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To Binge or not To Binge: viewers' moods and behaviors during the consumption of subscribed video streaming

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Abstract. The popularity of internet-distributed TV entertainment services, such as Netflix, has transformed TV consumption behavior. Currently, the level of control viewers have over their TV experiences, along with the release of complete seasons at once, are some of the factors that stimulate the so-called binge-watching phenomenon (the consumption of several episodes of a program in a single sitting). Most of binge-watching studies have focused on viewers' habits and health effects. This paper presents a study that relates to viewers' behaviors and moods. It was carried out with 13 young participants at their home, watching online content, collecting physiological, inertial, and self-reported data. We identify and compare binge-watching with non-binge-watching behaviors. Our results suggest that while viewers recur to online serial entertainment in pursuit of leisure related needs, such as relaxation, relief from boredom and escapism, the act of binge-watching tends to make them feel rather unsatisfied with no change in Arousal. Nevertheless, in binge-watching the Positive Affect increases while the Negative decreases. Moreover, watching a single episode only, tends to result in increased arousal and but not necessarily in increased satisfaction. This preliminary finding can be the starting point of fruitful future investigations on unpacking further motives and nuances from this outcome.

Keywords: Binge watching, Television viewing behavior, Online TV, Video-on-demand, Video streaming.

1 Introduction

Popular press and media organizations have recently popularized the practice of “Binge-watching” referring to a viewing behavior enabled by the raise of entertainment

in the form of internet TV as well as TV on Demand. Binge-watching viewing modalities are not new and can be traced back to 80s and 90s, when the video recording and storing capabilities of VCR and DVD made possible for the viewers to engage with hours of sequential episodes consumption. Later on, Internet-distributed TV services have facilitated this specific mode of viewing. Despite the different studies on the topic [4, 8, 13], today binge-watching still lacks a standardized definition. In the last years, both Industry and Academia have explored the phenomena of binge-watching, but from different angles. While Industry looks at the number of spectators binging, the frequency of this practice, and the device chosen [5], the academics look at its motivations and effects on health [15, 19].

In this work, we performed 13 participants in the wild study, where recruited users where binge-watching content on Netflix. We collected data on users' interface actions, self-reported data as well as physiological and inertial data, in a non-intrusive manner.

Despite the lack of consensus in the definition and connotation of the term, for the purpose of this research we decided to use the term binge-watching and defined it as watching two or more complete episodes of the same program immediately after each other, or with a maximum pause of 15 minutes, to ensure that the flow was not disrupted.

This work builds upon previous research [2], by analyzing and comparing the data of binge-watching behaviors with non-binge-watching behaviors. Thus, we have identified three types of online TV entertainment watching behavior: Binge-watching (as defined by the authors earlier in the text), watching just a single episode, and watching multiple episodes but not pertaining to the same series. Results from the analysis indicate that while binge watchers mainly look for leisure through relaxation, relief from boredom and escapism, binge watchers reported feeling rather unsatisfied after viewing several episodes, with no change in their excitement levels. At the same time, participants who manifested a Binge-watching behavior reported an increase in positive emotions and decrease in negative emotions after the sessions, being Sci-Fi the genre that present the highest positive impact and Comedy the one that reduces the most anxiety. Single Episode viewers end up their experience as happier and slightly more excited than before they started. While results already invite nuanced discussions on the binge phenomenon, further data is needed to clarify the complex reality of the entertainment experience. Our preliminary results point out to several avenues for further studies and unpacking of the experience.

