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The effects of juiciness in an action RPG

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ABSTRACT

"Juiciness" is a term that has been widely used to describe the positive feedback (both visual/audial) present in digital games. However, few empirical investigations have looked at how juiciness concretely impacts players. In this paper, we perform a study (N = 3018) in which we compare four identical versions of an action role-playing game with varying amounts of juiciness: (1) None; (2) Medium; (3) High; and (4) Extreme. We find that both *None* and *Extreme* amounts of juiciness lead to significantly decreased play time, significantly decreased player experience, significantly decreased intrinsic motivation, and significantly decreased performance relative to both *Medium* and *High*. This is, to the best of our knowledge, the largest study to date on juiciness. Our results have implications for designers, developers, and researchers.

1. Introduction

For 38 years, we have been interested in how graphics inside gaming environments affects its users [2,11,21,37,42,45,66]. However, we yet lack a systemic understanding of its effects [23]—for example, "juiciness," or positive feedback, is extensively discussed [14,22,30,33,35,59]—yet very few studies have empirically investigated juiciness. However, we argue that understanding the actual impacts of juiciness on players is imperative for continued discourse on this topic.

In this paper, we review work on juiciness and related topics, implement a carefully controlled study on juiciness to study its impacts on users, and discuss the implications for this domain.

In our study, we had four research questions:

RQ1: Does juiciness impact player experience?
RQ2: Does juiciness impact intrinsic motivation?
RQ3: Does juiciness impact motivated behavior as operationalized by time spent?
RQ4: Does juiciness impact game performance?

We perform a study (N = 3018) in which we compare four identical versions of an action role-playing game with varying amounts of juiciness: 1) None; 2) Medium; 3) High; and 4) Extreme. Overall, we find the following results:

- Both *None* and *Extreme* lead to significantly decreased player experience.
- *Extreme* leads to significantly decreased intrinsic motivation.
- Both *None* and *Extreme* lead to significantly decreased motivated behavior as operationalized by time spent.
- Both *None* and *Extreme* lead to significantly decreased performance: final character level, total attacks, monsters defeated, and total actions.

Our results strongly support the notion that both minimal amounts of juiciness and extreme amounts of juiciness are harmful to the player experience, intrinsic motivation, motivated behavior, and performance of players. We suggest carefully moderating juiciness to achieve a balance that is satisfying but not distracting to users.

2. Related work

2.1. Juiciness

Video game special effects have been described as "juiciness" [14,22,59]. In this section, we review how juiciness has been defined in the literature. One of the most widely used definitions of juiciness is "excessive positive feedback" [35]. Gray describes juiciness as a game that "feels alive" and uses examples from *Mario Bros.* ("bouncing through a room full of coins, blinging with satisfaction") and *Alien Hominid* ("enemies exploding and flinging blood to an almost unjustified extent") (2005). Gray [22] goes on to describe "juicy" games:

> A juicy game element will bounce and wiggle and squirt and make a little noise when you touch it. A juicy game feels alive and responds to everything you do—tons of cascading action and response for minimal user input. It makes the player feel powerful and in control

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of the world, and it coaches them through the rules of the game by constantly letting them know on a per-interaction basis how they are doing.

Similarly, Schell describes juiciness as giving "continuous feedback" for actions and "rewarding the player many ways at once" (2008). He describes juicy games as containing "second-order motion" or secondary motions that happen in consequence to player actions [59]. For instance, in *Fruit Ninja*, slicing a fruit not only performs the primary action of slicing, but creates two halves of fruit flinging in different directions, particle effects such as juice, and a splash on the wall [1].

Hunicke describes juiciness as inducing certain feelings: "Juicy feedback gives your users moment-to-moment joyful feelings when they engage with your design." Similarly, Juul describes juiciness not just as a source of feedback but also as a type of pleasurable experience: "Juiciness does not simply communicate information or make the game easier to use, but it also gives the player an immediate, pleasurable experience" (2010). More concisely, Juul describes juiciness as "excessive positive feedback." Deterding also describes juiciness using similar terminology: "[E]xcessive, varied sensual positive feedback" (2015). One contrast between "dry" and "juicy" has been made by Jonasson and Purho [33]. They created a minimalistic version of *Breakout*, which is black and white and contains no embellishments. They also created a juicy version that contains color, tweening, screen shakes, sounds, particle effects, and more (see Fig. 1). However, despite the extensive discussion around juiciness, to the best of our knowledge, very few empirical studies exist.

