UNIVERSITY OF TWENTE

Health Hazard or Unproblematic Free-Time Activity?

The Association between Binge-Watching and Depressive Symptomatology

An Experience Sampling Study

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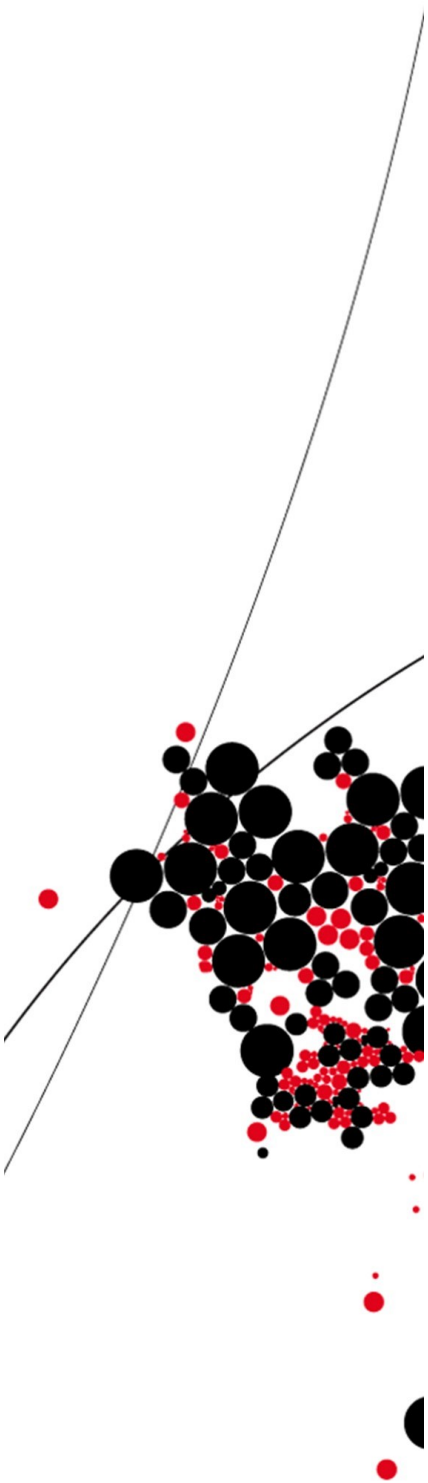
Master Thesis



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Abstract

Theoretical Background: Nowadays the majority of people watch films and series via video-on-demand streaming services and binge-watching has become one of the most popular ways of spending one's free time. Despite being a rewarding experience, studies also show that it may become a problematic behavior associated with depression. Most studies concerning binge-watching focused on cross-sectional designs and found mixed results on the association between video-on-demand (VoD) watching and depression. Therefore, the current study aims for additional insights using the experience sampling method to provide information on the association between VoD-watching and depression within individuals over time.

Method: The present study constitutes a post-hoc analysis of a two-week experience sampling study. The majority of participants ranged from 18 to 30 years and provided daily information on their level of depression and VoD-watching behavior. Considering the longitudinal nature of ESM data, multiple linear mixed model (LMM) analyses using an autoregressive covariance structure (AR1) were used to explore the association between depression and VoD-watching on a group level. To obtain results on the individual level, additional dynamic regression modeling to analyze four N-of-1 cases was conducted.

Results: Results demonstrate no significant association between state depression and number of VoD-hours watched the previous day ($\beta = -.054$, $SE = .051$, $p = .293$). Therefore, no temporal association between VoD-hours and depression was found at the group level. The association was however found to be significantly moderated by participants' gender ($\beta = .216$, $SE = .102$, $p = .036$), as male participants tended to experience slightly lower depression while females experienced higher levels of state depression when watching more VoD-hours. Analyses investigating possible temporal effects of the association up until four days after VoD watching showed no significant results. Results of the individual N-of-1 case analyses also found no significant association between depression and binge-watching.

Conclusion: The current study adds to contradicting previous research by showing no significant association between VoD-watching behavior and state depression. Thoroughly exploring the association between state depression and VoD-watching on a group as well as on an individual level, the study provides results on the association between binge-watching and depression within individuals over time. Thereby, giving the first insight into the potentially problematic over-pathologizing of VoD-watching behavior in this sample.

Introduction

Over the last couple of years, the evolution of television technology demonstrated a transition to the delivery of content over the internet. The line between broadcast or cable TV and online TV programming continues to blur and more and more people watch films and series via video-on-demand (VoD) streaming. With the rise of video streaming services such as Netflix and Amazon Prime, online TV has become an important part of a user´s media entertainment repertoire, as it allows users to watch their preferred series anytime and anywhere. It enables an unprecedented "all you can watch" culture moving away from the traditional week-by-week release of episodes and instead makes entire seasons of TV series available at once. Thereby, putting users in control of their watching behaviors, however, they may fail to control their time spent watching. Through this, excessive use of VoD-services is enabled, including the so-called phenomenon of binge-watching (BW). Due to its novel nature, a specific framework and definition of binge-watching still needs to be investigated. Generally, it is considered as watching several episodes of a series in one sitting (Flayelle et al., 2020). However, Flayelle et al. (2020) showed that definitions used in research papers vary based on the frequency of the behavior, the number of episodes watched, the episode duration as well as the content that is streamed. Therefore, there is great variability in the operationalization of binge-watching.