2 Related work

Scholars have used traditional psychological assessment scales to quantify audience emotions while watching TV or Film content. Some have used PANAS [23], a scale for measuring the positive and negative dimensions of affective states, to study whether watching emotionally arousing films increases pain thresholds and group bonding [7], the release of hormones by TV soccer spectators [21], and to analyze the relationship between serialized TV fiction watching and binge-watching [9]. Other studies have

used SAM [1], a pictorial scale that assesses arousal, valence, and dominance, applied to advertising studies [14] and to analyzing affective reactions to movies [3]. Regarding in the wild studies targeting TV or streaming consumption, the methodologies adopted vary, ranging from online questionnaires after viewing sessions [8], to gathering data in the wild, from hacking TV boxes [11] or placing cameras in households [18]. However, these approaches face technology and privacy limitations, which are even more challenging when employed to collect audiences' emotional data [20, 22]. Moreover, audiences' emotional changes can be related to physiological reactions [10, 12, 20]. Therefore, self-reported data combined with physiological data can shed new light on moods, hence motivations of binge watchers, innovating in the data collection methods. While enriching existing binge-watching data collection methods, we performed an in the wild study focused on Netflix content consumption, collecting data on users' interface actions, self-reported mood data as well as physiological and inertial data, in a non-intrusive manner.

3 In the wild study

In this paper, the authors describe a multifaceted exploratory study and analysis of a Netflix's based entertainment experience. Data were collected from 13 users before, during and after online TV exposure. We collected physiological (heart rate) and inertial (wrist movement) data, through a smartwatch; online actions, logged from the Netflix interface, into a custom-made browser extension. Finally, users filled in pre and post viewing questionnaires self-reporting on arousal, valence and positive negative effects.

A browser extension (specific to Chrome) was developed to register participants' interactions on the Netflix interface (e.g. pauses, skip content), and to synchronize these actions with the smartwatch data. The extension was installed on each participant's laptop, which was synchronized with the same clock server as the smartwatch (time.google.com). In addition, the browser extension automatically presented the pre and post viewing online questionnaires to participants. All the data collected (action logs and questionnaires' answers) were automatically stored in a Google Sheet. The questionnaires include questions before and after a watching session regarding participants' motivations and mood.

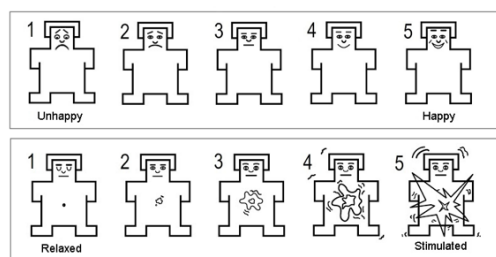


Fig. 1. Self-Assessment Manikin (SAM): Top - Valence; and Bottom - Arousal.

Two scales were used: 1) the Self-Assessment Manikin (SAM) [1], a pictorial scale which assesses participants' arousal and valence (Figure 1), and 2) the Positive Affect and Negative Affect Schedule (PANAS) [23], a scale that consists of a number of words that describe different feelings and emotions (affects).



Fig. 2. Smartwatch App (left) and Phone App (right)

A custom-made app (Figure 2) was developed for the Android smartwatch (Moto 360) that participants wore during the study. The app allowed the logging of the required data, otherwise limited by commercial devices that use their proprietary software. The app acquires readings from smartwatch sensors, such as heart rate (HR) and inertial data (accelerometer and gyroscope), once per second (1Hz). Initial validation tests showed that at 1Hz the heart rate readings collected through the smartwatch were accurate enough and followed ECG standards. The smartwatch connects via Bluetooth to a smartphone (Moto G4), storing all data in a Dropbox account.

The questionnaires, collecting the user's data, included the classification of content with participants' self-reported values of arousal and valence to understand their physiological variations while watching. Participants were asked to rate the clips after the end of the viewing session. To rate the short clip, participants were asked to recall how they felt when they were watching the content of that short clip. Participants were asked to rate the fragments according to the SAM scale (Figure 1). Asking this classification recurrently (e.g., every minute) would be quite demanding for the participants and break participants' watching flow. Thus, we decided to sample eight short (6-seconds) video clips, within equal time intervals, from each episode of a pre-select content. Due to the large number of shows available in Netflix, it was not realistic to perform such sampling for all available content in the streaming platform. Therefore, we decided to sample four of the most popular titles from a preliminary survey on online consumption, covering the TV genres of Comedy, Science Fiction (Sci-Fi), and Drama. The chosen TV series were: *Master of None*, seasons 1 and 2; *Sense8*, seasons 1 and 2; *13 Reasons Why*, season 1; and *Stranger Things*, season 1.

