. Participant responses are automatically uploaded to an online database after obtaining consent for storing anonymous data. In-person participants play the game on an Apple iMac, with Monoprice-branded over-the-ear headphones. Remote participants are free to use any setup they are comfortable with, as long as they are able to hear the audio. While lack of environment control may seem to be a weakness of the design, it more closely simulates the actual audio conditions of playing a game, increasing external validity.

C. Participants

35 participants took part in this study: 8 in-person and 27 online/remote. 5 remote participants were removed from the data after failing to complete all four conditions, leaving a final participant pool of 30. Participants were recruited from mailing lists for games music, online gaming boards, students from an undergraduate 3rd year sound design class, and Amazon's Mechanical Turk. The course material in the sound design class is not directly related to the research. The data is consistent between participant groups. Participant age ranges from 17-54, with an average age of 28 (SD = 10.08). 12 participants are female. Participants spend an average of 90 seconds in each game scenario, and 90 seconds answering each survey. Participants report a variety of gaming experience, with 10 participants who report playing 0-2 hours of games per week, and two participants who report playing over 10 hours per week.

D. Procedure

Each of the four conditions consists of a single play of the game, with the associated musical condition. The order of the conditions is randomized by Unity to prevent order effects. Before the first condition, demographic data about the participant's age, gender, and gaming experience is taken. The participant is then shown a brief tutorial that explains the gameplay of *GE*, and then plays a training game without loss, music, or timers, to familiarize themselves with the game. The player indicates when they are ready to begin the first condition by pressing a button.

After each condition, the participant fills out a survey with 13 quantitative, and 2 qualitative questions. The questions are a modified version of an instrument designed to measure game enjoyment [44]. Questions from the original instrument that are not relevant to the study are removed, and questions are added to tailor the instrument to the affective nature of the study. Fang et al. verified the original instrument with a Cronbach's alpha of 0.73, indicating consistency and reliability. After filling out the survey, the participant begins the next condition. This results in one value per question for each condition. Participants indicate their response between 0 (Disagree) and 1 (Agree), using a continuous slider with a granularity of $<.001$. The questions are grouped together for analysis. These questions and groups are shown in Table V. The "code" refers to the internal representation for analysis and charts, and will be used to refer to the questions moving forwards. These questions are also split into 3 primary groups:

1) Experienced enjoyment questions: These questions were derived from previous research on player engagement and enjoyment [44], and measure positive and negative emotions for gauging overall player enjoyment. These questions are not intended to map to affective dimensions, but they provide a non-dimensional overview of player enjoyment. As player enjoyment increases, positive responses will rise in reported value, and negative responses will fall in reported value.

2) Affect/Emotion questions: These questions are split into two groups:

a) Experienced affect questions: These questions measure the player's self-reported experienced feelings of the major affective dimensions, and directly address the 3-dimensional model of affect [15].

b) Perceived emotion questions: These questions measure the player's perception of the soundtracks emotional congruency with the gameplay.

TABLE V
QUESTIONS FROM MODIFIED INSTRUMENT

Category	Code	Question
Enjoyment		
Positive	happy	I feel happy when playing this game
	calm	I feel calm when playing this game
	immersion	I am aware of my surroundings when playing this game
	enjoyment	I enjoy playing this game
Negative	unhappy	I feel unhappy when playing this game
	worried	I feel worried when playing this game
	exhausted	I feel exhausted when playing this game
	miserable	I feel miserable when playing this game
Affect/Emotion		
Affect	valence	This game was pleasant to play
	arousal	I feel energetic when playing this game
	tension	I feel tense when playing this game
Perceived emotion	soundtrack experience	The soundtrack added to the experience of playing this game
	soundtrack matching	The soundtrack matched my progress in the game
Other		
Qualitative	N/A	Please describe what you think of the soundtrack in this game
	N/A	Please describe any additional thoughts about this game
Play Data	N/A	Order of tests
	N/A	Num. of challenges reached
	N/A	Time taken from start-finish
	N/A	Number of success rolls
	N/A	Number of partial success rolls
	N/A	Number of failure rolls

3) Other: These questions are also split into two groups. Qualitative data is collected, but did not contain any discussion of the adaptivity of the music or affective response to the game. Play data was collected to check for any potential confounding effects from player differences.

We are aware of critiques of rating-based models in HCI research [45]. However, these critiques do not apply to this study. Individual differences are accounted for by using a within-subjects approach. The participants give their ratings as a numeric slider value, rather than by interpreting language or categories. Because each playthrough of *GE* takes ˜120 seconds to complete and has an affective impact on the player, using a ranking system is not feasible as the player may not remember their affective state from over two minutes prior. We acknowledge that self-report data collection methods can only give subjective experiential data rather than the objective data that biofeedback technologies can give, self-report methods are common in studies of musical affect and are valid for understanding experienced and perceived emotion [4].