The concept of juiciness inherently raises several questions. Should we add effects to everything? Should we "juice" every interaction? There have been few studies that have addressed juiciness. Despite the fact that there have been various definitions of juiciness in the literature, we use the most widely understood definition of juiciness as "excessive positive feedback" [14,35] in this paper. One pilot study found that a "juicy" version of a game was rated higher but that players performed worse than in the "nonjuicy" version [36]. However, these results were not significant; hence, further investigation is required. More recently, Hicks et al. developed a framework for juicy design [25], and through empirical studies determined that juiciness influences user experience, need satisfaction, and intrinsic motivation [26,27]. However, they found that juiciness did not affect the performance of players. In the remaining subsections, we review work in the literature related to the concept of juiciness.

2.2. Color

One aspect of juiciness is color. Researchers have developed a framework called Color-in-Context (CIC) Theory [18,37], which has six premises:

1. Color carries meaning (i.e., color is more than aesthetics).
2. Color influences psychological functioning (e.g., colors are evaluated to be hospitable or hostile) [8].
3. Color effects are outside of conscious awareness [53].
4. Color meaning is both learned and intrinsic (e.g., paired color associations, such as "pink is feminine"; color vision as an adaptation) [50].
5. Color perception influences affect, cognition, and behavior, and vice versa [49].
6. Color is context-specific (e.g., pink is frequently viewed as feminine on a baby's blanket, but not on Bazooka bubble gum) [63].

For example, color has been found to significantly affect sport performance. Hill studied the Athens Olympic Games in 2004, in which it was found that red-wearing competitors won more bouts than blue-wearing competitors in four different sports [28]. This advantage for red-wearing teams has even been found in an online first-person shooter game [31]; it is hypothesized that blue teams are at a disadvantage because they "see red." Researchers have shown a single-player context in which players using a red avatar experience decreased competence, immersion, and flow [37]. Using black-cloaked avatars, on the other hand, has been associated with an increase in aggressive intentions and attitudes compared to using white-cloaked avatars [54].

Biologically, it has been hypothesized that the color red is a distractor signal to humans. Red causes a lower so-called high-frequency heart rate variability (HF-HRV), measured via an electrocardiogram (ECG) [17]. These lower levels of HF-HRV are correlated to an increase in worry and anxiety [20,37]. Nonetheless, studies on color in games are still in their nascence, and the few studies that do exist have explored a limited number of colors (e.g., red versus blue).

2.3. Audio

One important aspect of juiciness is audio. Audio can provide specific information to the player [34], improve the performance of the player [32], and also generate emotional impact/realism [5,15]. A meta-analysis of 83 studies found that the presence (versus absence) of sound has a small to medium-sized effect on presence [12]. Audio has been often linked to increased immersion/presence in games [16,43,51] and can influence physiological responses [24]. More specifically, work has suggested that audio influences the "aura" of a computer game [67]. For example, Wolfson found that the combination of loud audio and the color red gave players the perception of excitement [67]. It has also been shown that matching the audio appropriately to the visuals being displayed is important—different sounds can lead to different visual interpretations of an identical animation [60,64].

Audio in games has been classified into the following categories: speech/dialogue, music, and sound effects [44]. Sound effects can be further classified into avatar sounds, object sounds, character sounds,

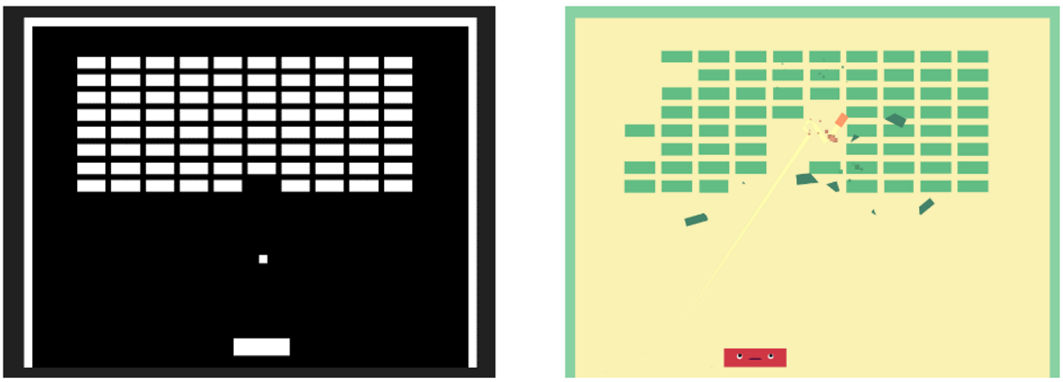

Fig. 1. Dry (left) and juicy (right) versions of the same game.

Fig. 2. The action RPG we developed.

and ornamental sounds [19]. In our study, we focus on sounds that result from user-interaction (i.e., "juicy" audio).