For most people, it constitutes a highly rewarding and pleasurable experience, fulfilling hedonistic motives in terms of the need for entertainment and enjoyment in one's free time (Flayelle et al., 2020). However, binge-watching may also be considered a potentially problematic behavior leading to maladaptive patterns of online media consumption. It might challenge a user's self-control abilities and thereby demonstrates its potential addictive qualities (Flayelle et al., 2020). Recent research has identified several harmful consequences of this rising phenomenon, ranging from an unhealthy lifestyle (Vaterlaus, Spruance, Frantz, & Kruger, 2019) to diminishing of social interactions (Feijter, Khan, & van Gisbergen, 2016). Heavy binge-watchers may elevate several depressive symptoms over time and generally show higher levels of depression than non-binge watchers (Ahmed, 2017; Flayelle et al., 2020). A positive relation between excessive binge-watching and depression was found among participants using a self-administered questionnaire in a cross-sectional study by Sun & Chang (2021). Yet it could not be confirmed by Tefertiller and Maxwell (2018), who found no connection between depression and binge-watching.

This demonstrates the discordant nature of this rising phenomenon. Studies on binge-watching have shown recurring discrepancies and mixed findings on the impact of binge-

watching on users' mental health, especially concerning the association between depression and binge-watching (Flayelle et al., 2020). Thus, it remains unclear so far what constitutes problematic binge-watching behavior and how it may be associated with depression within individuals over time. The current study tries to provide a first insight into the research gap by thoroughly examining the relationship within individuals over time.

Binge-Watching as a Predictor for Depressive Symptomatology

The growing prevalence and significant time invested into binge-watching suggest a need for further investigation into the effects of this new mode of entertainment media consumption on mental well-being (Granow, Reinecke, & Ziegele, 2018). Research has shown that media consumption at the costs of other goals can result not only in feelings of guilt, but also consequently decreases the situational well-being of a person (Reinecke, Hartmann, & Eden, 2014). Using a cross-sectional online survey, Reinecke, Hartmann, and Ede (2014) found that individuals may feel guilty, depressed, and frustrated after repeated exposure to entertaining media content. Individuals' level of appraisal of their own media consumption was found to be the main key to understanding the effects of media exposure on psychological well-being. Consequently, these findings demonstrate that an individual's intentions while watching VoD as well as repeated media exposure may have several negative effects (Reinecke, Hartmann, & Eden, 2014). Thus, the consequences and possible depressive symptomatology related to binge-watching should be further explored as well. Also, it has been shown that the more time people spend binge-watching series online, the more likely they are to keep on binge-watching subsequently (Panda & Pandey, 2017). Thus, people engaging in binge-watching may get addicted to it, with high watching behavior leading to a vicious cycle of continuing to watch (Panda & Pandey, 2017).

The systematic literature review by Flayelle et al. (2020) found mixed results on the actual relation between binge-watching and well-being. Besides binge-watching being related to higher levels of enjoyment, autonomy, as well as user satisfaction, and harmonious passion, the review emphasized that heavy binge-watchers may, however, indeed experience symptoms of anxiety, depression, and addiction-like symptoms. Thus, binge-watching may be especially pleasing in the light of associated emotional outcomes in the short term. However, despite the immediate positive emotional consequences, binge-watching has been shown to elevate several depressive symptoms over time (Flayelle et al., 2020). Thereby, it constitutes a highly complex phenomenon with two different manifestations. Firstly, a rewarding and pleasurable experience that may distract from current issues and leads to feelings of happiness, and secondly, an excessive and problematic behavior that may be associated with

several negative effects on the viewer's mental status (Flayelle et al., 2020). While binge-watchers generally showed higher levels of depression than non-binge watchers (Ahmed, 2017) and other findings underline the notion that binge-watching leads to depressive-like symptoms in college students (Vaterlaus et al., 2018), it was also discovered that regret was associated with a higher watching pattern (Walton-Pattison et al., 2016).

Along with finding a relation between binge-watching and depression, a range of risk factors have been associated with the dysfunctional use of video-on-demand streaming services. A younger age, underlying coping motives, as well as high levels of impulsivity, are found to be associated with the user´s watching behavior (Flayelle et al., 2020). It can thus be assumed that a wide variety of characteristics may sensitize individuals to engage in higher levels of VoD-watching behavior.

Gender as a Predictor for VoD-Watching Behavior

Besides age, coping strategies, and personality, recent research on the topic of binge-watching demonstrates a wide variety of results in gender predicting a user´s watching behavior. In a study conducted by Merrill, and Rubenking in 2019, females were more likely to watch for longer periods. Those findings were in line with other studies investigating gender and binge-watching behavior. Females were found to report higher loss of control and time while watching VoD services (Steins-Loeber, Reiter, Averbeck, Harbarth, & Brand, 2020), which supports the idea of females watching for longer amounts of time. This suggests possible gender differences in becoming more sensitive to the development of maladaptive behavior patterns of VoD-watching. Additionally, the female gender was found to be an indicator of negative consequences from binge-watching (Steins-Loeber, Reiter, Averbeck, Harbarth, & Brand, 2020). Also, females demonstrated higher levels of depression and loneliness among a binge-watching sample (Ahmed, 2017). With high watching behavior leading to a vicious cycle of continuing to watch (Panda & Pandey, 2017), females tended to watch more hours when feeling depressed (Ahmed, 2017).

Besides several studies that found an association between female gender and engagement in binge-watching in terms of frequency and intensity of viewing, however, the literature review by Flayelle et al. (2020) also found several contradicting results. According to Flayelle et al. (2020), several studies found no gender effect on participant's binge-watching behavior or it was found that binge-watching sessions lasted longer among male participants compared to females. Thus, previous studies provide no clear insight into the role of participants' gender in the context of binge-watching and its relation to depression. Does the female gender indeed influence VoD-watching and lead to higher levels of depression?