3.1 Participants and Procedure

We recruited 13 (five female and eight male) participants, all from the Millennial Generation (1981-1997) as natural consumers of online media content, with the average

ages $M = 26.85$ ($SD = 4.41$). Out of 13 participants, six were students, five workers, and two were both workers and students. Based on online pre-study that allowed us to understand their viewing habits, we characterized all of them as potential binge-watchers. Previous to the beginning of the study, participants were informed and instructed about the study, how to use the different devices and technologies we would be providing them with (i.e., smartwatch and browser extension). After agreeing to participate they signed a consent form and installed the browser extension on their laptops. The participants were informed that during the study, they could watch any content they wish and how they wanted but we invited them to watch the four pre-selected series. Participants signed up for a free month trial with Netflix. The study took place at participants' homes for ten days (six workdays and two weekends). At the end of the field study, the participants received a 20 euros gift card reward.

3.2 Study Results

We collected a total of 97 watching sessions, where for “session” we consider any moment when participants have watched some Netflix content for more than 2 minutes and without a break longer than 15 minutes. Of these 97 sessions, we discarded: 24 sessions because missing part of the questionnaires' answers; 4 sessions with no single episode watched until the end and 3 sessions were participants were not watching a tv series. We defined that an episode was “watched until the end” when a participant watched its content 10 seconds before the beginning of the final credits of that particular episode. The tolerance of 10 seconds before the start of the credits aimed to mitigate different reaction times (stop or move to the next episode) without losing the episode narrative. The remaining 66 session were considered valid and were analyzed, categorizing them into three main clusters: A) Binge-watching sessions (60.61%); B) Single Episode sessions (19.70%); and C) Multiple Episodes sessions (19.70%). These categories identify three different types of viewers' behavior, defined as:

- A) Binge-watching Behavior: watching at least 2 episodes of the same TV series watched until the end (40 Sessions; $M = 02:10:40$; $SD = 01:09:33$; Average of episodes $M = 3.43$; $SD = 1.69$)
- B) Single Episode Behavior: watching just 1 episode of any TV series, watched until the end and any other episodes watched for less than 2 minutes (13 Sessions; $M = 00:54:59$; $SD = 00:25:23$)
- C) Multiple Episodes Behavior: watching multiple episodes, but from different TV series. This mode entailed that 1 episode at least was watched until the end and other episodes (not of the same series) watched for more than 2 minutes or until the end (13 Sessions; $M = 01:28:10$; $SD = 00:44:34$; Average of episodes $M = 3.00$; $SD = 1.29$)

Motivations

Before starting any online entertainment sessions on Netflix, participants were asked about their watching motivations; the question allowed multiple answers. “Relaxation”

and “Boredom relief” emerged as the main motivations, followed by “Escapism” (Table 1).

Table 1. Online Entertainment Watching Motivation

Motivation	Binge-watching Behavior (N=40)	Single Episode Behavior (N=13)	Multiple Episode Behavior (N=13)
Relaxation	23	7	10
Boredom relief	18	7	6
Escape	15	6	3
Learning	3	2	-
Hedonism	1	-	-
Companionship	1	-	-
Social Interaction	-	1	-
None of These	-	1	-

Mood assessment

Because of the ordinal nature of the data (SAM and PANAS), the Wilcoxon Signed Rank (WSR) was used to test for differences. Regarding SAM (Valence and Arousal), the WSR tests showed significant differences for Valence Before (Mdn = 3) and After (Mdn = 1) Binge-watching; and for Arousal, Before (Mdn = 2) and After (Mdn = 3) watching a single episode (Table 2).