2.4. Feedback

Merely the blood expelled by avatars affects human behavior [71–73]. One study of *Mortal Kombat: Deadly Alliance* compared four different levels of blood; when avatars expelled the most blood, participants had increased hostility, arousal, and weapon usage [72]. An effect like blood—for all its potential vulgarity—can be very useful as a form of feedback.

Inevitably, juiciness involves feedback. Research on feedback interventions (FIs) has shown that predicting the effect of any given feedback is contingent on a wide array of factors: personality, feedback type (verbal, etc.), frequency of feedback, task complexity, task novelty, type of task (physical, etc.), and so forth [38,74–80]. Therefore, feedback should always be designed with the specific context in mind.

Effects in games can be a primary mean of instrumentally communicating feedback (e.g., taking damage, status effects, healing, etc.). Effects that communicate feedback should be designed with several aspects in mind. For instance, Deterding [14] suggests a set of feedback design lenses, which provide general principles in creating feedback: immediate (feedback immediately after the action), glanceable (feedback without visually obstructing the view), and juicy.

2.5. Seductive details

While most researchers have talked about juiciness in a positive manner, pre-existing work in the learning sciences provides contradictory evidence [70]. Researchers have shown that the addition of so-called seductive visual details hinders the performance of learners [81–83]. Many researchers argue that deliberate embellishments constitute seductive details that can impede the efficacy of learning [84,81,85,86,88,90,91,92,83]. For example, the coherence principle of multimedia learning is a culmination of this line of work. It advises removing any illustration not of fundamental importance to the goal [93,94].

Seductive details can interfere with problem-solving abilities in high cognitive load environments [88,89]. This happens because of three things [85]: *distraction* (taking attention away from the relevant and moving it toward the irrelevant) [92]; *disruption* (making it harder to create correct mental schemas) [86]; and *diversion* (priming prior knowledge that is unhelpful) [85,95]. This is well-known in instructional media, in which embellishment is known to distract and also create ambiguity (e.g., line sketches versus 3D graphics) [96–99,39].

One study compared three different visual themes—changing only the textures of the background and UI elements—and found that the more embellished and more ambiguous, visual themes thwarted performance (and self-efficacy, or the belief in one's ability to succeed at a task), but improved engagement [39].

Our study here deliberately contrasts four different conditions of juiciness (from minimal to extreme) of the same game to test whether extreme amounts of visual effects hinder players (possibly through the seductive-details framework).

3. The game

For the purposes of this study, we developed an action role-playing game (RPG) from scratch. We used the "Action-RPG Starter Kit" on the Unity asset store, and over the course of a year, modified it for use in this study. We changed the player model, the interface, game-play elements, the environment, and other aspects of the game.

The game itself plays similarly to other action RPG games such as *Diablo*. Players can walk, run, ground roll, block, attack with both melee/ranged weapons, and cast spells. There is a basic questing progression (e.g., defeat five slimes), boss battles, inventory for equipping better armor/weapons, crafting (e.g., better equipment, potions), mounts (faster travel), and five playable areas/environments. Players earn experience points from defeating enemies and completing quests. When players level up, they can then distribute attribute points (e.g., attack, defense, etc.) and learn new abilities/magic.

There are two players to choose from: Knight or Ranger. The Knight can use abilities such as "bash" and "firebolt." The Ranger can use abilities like "multishot arrow" and "summon wolf." The Knight can learn up to 16 different abilities; the Ranger can learn up to 15 different abilities. (See Fig. 2 for a screenshot of the game.)

4. Methods

4.1. Creating conditions

In order to develop the different game-condition versions, we hired a professional artist with extensive experience in developing special effects for games. This artist helped develop four levels of juiciness for our game:

1. No juiciness
2. Medium juiciness
3. High juiciness
4. Extreme juiciness

These conditions were designed to be far below average for a typical Action RPG game ("No juiciness"), average ("Medium juiciness"), above average ("High juiciness"), and far above average ("Extreme juiciness"). Designing these conditions was an iterative process involving the artist and two game designers whom were briefed on the topic of juiciness through readings. The juiciness conditions were repeatedly iterated on and tweaked before being finalized. The following aspects of the game were modified for each condition:

- Audio effects (melee attack, ranged attack, abilities/spells, enemy sounds)
- Visual effects (melee attack, ranged attack, abilities/spells, screen shakes)
- Audio/visual effects for hovering/clicking menu buttons (main menu, dialogue menus, shop menus)

This involved creating 120+ different visual and 120+ different audio effects. (See Figs. 3 and 4 for examples of still frames.) For both a video/audio side-by-side comparison of effects, see the following video: https://www.youtube.com/watch?v=VDRLaE1S5a4&t=1s. In some cases, additional visual effects were added as part of the

Fig. 3. Knight firebolt juiciness levels (top to bottom, left to right): none, medium, high, extreme.