Findings indicate that gender differences might affect the development of problematic watching behavior, however, no studies explored the association between binge-watching and depression while taking gender differences into account. Thus, further research is needed. A possible moderating effect of participants' gender on the association between depression and VoD-watching may give a precise picture of the impact of gender on the relationship between VoD-watching and depressive symptoms.

New Insights into Binge-Watching

Taking the discrepancies and inconsistencies among previous studies into account, there is a need to further investigate the rising phenomenon of binge-watching. Binge-watching is thought to be a rather multifaceted concept that may have several individual predictors as well as potentially problematic consequences for mental health. Binge-watching remains an ill-defined construct with a lack of comparability of the research data and results. There is a strong need in research to be able to distinguish healthy watching behavior from problematic binge-watching behavior and an evidence-based definition is needed (Flayelle et al., 2020). Until now, most of the research has focused on providing a theoretical definition. Exploring a more evidence-based cutoff score for problematic binge-watching would lead to a clear formulation of the novel problem. Thereby, unnecessary pathologizing of the highly popular activity can be avoided and an idea is given as to from which point binge-watching may become hazardous, thus distinguishing unproblematic and problematic involvement (Flayelle et al., 2020).

Since most of the research concerning binge-watching has been focused on cross-sectional studies, another way of looking at this behavior pattern needs to be found (Wheeler, 2015). Cross-sectional studies constitute a suitable type of research to identify many outcomes and risk factors associated with binge-watching (Levin, 2006). However, they are limited to the fact that cross-sectional studies are only carried out at one point, asking about feelings of a retrospective period and not the momentary state of feelings. Thus, findings on binge-watching of cross-sectional studies give no insight into the temporal effects of the variables and may provide different results if another time frame had been chosen (Levin, 2006). Additionally, recall bias is one of the consequences of the retrospective assessments in cross-sectional studies (Raphael, 1987). Participants may incorrectly recall or report their level of feelings and the number of hours watched. Further, cross-sectional study designs are limited to between-person processes and do not allow investigation of within-person associations (Hoffman, & Stawski, 2009). Thereby, ecological fallacy might lead to failure in reasoning, by making inferences about individuals based on aggregated group-level data.

Taking within-person associations into account would therefore benefit the overall study design and may demonstrate how the relationship between variables is on an individual level (Myin-Germeys, et al., 2018).

Therefore, research on binge-watching should focus more on longitudinal and experimental research designs (Wheeler, 2015). The current study attempts to solve some of the problems previous studies were confronted with utilizing the experience sampling method (ESM) as a means of data collection. ESM is a methodology that confronts participants with repeated measures of behaviors and feelings over a given period while allowing them to function within their natural setting (Scollon, Prieto, & Diener, 2009). The longitudinal nature of ESM data enables researchers to get an insight into the possibility of lagged analyses (Wheeler, 2015). Thereby, it is possible to observe how depressive symptoms and VoD-watching behavior are associated over time. As research has shown that feelings of guilt and depression may rise after repeated exposure to entertaining media content (Reinecke, Hartmann, & Ede, 2014), a negative association between both variables might grow after considering a time lag. Thus, repeated VoD-watching of one day may evoke feelings of depression after several days.

Another advantage of ESM is the possibility of investigating within-person processes to get individual data insight and examine how a relationship between variables proceeds for specific individuals (Scollon, Prieto, & Diener, 2009). Studying specific individuals over time may give context- and individual-specific feedback and allows for exploring detailed idiographic information (Bringmann, Wichers, Riese, & Stulp, 2020). Thereby, possibly revealing patterns that may have been masked at mean levels (Scollon, Prieto, & Diener, 2009). Additionally, making use of the N-of-1 case analyses method to describe the occurring changes in the behavior pattern of VoD-watching over time in one individual, shortcomings of group-level analyses would be tackled as well. As the models analyzing data at the group level address all participants on one regression line, the N-of-1 study of one case might provide a different picture as it only makes up a regression line for one participant. Therefore, results might be different from the general group-level results. Associations between depression and binge-watching that have been found on a group level by previous studies might diminish or strengthen on an individual level (e.g., Flayelle et al., 2020). So far, N-of-1 methods remain an underused and neglected area of research in health and behavioral psychology. Despite relying on a sample of one participant, the statistical power of this method is a function of the sample size of the repeated measurements taken from that same

individual over time. Therefore, providing a powerful statistical technique in detecting associations (McDonald, Vieira, & Johnston, 2020).

Thereby, the study aims to explore the relationship between binge-watching behavior and the psychological variable of depression overtime on a group and individual level. Further, the study attempts to produce a detailed understanding of the potentially negative association and possible moderating effects of gender on this behavior pattern. Besides, it provides a possible investigation into the within-person process as well as the temporal relation

Current Research

Several studies have shown that binge-watching as media entertainment is a rising phenomenon that is yet not fully understood. To be able to better understand it as well as to gain an insight into the potentially negative associations of this type of watching behavior and user's mental well-being, further research is needed (Flayelle et al., 2020). The central aim of the present paper is thus to provide a differentiated picture of the association between binge-watching and depressive symptoms over time. Thereby, the study contributes to previous research by exploring the following research question: *Is more VoD-watching behavior associated with more depressive symptoms within individuals over time?* Providing a more detailed picture of this association, the current study additionally explores the potential moderating effects of participants' gender by examining the first subquestion: *Is the association between VoD-watching and depressive symptoms moderated by participants' gender?* Secondly, the temporal effects of VoD-watching on depressive symptomatology will be investigated employing a second subquestion: *Is there a temporal association between VoD-watching and depressive symptoms?*