VI. RESULTS

All surveyed results show a response to the IV manipulation, as shown in Figures 8-10. A surprising result is that there appears to be a stronger impact with the introduction of adaptive music than when the music adaptively matches game tension. The statistical significance of these results will be discussed in Section VI-B.

A. Descriptive statistics

The experienced enjoyment emotion responses indicate that players enjoy the game more with the introduction of music. Enjoyment slightly decreases as the music tension adapts inversely to the game tension, and increases more as the music tension matches the game tension. This is shown with the aggregate positive and negative scores in Figure 8.

The perceived emotion responses show a more consistent trend. Players report that they feel the music adds to the experience. This effect increases as music tension adapts to

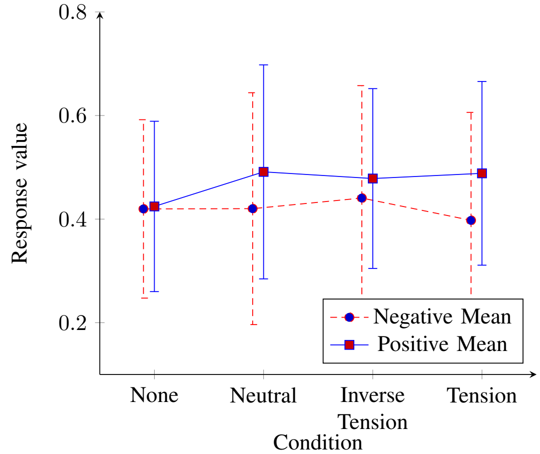

Fig. 8. Experienced enjoyment means and Standard Deviations

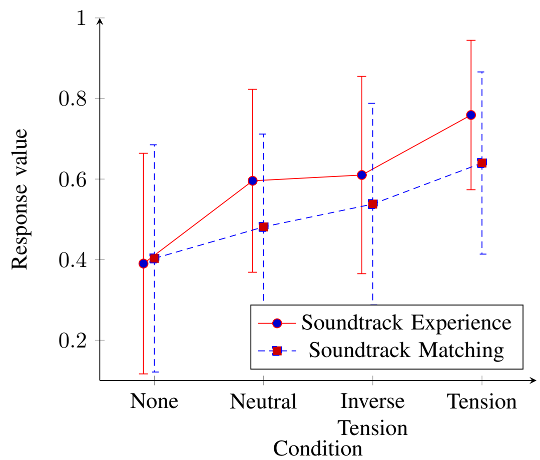

Fig. 9. Perceived emotion means and Standard Deviations

game tension, and further increases as music tension matches game tension. This effect is shown in Figure 9.

The experienced affective dimensions of valence and arousal follow a similar pattern to the perceived dimensions, and can be seen in the dotted blue and dashed green lines in Figure 10. Reported values for valence and arousal rise when music is introduced. These values further rise when the music is adaptive. These values rise again when the music adapts to match the gameplay tension.

The player's reported feeling of tension differs from this path, and can be seen in the solid red line of Figure 10. As music is introduced, player tension is reduced. As the music tension adapts to the game tension, player tension increases. As the music tension matches game tension, player tension rises further.

B. Inferential statistics

Our hypothesis is that tension-adaptive music will strengthen the player's experienced tension. To test this hypothesis, we perform a repeated measures multivariate

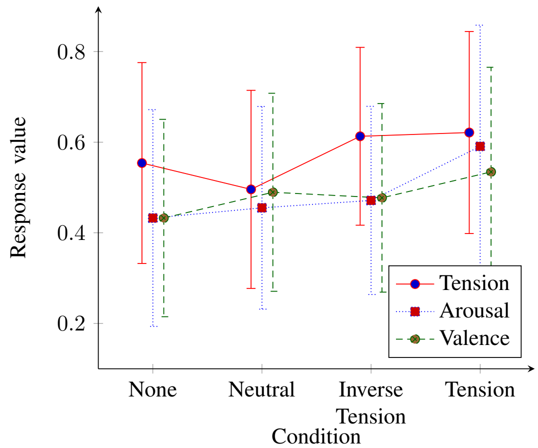

Fig. 10. Experienced affect means and Standard Deviations

TABLE VI
VIOLATIONS OF NORMALITY

Condition	Violations
None	exhausted, arousal, soundtrack matching, soundtrack experience
Neutral	miserable
Inverse Tension	immersion
Tension	worried, exhausted, miserable, enjoyment, valence, tense, soundtrack matching