Fig. 4. Ranger fire bird juiciness levels (top to bottom, left to right): none, medium, high, extreme.

operationalization of our conditions.

Except for the aspects of the game that were modified, the game is identical in all respects across conditions. In designing the juiciness conditions, the Extreme condition was intentionally made to be above and beyond typical juiciness levels found in games.

4.2. Ensuring consistent frame rate

To ensure the validity of the experiment, one of our initial goals was to normalize frames per second across our four juiciness conditions. A lower frames-per-second count in one or more of our conditions would present a possible experiment confound.

For testing, we used a 2018 PC (Windows 10) and a 2012 Macbook Pro (MacOS High Sierra). The PC had an Intel Core i7-7700k CPU (4.20 GHz), an NVIDIA GeForce GTX 1070, and 16 GB of RAM. The Mac had an Intel Core i5 (2.5 GHz), an Intel HD Graphics 4000 GPU, and 6 GB of RAM. Both systems used Firefox Quantum 63.0 to run the Unity WebGL game and for performance profiling.

We created an automatic-running test in the game, which generated five stationary enemies in close proximity to the player and ran a macro in which the game character would run to each enemy and defeat it in a different way. For the purposes of this test, we used the Knight character. Specifically, the macro caused the game character to defeat each enemy in turn with: (a) melee attack; (b) ranged attack; (c) firebolt; (d) triple firebolt; and (e) ground crush. This ensured that a wide range of spells/abilities/effects were being triggered.

We then produced a performance profile for each machine and for each juiciness condition. Because there were initially some significant differences in frames per second between juiciness conditions, we tweaked the games repeatedly. Specifically, we removed some of the environmental effects, such as bloom and screen-space ambient occlusion. We also tweaked Unity quality settings. These changes were made to *all* juiciness versions and were made to increase the consistency of the frame rate during game play. After several such iterations, the juiciness versions had sufficiently consistent frame rates for our purposes:

1. No juiciness (PC: 58.87 fps, Mac: 28.17 fps)
2. Medium juiciness (PC: 58.17 fps, Mac: 28.40 fps)
3. High juiciness (PC: 58.97 fps, Mac: 29.24 fps)
4. Extreme juiciness (PC: 58.75 fps, Mac: 28.10 fps)

These average frame rates are ~1 fps apart, and are sufficiently identical for the purposes of this experiment.

4.3. Validating fit/valence of conditions

Before conducting the study, we wanted to ensure that the visual/audio effects in each condition "fit" the game as equally as possible and that the juiciness valence for each condition was perceived to be appropriately higher/lower valence relative to each other condition. If the effects did not fit the game equally well across conditions, or if the relative juiciness valence was not as we had intended, this would confound our results.

We recruited 119 participants on Amazon Mechanical Turk (AMT) (United States only). Participants were first asked to do a sound check to ensure their sound was turned on. They listened to a sound file containing English speech and were asked to type the words. Once they typed the dialogue correctly, they were presented with a game-play video clip. This video clip was randomly selected to be from one of the four conditions; it showed the player character performing basic melee/ranged attacks and five different abilities. Video clips from each condition were identical except for the visual/audio effects that were modified. We measured the amount of time that participants spent watching the video to ensure that the entire video was watched. Additionally, participants' prior gaming experience was assessed with the question "I have a lot of prior experience playing video games" on a seven-point Likert scale (1: *Strongly Disagree* to 7: *Strongly Agree*). A one-way ANOVA found that participants did not differ significantly in their previous gaming experience across each condition, $F(3, 115) = 0.451$, $p = 0.72$; with an overall average of $M = 3.90$, $SD = 1.50$. Participants were then asked the following questions on a seven-point Likert scale (1: *Strongly Disagree* to 7: *Strongly Agree*):

- The sounds fit the game.
- The visual effects fit the game.

They were additionally asked "On a scale from 1 to 10, with 1 being minimal special effects (visual/sound), and 10 being excessive special effects, how would you rate the level of special effects in the game?"

A one-way ANOVA found no significant effect of condition on fit of sounds, $F(3, 115) = 0.266$, $p = 0.85$. A one-way ANOVA found no significant effect of condition on fit of visual effects, $F(3, 115) = 1.927$, $p = 0.13$. These tests confirm that conditions were not perceived as having significantly different "fit" in terms of visuals/audio in the game. Ratings for the levels of special effects by condition were as follows: No juiciness ($M = 5.06$, $SD = 2.01$), medium juiciness ($M = 5.38$, $SD = 1.94$), high juiciness ($M = 5.64$, $SD = 1.98$), extreme juiciness ($M = 6.08$; $SD = 1.91$). These mean scores confirm that each condition has a relative valence matching our expectations.