Methods

Design and Participants

The present study constitutes a post-hoc analysis of the data collected by Buschmeyer (2020), Erker (2020), and Lehmkühler (2020) at the department of Positive Psychology and Technology at the University of Twente. The study used a two-week longitudinal experience sampling method (ESM) design, using interval contingent sampling to collect repeated measures on respondents' VoD watching behavior, as well as momentary depressive symptoms. For this, questionnaires were presented to the participants repeatedly in predetermined time slots. Further, a single questionnaire survey design was employed to obtain the students' demographic data at the start of the study. For data collection, Ethica Data

was used, a platform that provides an end-to-end research platform enabling researchers to quantitatively measure respondents' behaviors and feelings utilizing a smartphone app (Ethica Data, 2020).

Participants were recruited through convenience sampling in the researchers' social environments and contacted via different social networks. Additionally, researchers distributed the recruitment message on their social media platforms. Participation in this study was voluntary and participants confirmed their informed consent online after being informed about the study in general as well as their right to withdraw at any time. The Ethics Committee of the University of Twente gave ethical approval for the study.

The inclusion criteria for the participants required the respondents to be over the age of 18, to have a good English proficiency, and to own and be able to use a smartphone with the Ethica mobile application (version 157). A sample with the majority of participants ranging between the age of 18 to 30 years old was desired, as VoD watching was found to be most popular in this age group (Ahmed, 2017; Exelsmans & Van den Bulck, 2017; Flayelle et al., 2020). In total, 41 participants were recruited, of which 4 participants were excluded from the analysis due to a high number of missed or expired survey sessions. This was based on Conner and Lehman (2012), who stated that participants with a response rate below 40% of the surveys should be excluded. The relatively small sample size is in line with typical ESM research as a literature review by van Berkel, Ferreira, and Kostakos (2017) showed that ESM studies generally contain a much smaller sample size than cross-sectional studies with a median number of 19 participants in a variety of ESM studies. The reliability of ESM research is assumed by the high number of measurements and not the number of participants, therefore smaller sample sizes are acceptable. With the median sample size of 19 participants being in line with the standards of the HCI (Human-Computer Interactions) community, power analysis becomes redundant to determine the sample size for novel ESM studies (van Berkel, Ferreira, & Kostakos, 2017). Therefore, the sample size of around 40 participants was considered suitable.

Materials

During the study, three different types of questionnaires were distributed among the participants. First, the demographic data of the participants were collected through a one-time baseline questionnaire. Secondly, a once-daily behavior assessment in the morning and third two-daily state assessments, one in the morning and one in the evening, were distributed among the participants. All measurements were in English and assessed by the mobile application app Ethica Data. The full questionnaires can be found in the appendices.

Demographics questionnaire

Through the demographic's questionnaire, the gender, age, nationality, and occupation of the participants were assessed. Additionally, information about the participant's VoD watching behavior, in general, was gathered. Here, it was for example asked whether they were using streaming services and if so, which ones.

Behavior assessment

The daily behavior assessment included several questions concerning the participant's VoD watching the behavior of the day before and was distributed to the participants in the morning. It was asked whether the participant had indeed watched something on a VoD platform such as Netflix. For this the question of "Did you watch a series on a video-on-demand platform such as Netflix or Amazon Prime Video yesterday?" provided a dichotomous answer possibility, where "No" led to the end of the survey session and "Yes" enabled the following items. A question concerning the time of day when participants engaged in the video streaming website was addressed. Also, the type of content (e.g., comedy, documentary, action), the reason for watching (e.g., entertainment, boredom, curiosity), and whether participants watched alone or with someone were asked. Additionally, the number of hours invested in watching videos on demand was considered. Using an up/down key to indicate the hourly watching time, participants were able to select their watching time in quarter hours. To measure the time spent watching online, the question of "Did you watch for more than 1 hour?" with the answer possibilities "Yes" and "No", and "Please indicate how many episodes you watched. If you watched more than 20 episodes, choose 21" were used in the behavioral assessment. Answers were given in 0.5 intervals.

State Assessment

The daily state assessment was provided twice a day and included several questions concerning the mood of the participants, focusing on depressive symptoms. It was chosen to measure participants on five depressive symptoms rather than depression in general to get a more detailed and specific image of the impact of BW on mental well-being. Therefore, five symptoms of depression from the diagnostic criteria for a depressive disorder from the DSM Manual (American Psychiatric Association, 2013) which were found to be correlated with BW in previous research, were the basis for the measurement items. The symptoms found to be correlated with BW through previous research were low mood, guilt (Flayelle et al., 2020), fatigue/low energy, sleeping problems (Exelmans & Van den Bulck, 2017), and concentration problems (Kavyashree et al., 2013; Schoeni et al., 2016). Therefore, the item “Please indicate to what extent you experienced the following feelings within the past hour.” was established,

measuring the extent of participants 1. mood 2. energy/fatigue 3. feelings of guilt 4. problems with concentration, and 5. sleeping problems during the last night. However, the item on sleeping problems was only asked in the morning measurement, as it did not seem to be of importance in the evening. All the items were constructed by the researchers and could be answered utilizing a 5-point-Likert scale (Not at all, Slightly, Moderately, Strongly, Extremely). The items measuring depression symptoms showed high internal consistency with a Cronbach's alpha of α=.828. Thus, the depression scores of the morning, as well as evening assessment, were calculated by summing up the respective items. The mean of both variables of depression was computed and addressed as the outcome variable of daily state depression for all analyses.