TABLE VII
MEANS AND STANDARD DEIVATIONS FOR INDIVIDUALLY SIGNIFICANT UNIVARIATE RESPONSES BY CONDITION

	None		Neutral		Inverse Tension		Tension	
	M	SD	M	SD	M	SD	M	SD
Tense	0.55	0.22	0.49	0.21	0.61	0.19	0.62	0.22
Soundtrack Matching	0.40	0.28	0.48	0.23	0.53	0.25	0.63	0.22
Soundtrack Experience	0.39	0.27	0.59	0.22	0.61	0.24	0.75	0.18

ANOVA. Before running the ANOVA, we test the assumptions. A majority of the affective responses for each scenario are normally distributed. The violations are shown in Table VI. These violations contain 25% of all responses. Because of the robustness of the ANOVA, and because the violations are small and in only 25% of all responses, a normal ANOVA is performed. Mauchly's assumption of Sphericity is not violated in any of the responses, and no corrections are necessary.

The ANOVA shows significant change across multivariate responses to the conditions F(39, 231) = 1.521, *p*=.032. Separate post-hoc univariate repeated measures ANOVAs are then performed on each of the dependent variables. Three responses from participants are individually significant.

Both perceived emotion responses - "soundtrack experience", F(3, 87) = 11.227, p<.001,η_p^2=.279, and "soundtrack matching", F(3, 87) = 6.967, p<.001, η_p^2=.194, are significant with large effect sizes. Tension is also individually significant F(3, 87) = 3.662, p=.015 η_p^2=.112. The values for these means and differences are shown in Table VII.

Individual post-hoc t-tests further clarify these results. For tension, there is a significant change between the Neutral and Inverse Tension conditions *p*=.048 and Neutral-Tension conditions *p*=.036. For "soundtrack matching", there is significance between None-Tension *p*<.001, Neutral-Tension *p=.022*, and None-Inverse Tension *p*=.045. For "soundtrack experience", individual t-tests show significance between all conditions with the exception of Neutral-Resolution *p*=.824.

VII. DISCUSSION

We demonstrate significant support for the hypothesis that as musical tension adapts to game tension, the player's experienced tension is increased. However, this relationship is not a linear one. The player's experienced tension is reduced with the introduction of static music, and increases with the introduction of adaptive music, even if the musical tension is inverse of game tension. This may be the result of tension's nature as a temporal affect, as tension must be created before it can resolve.

We also show that players perceive the emotional congruency of the music that is playing, during gameplay, and report that they feel that tension-adaptive music adds more to the experience of playing a game. This indicates that players both perceive and value music, and perceive and value adaptive music more.

Viewers rate films higher when the music is emotionally congruent [28], though film music is sometimes intentionally incongruent [46]. While players in this study report increased tension when adaptive music is emotionally congruent, the more significant change occurs with the introduction of adaptive music. This suggests that the adaptivity of the music is more important of a factor than the emotional congruency of the music.

VIII. CONCLUSION

We present an empirical study on the affective ludology of adaptive music, focused on the affective dimension of tension. We show that tension-adaptive music amplifies the player's experienced tension when compared to linear or no music. We also show that players are aware of the affective congruency of music and gameplay, and that their experienced tension increases with affectively-congruent adaptive music.

While this study provides an important step in understanding the relationship between music and video games, it is only a step. Our results align with Prechtl and Scirea's previously mentioned research. While both the musical and game tension are grounded in literature and theory, they have not been independently confirmed. It is unknown if the measured effects will change if interaction speed changes, or whether different camera or avatar representations may disrupt or change these effects. Other currently unstudied facets of this interaction are the potential roles of listening environment, previous gaming experience, input device, and narrative elements. Finally, while we measure subjective experienced and perceived emotion with self-report methods, biofeedback technology would provide objective data on felt emotion. We do note that both Prechtl and Scirea described difficulties in comparing biofeedback in their studies, but that the biofeedback data agreed with the subjective data.

We present support for our hypothesis. We also present support for the statement that for affective impact, music matters in video games, and that adaptive music matters more. While only some of our measured data is significant, the trends are consistent: adaptive music increases player enjoyment, and strengthens the affective impact of a game.

Acknowledgments

We would like to thank Kivanc Tatar for assisting with participants and data-gathering. We would also like to thank Bernhard Riecke and Alexandra Kitson for their assistance with the design of this study, and we would like to thank Jianyu Fan for his help in proofreading and reviewing this paper.

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