4.4. Quantitative and qualitative measures

Player Experience of Need Satisfaction: We use the 21-item Player Experience of Need Satisfaction (PENS) scale [58] that measures the following dimensions: competence, autonomy, relatedness, presence/immersion, and intuitive controls. PENS is based on self-determination theory (SDT) [13]. PENS contends that the psychological "pull" of games is largely due to their ability to engender three needs:

1. Competence: Seek to control outcomes and develop mastery [65]
2. Relatedness: Seek connections with others [3]
3. Autonomy: Seek to be causal agents [10] while maintaining congruence with the self [58].

PENS is considered a robust framework for assessing player experience [14,56].

Intrinsic Motivation Inventory: The Intrinsic Motivation Inventory (IMI) assesses intrinsic motivation using four dimensions:

- Interest/enjoyment (e.g., I enjoyed doing this activity very much)
- Effort/importance (e.g., I put a lot of effort into this)
- Pressure/tension (e.g., I felt very tense while doing this activity)
- Value/usefulness (e.g., I believe this activity could be of some value to me) [48]

Time Played: We directly measure motivation as operationalized by the amount of time spent playing the game.

Performance: We also measure participant performance via the following variables:

- Character level
- Total attacks (melee/ranged combined)
- Total magic uses (spells/abilities combined)
- Total monsters defeated
- Total keyboard/mouse actions (all game actions combined)

4.5. Participants

A total of 3,018 participants were recruited through Amazon Mechanical Turk (AMT). Studies have shown that AMT provides data as good as traditional methods, such as through college campuses [7,46];

that AMT workers represent a highly diverse sample [9,52,29,4]; and that AMT is reliable for conducting experiments [47,7]. AMT is commonly used in games user research. The data set consisted of 1,555 male and 1,463 female participants. Participants self-identified their races/ethnicities as White (2,309); Black or African American (297); Chinese (65); Asian Indian (52); American Indian (42); Filipino (38); Korean (28); Vietnamese (21); Japanese (19); and other (147). Participants were between the ages of 18 and 80 (M = 35.5, SD = 10.7), and all were from the United States. Participants were reimbursed $1.50 to participate in this experiment. The Purdue Human Research Protection Program approved the study.

4.6. Design

A between-subjects design was used: juiciness level was the between-subject factor. Participants were randomly assigned to a condition.

4.7. Protocol

Participants were first asked to do a sound check to ensure their sound was turned on. They listened to a sound file containing English speech and were asked to type the words. Once they typed the dialogue correctly, they were able to proceed. Participants were then informed they could *exit the game at any time* without penalty. Participants then opened the link to the version of the action RPG game that corresponded to their randomly assigned condition. When participants quit the game, they returned to the survey to complete the PENS and the IMI. Game statistics (e.g., time played, character level) were tracked automatically. In the final portion of the survey, participants were asked how they felt about the visual/sound effects in the game (free-text response). Participants then filled out demographics.

5. Analysis

Data were extracted and imported into Statistical Package for Social Science (SPSS), version 22, for data analysis using multivariate analysis of variance (MANOVA). MANOVA is a procedure for comparing conditions across multiple dependent variables. Significant MANOVAs can be followed up with univariate testing to find significant dependent variables. Significant univariate tests can then be followed up with post-hoc tests to determine significant differences between conditions. Separate MANOVAs are run for each separate set of items (*PENS, IMI, game statistics*) with the independent variable *juiciness condition*. The independent variable juiciness condition (0 = no juiciness, 1 = medium juiciness, 2 = high juiciness, 3 = extreme juiciness) is a tetrachotomous variable. To detect the significant differences between juiciness conditions, we utilized one-way MANOVA. These results are reported as significant when $p < 0.05$ (two-tailed). Prior to running our MANOVAs, we checked both assumption of homogeneity of variance and homogeneity of covariance by the test of Levene's Test of Equality of Error Variances and Box's Test of Equality of Covariance Matrices; both assumptions were met by the data ($p > 0.05$ for Levene's, and $p > 0.001$ for Box's). However, these assumptions were violated for *game statistics*. To deal with these violations, we use the more conservative Pillai's Trace [61]; we also set the more conservative significance criterion of $p < 0.01$ (two-tailed) for univariate testing as suggested in the literature [61]. Post-hoc testing is performed using Tukey Honestly Significant Difference (HSD), which controls for Type I errors (i.e., false positives) [62].

6. Results

RQ1: Does juiciness impact player experience?