Analyzing the SAM data by TV genre (Comedy, Sci-Fi, Drama and Action) WSR tests showed significant Valence decrease for Comedy Binge-watching (N = 10; Mdn Before = 3; Mdn After = 1; $Z = -2.877$; $p < 0.005$); Drama (N = 13; Mdn Before = 3; Mdn After = 1; $Z = -2.994$; $p < 0.005$); and Sci-Fi (N = 10; Mdn Before = 3.5; Mdn After = 2; $Z = -2.539$; $p < 0.05$).

For Single Episode sessions, WSR test showed significant increase for Arousal when watching Drama (N = 5; Mdn Before = 2; Mdn After = 4; $Z = -2.060$; $p < 0.05$), compared to Comedy and Sci-fi, which did not show any significant differences.

No significant differences in Valence or Arousal were observed for Multiple Episode sessions by genre (Comedy, Sci-fi, and Action).

Table 2. SAM: Median Values Before and After, for all three categories of behaviors.

SAM	Binge-watching Behavior (N=40)	Single Episode Behavior (N=13)	Multiple Episodes Behavior (N=13)
Valence Before	3**	3	3
Valence After	1**	2	3
Arousal Before	2	2*	3
Arousal After	2	3*	3

* $p < .05$ ($Z = -2.232$); ** $p < .0000001$ ($Z = -5.387$)

Regarding the analysis of the PANAS data (Table 3), WSR tests showed significant differences for Positive (PA) and Negative Affects (NA) for the Binge-watching behavior sessions. The PA increases, while the NA decreases. No significant differences were observed for Single Episode and Multiple Episodes sessions. Analyzing PANAS by genre for Binge-watching sessions, WSR testing showed significant increase for PA in Sci-Fi ($N = 10$; Mdn Before = 18; Mdn After = 24; $Z = -2.807$; $p = 0.005$); and a significant decrease for NA in Comedy ($N = 10$; Mdn Before = 13; Mdn After = 11; $Z = -2.506$; $p < 0.05$). Moreover, within the PANAS scale, the variable “guilty” is particularly relevant in the context of Binge-watching, due its relevance in addiction and addictive behaviors [15]. The level of guiltiness, presented on PANAS, did not change Before (Mdn = 1) and After (Mdn = 1) Binge-watching.

Table 3. PANAS: Median Values for Positive and Negative Affects

PANAS (10-50)	Binge-watching Behavior (N=40)	Single Episode Behavior (N=13)	Multiple Episodes Behavior (N=13)
Positive Before	18*	22	18
Positive After	20.5*	20	16
Negative Before	12*	13	12
Negative After	11.5*	12	14

* $p < 0.05$ (PA $Z = -2.028$; NA $Z = -2.573$)

Interface Actions

We also compared the different interface actions such as the number of pauses per hour, setting a new position in the timeline (skipping content or getting back to re watch it) per hour, pressing the full-screen button per item watched and skipping the intro per item watched (Table 4). Because data were not normality distributed, as assessed by the Shapiro-Wilk test, we used the Wilcoxon Signed Rank test to compare the different actions. The only significant difference found was skipping the intro per item, where Binge-watching shows a higher tendency regarding this action, as shown in Table 4.

Table 4. Interface Actions

Action	Binge-watching (N = 40)		Single Episode (N = 13)		Multiple Episodes (N = 13)	
	M (SD)	Mdn	M (SD)	Mdn	M (SD)	Mdn
Pause /hour	0.65 (0.97)	0.10	1.48 (1.30)	1.51	0.69 (1.08)	0.00
New position in the timeline /hour	1.74 (6.66)	0.00	0.08 (0.30)	0.00	1.00 (3.14)	0.00
Full screen /item	0.82 (0.90)	0.50	1.85 (2.12)	1.00	1.31 (1.84)	1.00
Skip intro /item	0.16 (0.30)*	0.00	0.08 (0.28)*	0.00	0.54 (0.88)	0.00