Procedure

The study took place over the course of two weeks, starting on the 9th of April and ending on the 22nd of April 2020, and thereby consisted of 14 potential measurements of watching behavior and 28 state measurements of depressive symptoms. Research has shown that this length seems to be a suitable duration for an experience sampling research topic, allowing a good connection and comparison of the data between days (Conner & Lehman, 2012). Employing this time frame, it was possible to obtain a detailed insight into the personal VoD watching routines of the participants.

Before the data collection started, participants were provided with general information about the upcoming study and presented with a guide through the following activities. On the starting day of data collection, participants were invited through Ethica and asked to begin the survey on the same day. After downloading and registering in the Ethica app, participants were asked to provide their informed consent, thereby agreeing to the requirements of participation, and asked to provide their demographic data. For each day three time frames were set when the participants received a signal to complete the measurements. The behavior assessment was randomly distributed once a day between 10 a.m. and 10:30 a.m. and disappeared after 10 hours. To avoid memory bias, the participants were presented with the items early each day. An in-app notification was sent to the participants 90 minutes later if the questionnaire was not completed already. The state assessment was measured twice a day, first around noon between 11 a.m. and 1 p.m. and second in the evening between 7 p.m. and 9 p.m. To generate a more accurate assessment of participants' feelings over the day, the state observations were gathered at two different time points, as recommended by Conner and Lehman (2012). A notification was provided after 30 minutes in case the questions were not completed at first. Finally, at the end of the study, participants were thanked for their

participation and welcomed to contact the researchers for further questions about the study and its results.

Data Analysis

For all statistical analyses, SPSS version 26.0 and 2-tailed tests with a significance level < 0.05 were used. Excel was used for graphical illustrations of the results. Prior to the analyses, the data needed to be prepared accordingly, and the three datasets were merged into one dataset suitable for statistical analyses. The dataset was presented in long format and included the demographics questionnaire as well as the behavior and state assessments. Descriptive statistics were used to present the participant's demographic data.

Considering the longitudinal nature of the ESM data, multiple linear mixed model (LMM) analyses were conducted using an autoregressive covariance structure (AR1) to explore the associations between VoD watching and depression at the group level (Verhagen, Hasmi, Drukker, van Os & Delespaul, 2016). For the variable of state depression and the variable of number of VoD-hours watched, z-scores were computed to obtain standardized estimates. Thereby allowing a comparison of the research results, the group-level analyses were conducted using the standardized scores. To examine the main research question, namely whether participants' VoD watching behavior is associated with depressive symptoms over time, a multilevel linear mixed model analysis was performed. State depression was included as a dependent variable and the number of VoD-hours watched as a fixed covariate in the model.

As the longitudinal nature of the data allows for further information about both between-person and within-person effects in participants over time, both types of associations between VoD watching and depression were considered during the analysis (Curran & Bauer, 2011). For this, person means (PM), and person mean-centered scores (PMC) were calculated for the independent variable of the number of VoD hours watched. PM scores were gathered by calculating the average number of VoD hours watched for each participant, thereby providing a mean of the individuals watching time of the different time points. PMC scores were determined by subtracting the PM score from each daily measure of VoD hours watched. Thus, demonstrating a momentary deviation in the participants' watching hours and showing how much more or fewer hours a participant may have watched at that specific time point. To examine whether the relationship between depression and the numbers of VoD-hours watched was a momentary (within-person) or a general (between-person) one, a multilevel linear model analysis was performed with state depression as a dependent variable.

The PMC (within-person) score and PM score (between-person) for VoD-hours watched were included as fixed covariates.

To explore this association further and answer the first subquestion of the research, the moderating effects of participants' gender were taken into account. For this, an additional LMM analysis was conducted including gender as a fixed covariate. Next, The data was split by participants' gender to obtain the estimates of the effects of this association.

Answering the second sub-research question by obtaining insight into the delayed temporal nature of this association (e.g., Are more watched VoD-hours associated with higher levels of state depression the second next day, the third or fourth next day?), lagged LMM analyses were conducted. A lagged variable of the number of VoD-hours watched was created including a lag of one, two, and three. As the non-lagged variable of VoD-hours watched of the dataset was already about the association with depression the next day, a lag value of 1 would describe the association between VoD-hours watched and the level of state depression of the second next day. Lag value 2 would describe the association between VoD-hours watched with the level of state depression of the third next day and a lag value of 3 would demonstrate the association between VoD-hours watched with the level of state depression of the fourth next day. LMM analyses were conducted using state depression as a dependent variable and the respective lagged variable of VoD-hours watched as a fixed covariate in the model.

Finally, to obtain insight into the association between VoD watching and state depression in an individual over time, dynamic regression modeling to analyze N-of-1 observational data was conducted in SPSS by following the 10-step procedure of McDonald, Vieira & Johnston (2020). This type of N-of-1 observational study provides an opportunity to examine the relationship between depression and VoD-hours watched for four participants on an individual level. This statistical method is a powerful tool available for the analysis of N-of-1 data that provides an opportunity to identify temporal relationships between variables due to the time-ordered nature of the data. Dynamic regression modeling to analyze N-of-1 observational data provides an approachable procedure that not only accounts for the autocorrelation in the data but also incorporates time-trends and periodicity in the model and is well suited for small sample sizes (McDonald, Vieira & Johnston, 2020). By means of this, it exceeds the merely visual exploration of individual data. Such quantitative procedures demonstrate more consistency over visual inspection as two judges will produce the same results with identical analyses. Additionally, the accuracy in detecting small but reliable effects is heightened compared to visual inspection (Ottenbacher, 1992). Thus, the use of this

method may give new insights on the association between VoD-watching and depression in individuals that earlier research, solely conducting a visual inspection of N-of-1 data, could not provide.