There was a statistically significant difference in player experience based on juiciness condition, $F(15, 8310) = 2.62, p < 0.001$; Wilk's $\Lambda = 0.987$, partial $\eta^2 = 0.004$. Univariate testing found that the level of juiciness has a significant effect on competence ($F(3, 3014) = 4.73; p < 0.005$; partial $\eta^2 = 0.005$), autonomy ($F(3, 3014) = 4.04; p < 0.01$; partial $\eta^2 = 0.004$), and presence/immersion ($F(3, 3014) = 3.14; p < 0.05$; partial $\eta^2 = 0.003$). Post-hoc testing was done using Tukey HSD:

Competence

- No Juiciness < Medium Juiciness, p < 0.05
- No Juiciness < High Juiciness, p < 0.05
- Extreme Juiciness < Medium Juiciness, p < 0.05
- Extreme Juiciness < High Juiciness, p < 0.05

Autonomy

- Extreme Juiciness < Medium Juiciness, p < 0.01
- Extreme Juiciness < High Juiciness, p < 0.05

Presence/Immersion

- Extreme Juiciness < Medium 'Juiciness, p < 0.05
- Extreme Juiciness < High 'Juiciness, p < 0.05

RQ1 Summary: Juiciness has a significant impact on player experience. Specifically, both the No Juiciness and the Extreme Juiciness conditions thwarted player experience as compared to Medium Juiciness and High Juiciness. (See Fig. 5.)

RQ2: Does juiciness impact intrinsic motivation?

There was a statistically significant difference in intrinsic motivation based on juiciness condition, $F(12, 7967) = 2.27, p < 0.01$; Wilk's $\Lambda = 0.991$, partial $\eta^2 = 0.003$. Univariate testing found that the level of juiciness has a significant effect on interest/enjoyment ($F(3, 3014) = 5.87; p < 0.001$; partial $\eta^2 = 0.006$), and value/usefulness ($F(3, 3014) = 3.86; p < 0.01$; partial $\eta^2 = 0.004$). Post-hoc testing was done using Tukey HSD:

Interest/Enjoyment

- Extreme Juiciness < Medium Juiciness, p < 0.001
- Extreme Juiciness < High Juiciness, p < 0.005

Value/Usefulness

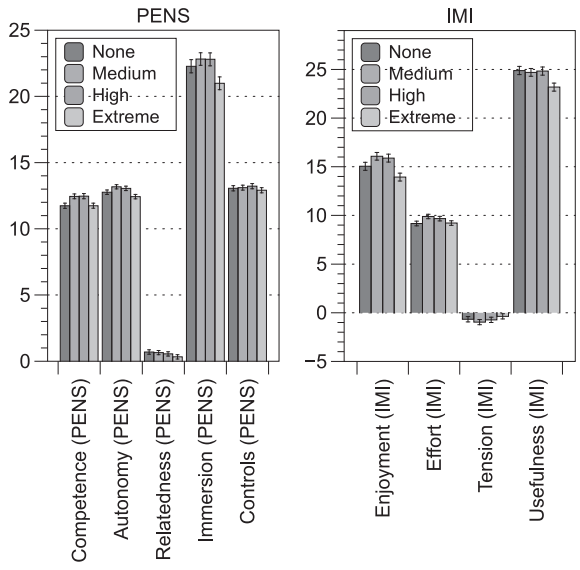

Fig. 5. Player experience of need satisfaction/intrinsic motivation inventory. Error bars show standard error of the mean (SEM).

- Extreme Juiciness < No Juiciness, p < 0.05
- Extreme Juiciness < Medium Juiciness, p < 0.05
- Extreme Juiciness < High Juiciness, p < 0.05

RQ2 Summary: Juiciness has a significant impact on intrinsic motivation. Specifically, the Extreme Juiciness condition thwarted intrinsic motivation as compared to No Juiciness, Medium Juiciness, and High Juiciness. (See Fig. 5.)

RQ3: Does juiciness impact motivated behavior as operationalized by time spent?

There was a statistically significant difference in game statistics based on juiciness condition, $F(18, 9033) = 2.00, p < 0.01$; Pillai's Trace = 0.012, partial $\eta^2 = 0.004$. Univariate testing found that the level of juiciness has a significant effect on time played ($F(3, 3014) = 5.83; p < 0.001$; partial $\eta^2 = 0.006$). Post-hoc testing was done using Tukey HSD:

Time Played

- No Juiciness < Medium Juiciness, p < 0.05
- No Juiciness < High Juiciness, p < 0.01
- Extreme Juiciness < Medium Juiciness, p < 0.05
- Extreme Juiciness < High Juiciness, p < 0.01

RQ3 Summary: Juiciness has a significant impact on time played. Specifically, both the No Juiciness and the Extreme Juiciness conditions thwarted play time as compared to Medium Juiciness and High Juiciness. (See Fig. 6.)

RQ4: Does juiciness impact game performance?