* $p < .05$ ($Z = -2.132$)

Physiological data

From the 40 Binge-watching sessions, 12 were valid for physiological and inertial data analysis, i.e., no gaps in the smartwatch data and with all episodes watched until the end. Following the same validation, 8 Single Episode sessions were considered for physiological and inertial data analysis. Multiple Episodes sessions were excluded from this analysis due to the lack of usable data. Figure 3 shows an example of a chart displaying synchronized data for a Single Episode session (Fig. 3 a)) and a Binge Watch session (Fig. 3 b)):

- Diff hr avg: the difference between the raw value and the average of heart rate beats for that particular session, i.e., heart rate values BMP but close to vertical axis = 0.
- The light blue line is the linear trend line for heart rate variations.
- Gyro_movement: Binary value (0 or 1) for wrist rotations.
- Acc_movement: the sum of the absolute differences between the current accelerometer values and previous values (1 sec of difference) of the 3 axes. Show arm movement: low values correspond to small variations, high values (higher than 5) correspond to big variations.
- Valence and Arousal (SAM) values associated with video clips.

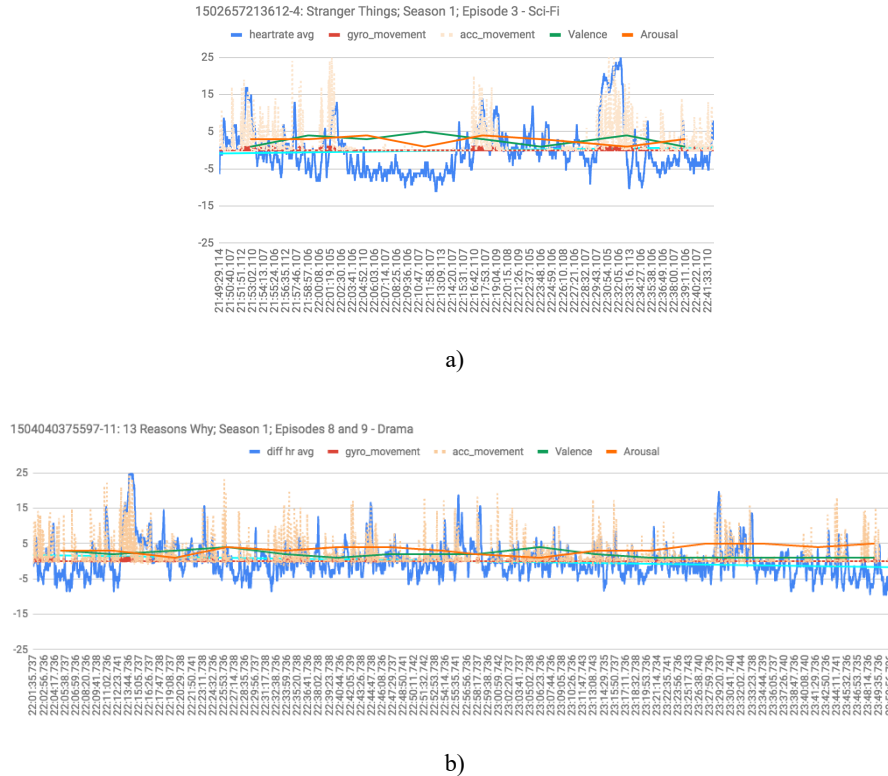


Fig. 3. Example of data synchronization through a watching session (time): a) Single Episode Session; and b) Binge-watching Session. Blue - Heart Rate Beats; Dark Red - Gyroscope; Yellow - Accelerometer; Red - Valence; Green - Arousal;

We did not find any clear pattern for physiological and inertial data comparing Binge-watching with Single Episode sessions through time, comparing the same episodes watched in both types of sessions (5 comparisons), and comparing the same episode watched at the beginning and the end of Binge-watching sessions (4 comparisons).