The steps outlined in the tutorial were followed individually for four participants of the study. The four participants were chosen by their score on the variable of number of VoD-hours watched. As individuals may feel depressed after great and repeated exposure to entertaining media content (Reinecke, Hartmann & Eden, 2014), the individuals with the two highest values of VoD-hours watched were compared to the two with the lowest scores of VoD-hours watched. Following the steps by McDonald, Vieira & Johnston (2020) missing data was identified and imputed, variation in the outcome variable was investigated visually using time plots and data was explored for time trends and periodicity. Next, the autocorrelation structure was identified and used to create lagged variables. Dynamic regression analysis was conducted for each participant to identify whether a significant relationship exists between VoD-hours watched and state depression, including the lagged variables, predictors, and taking into account autocorrelation. Additional information on the different steps taken in the process and preliminary analyses leading to the dynamic regression analysis are presented in Appendix E.

Results

Descriptive Statistics

Overall, the data of 37 participants were eligible for statistical analyses. The age of the sample ranged from 18 to 51 years, with a mean age of 23 years (*SD* = 5.3). In line with the expectations of the desired sample, the majority (97.3 %) of participants' age ranged between 18 to 30 years. 43.5% of the participants identified as female, whereas 56.5% identified as male, leaving a fairly even distribution among gender. The majority of individuals were German (91.9%), while 2.4% were Dutch and 5.4% of participants indicated another nationality. Slightly over half of the participants taking part in the study were students (54%), whereas the rest mostly indicated either full time-employment (21.7%) or apprentice (5.4%).

Descriptive data on the outcome measure of state depression demonstrate a relatively low mean score of 1.53 *(SD = 0.55)* over all repeated assessments as scores ranged from 1 to 5 on the Likert scale. Additionally, a visual inspection of the variable of state depression showed very limited variation over time (see Fig. 1). In contrast, participants showed a higher mean number of VoD-hours watched with 2.3 *(SD = 2.04)* and good variability in average

watching hours (see Fig. 1). Watching hours of individual participants ranged from 0 to 14 hours over the different time points.

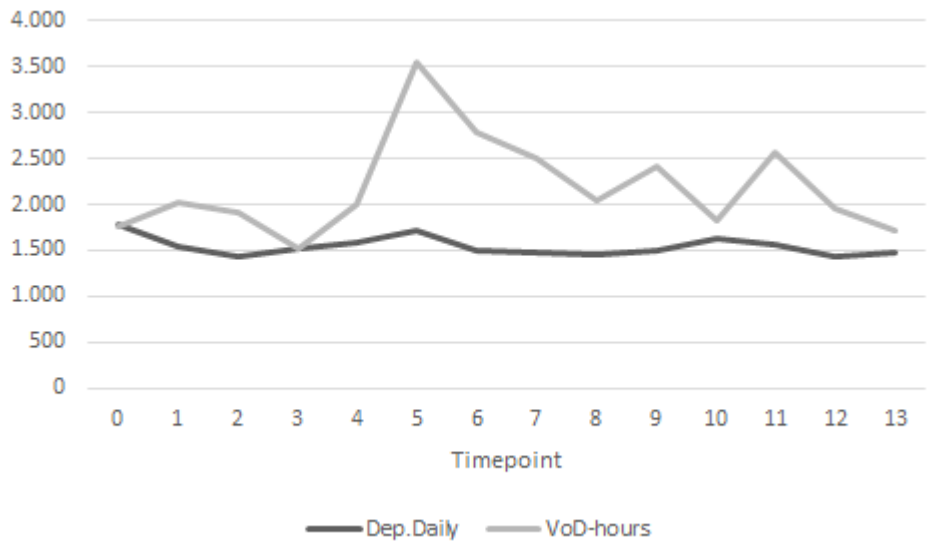

Figure 1.*: Means of the Variables of State Depression and VoD-hours watched overtime points.*

The relation between Depression and VoD-watching

The first research question explored the association between the number of VoD-hours participants watched and their level of depressive symptoms. A linear mixed model analysis, including state depression and the number of VoD-hours watched, did not show significant results (F (1, 251.189) = 1.111, β = -.054, *SE* = .051, *p* = .293). Therefore, despite earlier predictions, in this study, no linear association between VoD-hours and depression was found at the group level.

Further exploring the association between state depression and the number of VoD-hours watched, the between-person (PM) and within-person differences (PMC) were considered. It was found that neither the PM number of VoD-hours watched (F (1,48.44) = .014, β = -.012, *SE* = .09, *95%* CI [-.21; .19], *p* = *.907*) nor the PMC scores (F (1,196.04) = .048, β = .011, *SE* = .052, *95%* CI [-.11; .09], *p* = *.826*) of the VoD-hours watched significantly predicted state depression the next day. Therefore, state depression and the number of VoD-hours watched were not associated at either the between-person or within-person level.