Univariate testing found that the level of juiciness has a significant effect on character level ($F(3, 3014) = 6.49; p < 0.0005$; partial $\eta^2 = 0.006$); total attacks ($F(3, 3014) = 3.82; p < 0.01$; partial $\eta^2 = 0.004$); total monsters defeated ($F(3, 3014) = 4.79; p < 0.005$; partial $\eta^2 = 0.005$); and total keyboard/mouse actions ($F(3, 3014) = 6.85; p < 0.0005$; partial $\eta^2 = 0.01$). Post-hoc testing was done using Tukey HSD:

Character Level

- Extreme Juiciness < Medium Juiciness, p < 0.005
- Extreme Juiciness < High Juiciness, p < 0.001

Total Attacks

- Extreme Juiciness < Medium Juiciness, p < 0.005

Total Monsters Defeated

- Extreme Juiciness < Medium Juiciness, p < 0.01
- Extreme Juiciness < High Juiciness, p < 0.01

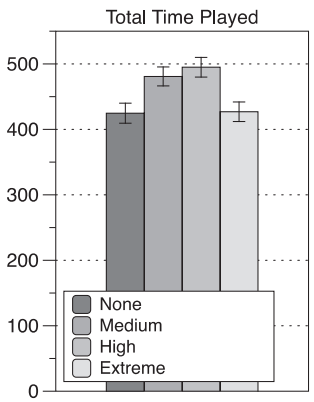

Fig. 6. Time played. Error bars show SEM.

Total Keyboard/Mouse Actions

- No Juiciness < Medium Juiciness, p < 0.05
- No Juiciness < High Juiciness, p < 0.05
- Extreme Juiciness < Medium Juiciness, p < 0.005
- Extreme Juiciness < High Juiciness, p < 0.005

RQ4 Summary: Juiciness has a significant impact on game statistics. Specifically, the Extreme Juiciness condition thwarted character level, total attacks, total monsters defeated, and total keyboard/mouse actions as compared to Medium Juiciness and High Juiciness. The No Juiciness condition thwarted total keyboard/mouse actions as compared to Medium Juiciness and High Juiciness (see Fig. 7). Overall, we see an extremely consistent trend where No Juiciness and Extreme Juiciness underperform compared to Medium Juiciness and High Juiciness.

7. Discussion

We first summarize our results:

- No Juiciness and Extreme Juiciness thwarted player experience.
- Extreme Juiciness thwarted intrinsic motivation.
- No Juiciness and Extreme Juiciness thwarted play time.
- The Extreme Juiciness condition thwarted character level, total attacks, and total monsters defeated.
- No Juiciness and Extreme Juiciness thwarted total keyboard/mouse actions.

Overall, we identify an extremely consistent trend in which Medium Juiciness and High Juiciness outperform No Juiciness and Extreme Juiciness across virtually all measures. The above examples represent cases in which statistical significance was detected using post-hoc Tukey HSD; however, this trend is even more widely consistent (i.e., across measures where statistical significance was not detected). (See Figs. 5–7.)

These results suggest that both underwhelming and overwhelming amounts of juiciness have significant consequences across a wide range of measures. It is likely that in the No Juiciness condition, players found the game dry and less engaging, whereas in the Extreme Juiciness condition, players may have been irritated by the excessive graphics/sound effects. The Medium Juiciness and High Juiciness condition seemed to meet an optimal level of special visual/audio effects that participants felt was pleasurable without being overly excessive. Other studies have also found that juiciness can impair player performance [55,36]. In a study where praise and flattery in the form of audio (e.g., "Amazing!") was given to half of the participants (both intermittently and after specific game interactions), those participants performed significantly worse [55]. Similarly, in another study, a juicy version of a game led to lower game performance despite higher ratings when compared to a control version of the same game [36]. Another recent study examined simulated loot box opening and found that participants exposed to juicier audio effects opened more loot boxes [40]. Other studies have shown that juiciness can influence variables such as need satisfaction and intrinsic motivation [26,27]. Here, we studied four different juiciness conditions, and show that juiciness is a double-edged sword that can imbue both significantly positive *and* negative effects—and that degree of juiciness determines the valence of these effects. These results can also reconcile oft-conflicting research from multiple domains in the context of juiciness, e.g., seductive details vs. game designers' perspectives. Despite that we found moderate amounts of juiciness to be optimal, even these moderate amounts may come at a trade-off with variables that were not observed in this experiment (e.g., learning about the game world). Our study complements prior work with a large sample size—we find that juiciness can indeed influence performance, as well as player experience and intrinsic motivation.