4 Discussion

From the analysis of the data we can infer that while majority of the participants (60,6%) adopted a Binge-watching behavior, many (43,3%) did not, consuming single and multiple series' episodes during their online entertainment sessions. Nevertheless, the motivations for the three different types of behaviors appear to be underlined by the same quest for leisure: "Relaxation"; "Boredom Relief" and "Escapism". However, "Relaxation" closely followed by "Boredom relief", emerge as the main motivation for the Binge-watching behavior and watching Multiple Episodes behaviors (i.e., longer sessions). For the Single Episode behavior the three leisure seeking related motives are

quite balanced as top choices. Therefore, this would suggest that participants who look for “Relaxation” tend to spend more time watching online content. “Learning” as a motivation scores low across three types of behaviors, reinforcing the leisure seeking attitude of all viewing behaviors. When looking at moods of the viewers across the SAM results, we can observe a striking decrease in Valence after the end of the Binge-watching sessions, suggesting that participants ended the experience in an unpleasant mood, less satisfied or unhappier than when they started it (Fig. 4). This decrease in Valence, before and after the viewing session, is less striking in the Single Episode watching behavior, and is not noticeable in the Multiple Episodes behavior.

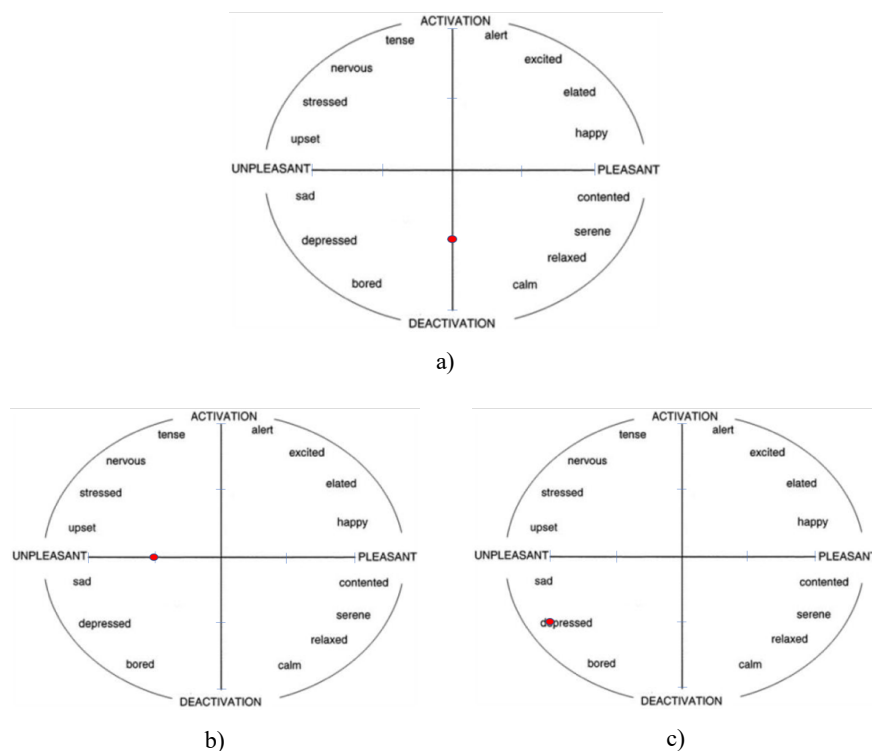


Fig. 4. Circumplex Model: Arousal vs Valence [17]: a) Before Watching Single Episode and Binge-watching; b) After Watching Single Episode; and c) After Binge-watching