Gender Differences in the Relation between Depression and VoD-watching

A LMM analysis conducted between state depression and the number of VoD-hours watched, while investigating the moderating effects of the gender of participants, produced

significant results. The interaction term gender × numbers of VoD-hours watched turned out to be statistically significant (F (1,259.14) = 4.43, β = .216, *SE* = .102, *p = .036*). Thus, analyses revealed that the association between state depression and VoD-watching is moderated by participants' gender. More precisely, male participants experienced slightly lower state depression when watching more VoD-hours (β = -.03, *SE* = 1.01, *95%* CI [-2.67; 2.61]). In contrast, females experienced higher levels of state depression when watching more VoD-hours (β = .09, *SE* = .605, *95%* CI [-1.35; 1.53]). Participant's gender has a very weak moderating effect on the association between VoD-hours watched and state depression, with the effect of the female gender being slightly stronger.

Delayed Temporal Dynamics of VoD-watching on Depression

Exploring the possible temporal effects of the number of VoD-hours watched on state depression up until four days after the VoD watching, lagged LMM analyses were conducted. First, investigating the lag value of one, the number of VoD-hours watched of one day had no significant effects on state depression of the second next day (F (1,232.80) = .232, β = -.023, *SE* = .049, *p = .630*). Further analysis including a lag value two, did not yield significant results (F (1,232.74) = .002*,* β = .002, *SE* = .054, *p = .965)* whereas a lagged LMM analysis with a lag-value of three also did not demonstrate significant results (F (1, 230.72) = .813, β = -.052, *SE* = .058, *p = .368).* Therefore, the number of VoD-hours watched a day has no significant association with state depression of the following four days.

N-of-1 Study for Individual Case Exploration

As a final step, dynamic regression modeling to analyze N-of-1 observational data was conducted to obtain insight into the association between state depression and VoD-hours watched in an individual over time. For participant A, a lagged outcome variable of state depression was entered into the regression model along with the predictor variable of VoD-hours watched and the variable of time trends. Thereby identifying whether a significant relationship exists between the predictor and the outcome variable while accounting for any autocorrelation. Results demonstrate no significant relationship between both variables for participant A (see table 4.). The number of VoD-hours watched of participant A did not predict a higher level of state depression for this person. For participants B and D similar regression analyses were conducted, including the outcome variable of state depression and the predictor variable of the number of VoD-hours watched. Both regression models reveal non-significant results (see table 4.). The number of VoD-hours watched for both participants did not predict a greater level of state depression. Lastly, regression analysis for participant C, including the outcome variable of state depression and the predictor variable of number of

VoD-hours watched revealed no significant results while controlling for a lagged predictor variable (see table 4.). Participant C also did not show higher levels of state depression after an extended number of VoD-hours watched. Exploring individual cases of the sample in the light of VoD-watching behavior on state depression, no significant linear association within any of the cases could be found. The number of VoD-hours watched of the four participants had no significant relation to participants' state depression.

Table 1.

Dynamic Regression Analyses Summary for Number of VoD-hours watched predicting State Depression.

Participant	Variable	B	95% CI	β	t	p
A	VoD-hours	.606	[-.415, .535]	.066	.779	.779
B	VoD-hours	.065	[-.151, .282]	.196	.520	.665
C	VoD-hours	.019	[-.315, .354]	.067	.893	.140
D	VoD-hours	-.029	[-.069, .010]	-.441	-1.630	.131

CI = confidence interval for B

Discussion

The purpose of this study was to explore the association between VoD-watching behavior and depressive symptomatology, by investigating temporal effects and moderating effects of participants' gender. More precisely, it was investigated whether a higher number of VoD-hours watched is associated with higher levels of depressive symptoms at the group and individual levels. The current research produced three key findings. First, the results of the study provide no evidence for a temporal association between the number of VoD-hours watched and depressive symptomatology at the group and individual levels. Second, the study demonstrated a significant moderating effect of participants' gender on the relationship between state depression and VoD-watching, with female participants experiencing slightly more state depression when watching more VoD-hours. Third, no delayed temporal effects of

this association could be found, demonstrating that the type of watching behavior also does not have a delayed effect on participants' later state of depression.

Depression and VoD-watching

The findings of this study stand in contrast to most previous studies on VoD watching and depression, showing no overall significant temporal association. The current study was the first to also explore the between-person and within-person associations between state depression and the number of VoD-hours watched. Results of the study indicate that the association was not significant at either the between-person or within-person level. Thereby providing additional evidence for the absence of an association. Previous research in the field demonstrated higher levels of depressive symptoms among binge-watchers than non-binge-watchers (Ahmed, 2017; Vaterlaus et al., 2018). On the one hand, depression was found to be positively related to instrumental and ritual television viewing as well as the frequency of watching. Thereby, participants high in depression also reported higher frequencies of engaging in binge-watching behavior (Wheeler, 2015). On the other hand, research by Tefertiller and Maxwell (2018) found no connection between depression and binge-watching. Overall, few previous studies investigated the association between VoD-watching hours and depression. Those studies exploring the association demonstrate inconsistent results and reveal no clear trends (Starosta, & Izydorczyk, 2020). Many previous studies confirmed the positive relation between binge-watching and indicators of mental well-being, such as perceived autonomy, harmonious passion, and enjoyment (Flayelle et.al., 2020). Thereby, these studies highlight binge-watching as a pleasurable experience that may lead to harmonious viewing engagement and fulfills various needs and desires (Flayelle et.al., 2020).

Discrepancies between the current study and previous studies may be due to the different nature of the assessment of depression. Whereas in the study by Wheeler (2015), the Center for Epidemiologic Studies Depression Scale (CES-D) was used, Ahmed (2017) assessed depression using the seven items of Mirowsky and Ross (1992), and the current study measured depression through five symptoms of depression from the diagnostic criteria for depressive disorder from the DSM Manual (American Psychiatric Association, 2013) Also, the overall low scores on the variable of state depression of the current study might have influenced the results and led to a non-significant association.