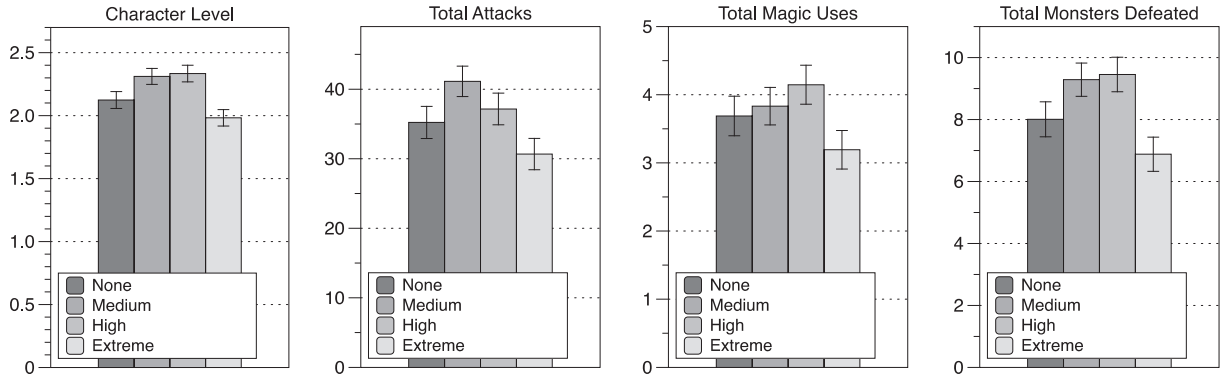

Fig. 7. Game statistics. Error bars show SEM.

However, further research is needed to better understand how contextual factors (e.g., game genre [68]) concretely influence players.

This is, to the best of our knowledge, the largest empirical study to date on juiciness. Juiciness has been discussed extensively in the academic literature, yet very few studies have attempted to study the topic in a controlled setting. Our study is the first large-scale attempt to do so. These results empirically support the notion that juiciness has positive effects across player experience, intrinsic motivation, play time, and in-game performance—*up to a limit*. We believe this study makes a contribution to the larger discourse surrounding feedback, special effects, and juiciness in games. Our work here is applicable to game designers, developers, and academic researchers and can better inform both practice/research as we continue to build/study digital games.

8. Limitations

Despite being methodologically cautious, our work here is not without limitations. One possible approach that may reveal additional results would be to allow participants to choose and be able to switch (at any time), between the four juiciness versions. This might reveal, for example, that there is a strong preference for Medium Juiciness or High Juiciness relative to the other or that different levels of juiciness are preferred at different stages of the game. We might imagine, for example, that Extreme Juiciness would be more irritating during a difficult boss fight but that it might be more fun when attacking easy monsters.

Another limitation is that only one game type was studied. We might imagine that levels of juiciness have very different effects and expectations with respect to the player depending on the game genre. Casual games, for instance, may do better with Extreme Juiciness than, for example, a game like chess or games in which user performance is the end goal, such as *FoldIt* [41]. Other aspects of gameplay which are influenced by game genre (e.g., avatar identification [69]) may in turn affect how juiciness is perceived. Additional investigation on how game genre moderates the effects found in our study would be beneficial.

The type of display may also moderate effects of juiciness. While we've considered standard desktop displays, it would be worthwhile to investigate other displays, such as head-mounted displays (HMDs). Work by Rogers et al. suggests that in virtual reality (VR), players focus more on the sensory experience [57]. As such, juiciness may be more impactful in VR. One recent study on juiciness was performed in VR [26]. As such, an interesting follow-up would be to compare the effects of juiciness across different types of displays.

Finally, it would be worthwhile to explore a finer-grained approach to juiciness (e.g., leveraging frameworks [25]) and to explore how specific aspects (e.g., screen shakes, juicy UI buttons) influence players. Eventually, developing player models of what types of juiciness players prefer (and even tailoring the type and amount of juiciness to individual players) would lead to more personalized systems that can provide optimal amounts of juiciness.

9. Conclusion

We created four versions of the same identical action RPG game, but with differing levels of visual/audio effects: No Juiciness, Medium Juiciness, High Juiciness, and Extreme Juiciness. Overall, both Medium Juiciness and High Juiciness outperform No Juiciness and Extreme Juiciness across all measures. This includes player experience, intrinsic motivation, play time, and in-game performance. This conclusion is consistently supported by the results of our experiment.

This is, to the best of our knowledge, the first large-scale study to attempt to empirically address the effects of juiciness on players. We show that juiciness has real, quantifiable impacts on player experience, intrinsic motivation, play time, and in-game performance. Our work here makes a contribution that is useful for designers (of both games and game-like environments/interfaces), developers, and researchers. This contribution can better inform both practice and research as we continue to build and study digital games.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.entcom.2020.100359.

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