Interesting to note is that all participants reported quite low Arousal values before even starting to watch any online TV entertainment. Participants that engaged in Single Episode watching behavior got more excited after a single episode session, while no change for arousal was observed after Binge-watching or watching Multiple Episodes. These results further support the idea that Binge-watching participants’ mood worsened after the session, while their arousal levels remained the same. On the other hand, the Single Episode watchers’ mood also deteriorated slightly during the session, but their arousal increased. Multiple Episode watchers did not report any changes in mood or

excitement. The fact that Arousal has only increased in Single Episode sessions and not in Binge-watching and Multiple Episodes might be explained by the circumstance that “Relaxation” was the top motivation for these long watching sessions behaviors, as previously mentioned. The curiosity induced by serial entrainment watching, to know how the story will develop in next episodes as well as the short time seated in front of a screen, might be considered as a reason for the increase in Arousal in Single Episode watchers. The analysis of the results by TV genres highlighted that Drama is the only genre that presented significant increase in Arousal.

Analyzing the PANAS data, Binge-watching, Single Episode and Multiple Episode sessions show similar values. In the case of the Binge-watching behavior, there was significant increase of PA and a significant decrease of NA after the session. Nonetheless, these values are still overall quite low, not enough to denote a change in participants’ mood (PA is far from normal values, which is rated at 25 or higher, and close the threshold of 18, which is an abnormally low value and might be associated with depression [6]). Such results are in line with the decrease in Valence after Binge-watching, as previously discussed. Looking at the data through the TV genre lens, the increase in PA values is mainly related with Sci-Fi content, while the NA decrease is related to the Comedy genres. Interesting also to note the Sci-Fi content almost set PA values near to normal (25 or higher [6]), and since PA might reflect better participants’ mood [6], such results indicate that Binge-watching Sci-Fi content have a higher positive impact on participants’ mood than Comedy.

The NA values are also low across the three types of behavior (far from the anxiety threshold of 29 [6]), which might be related with the second main motivation for watching online content, “Boredom relief”. The significant decrease of NA in Binge-watching is related to watching Comedy genre, and it might indicate reducing participants’ anxiety.

Regarding the levels of guilt reported through the PANAS, it is constant before and after Binge-watching. These results confirm Perckx studies which associate Binge-watching with addiction and addictive behaviors [15].

Regarding data emerging from the users’ interface actions, we observe a tendency to skip intros more often while Binge-watching, when compare with the watching of single or multiple episodes. This can be expected in order not to repeat the same titles or introductory content several times during a Binge-watching session.

No clear pattern was found for physiological and inertial data. Such a lack could derive from the challenges emerging from collecting physiological data in the wild, with no or little control of the experiment. Also, the choice of using minimally intrusive sensors (smart watch) also substantially limited the amount and quality of the physiological data that could be gathered since these devices do not provide access to raw ECG data. To conclude we would like to acknowledge several limitations of our study. A higher sample of sessions and more constraints on the physiological data collection are needed to be able to extract patterns from the data. Therefore, part of the experiment needs some controlled environment to achieve comparable data, e.g., all participants must watch the same series. It may reduce the pool of possible participants but will provide more meaningful data.

5 Conclusions

In summary, in this paper the authors present an exploratory field study, collecting physiological, inertial, and self-reported data from 13 young participants while watching online entertainment content. The authors developed a smartwatch app, collecting physiological and inertial data, and a chrome extension, logging participants' interface actions and opening questionnaires automatically. The study highlighted and compared three kinds of distinct behaviors on our participants: 1) Binge-watching (according to our definition reported in the first section of this article), 2) Single Episode watching and 3) Multiple Episode (from different series) watching. Results from the analysis of the data suggest that while most viewers engage in online TV entertainment mainly looking for leisure, the Binge-watching behavior affect viewers mood, resulting in lower levels of Valence and no change in Arousal at the end of the session. Nevertheless, Binge-watchers report an average increase in Positive Affect and decrease in Negative Affect at the end of the sessions, being Sci-Fi the genre with the highest positive impact and Comedy the one that reduces anxiety. On the other hand, Single Episode consumption can make viewers feel more excited after the session. More studies would be needed to deepen the reasoning behind these intriguing initial findings.

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