Previous studies have varied in their definition of what constitutes binge-watching and how many episodes or hours need to be watched accordingly. Thereby, directly focusing on the potential harmfulness of BW without exploring the specificity of the behavior. The review by Flayelle et al. (2020) demonstrates that definitions vary greatly which leads to a great

discrepancy in the prevalence rate of BW ranging from 44.6% to 98%. Thus, participants may easily be associated as binge-watchers in some studies, whereas not being defined as such in another. For example, in the study conducted by Ahmed in 2017, watching two or more hours or two episodes in a row was considered binge-watching. This demonstrates the low threshold for conceptualizing as the review by Flayelle et al. (2020) found broader-based operationalization by relying on watching a full season. This lack of a common definition is a major obstacle to the coherence and comparability of results. The current study enabled a broader image of the association by means of not classifying participants as binge-watchers or not before analyses. The findings of the current study could, however, not provide a data-driven cut-off for problematic VoD-watching behavior, as to when it may be considered binge-watching.

However, the discrepancies in findings between this study and previously conducted studies might also be due to the different nature of the methodological research designs. Most of the previous studies used a cross-sectional design which is generally more prone to recall bias (Granow et al., 2018). ESM studies in contrast reduce the memory bias of participants, by assessing the behavior as it naturally occurs repeatedly over time. Thus, accuracy and sensitivity to detect change are heightened. Participants are not prone to remember the self and how one felt, but rather are enabled to address the experiencing self. (Myin-Germeys et al., 2018; Verhagen, Hasmi, Drukker, van Os, & Delespaul, 2016). Verifying the occurrence of a recall bias, studies comparing retrospective studies with ESM assessments found that reported symptoms of depression were under- or over-estimated among participants in retrospective study designs (Ben-Zeev, & Young, 2010). Ben-Zeev and Young (2010) compared momentary reports to retrospective summaries among hospitalized depressed patients and nonclinical controls. Results revealed similar retrospective biases of both groups regarding their recall of experienced tension, difficulty concentrating, and guilt. Thereby, indicating that cross-sectional studies could suggest an association while the current ESM findings could not. Participants of previous cross-sectional studies on VoD-watching and depression may have incorrectly recalled their level of the measured variables. The current study thereby enabled a more precise and accurate picture of the momentary state of depression or watching behavior measuring possible data at the occurrence.

Gender Differences in the Association between VoD-watching and State Depression

Results of the study demonstrate a significant difference in the relationship between state depression and the number of VoD-hours watched between males and females. More precisely, female participants demonstrated slightly higher levels of state depression, whereas

males experienced slightly less state depression when watching more hours of VoD. Nonetheless, results were not found to be significant in either separate group. These findings support previous research showing the female gender to be a significant predictor regarding negative consequences of binge-watching with females being more prone to the development of problematic binge-watching behaviors (Steins-Loeber, Reiter, Averbeck, Harbarth, & Brand, 2020).

Despite the current study, no further studies focused on the moderating effects of gender on the relationship between state depression and VoD-watching. Therefore, the present study extends the research on the role of gender, highlighting the slightly negative moderating effect of female gender and possible positive influence of male gender on the association. In a study conducted by Merrill, and Rubenking in 2019, female participants were found to be more likely to watch for longer periods. In line with other studies investigating gender and binge-watching behavior, females were found to experience more loss of control while watching VoD services (Steins-Loeber, Reiter, Averbeck, Harbarth, & Brand, 2020). Those findings elicit the idea of females watching for longer amounts of time and thereby, highlighting gender differences in becoming more sensitive to the development of higher levels of state depression.

However, research has also shown that VoD-watching may be highly rewarding and pleasurable by fulfilling users' need for entertainment in one's free time (Flayelle et al., 2020). The current study underlines this notion and provides evidence for possible pleasing and beneficial effects of binge-watching on the individual's level of depressive symptoms. Binge-watching may rather be a rewarding and pleasurable experience leading to positive emotions, especially for males. Results by Flayelle et al. (2020) support the notion of binge-watching as a strategy to regulate negative and elicit positive emotions.

Temporal Association between VoD-watching and State Depression

In contrast to cross-sectional assessments, the present ESM allowed exploration of the temporal direction of the effect of VoD-hours watched and state depression. Lagged analyses indicated no delayed association of VoD-hours watched on state depression of the following four days. Research on cross-lagged associations between pathological gaming and mental health over time demonstrated a cross-lagged association between depression and pathological gaming (Krossbakken, et.al., 2018). Despite previous longitudinal studies demonstrating depression as a consequence of pathological gaming, the study by Krossbakken et.al. (2018), indicates that symptoms of depression predict pathological gaming. Results of this study highlight the possible negative aspects of online media consumption over time,

leading to higher levels of depression over time. The current study could not demonstrate a significant association, while solely considering lagged analyses. In contrast to the study by Krossbakken et.al. (2018) investigating the directional influence of both variables in order to examine a causal relationship, the current study only considered the delayed temporal association between state depression and VoD-hours watched. Also, it is suggested that researchers might bear in mind that excessive inclusion of lags leads to a decrease of degrees of freedom. Thereby making statistical inferences more unstable (Wooldridge, 2015).

Individual Case Exploration

Exploring individual cases of the sample in the light of VoD-watching behavior on state depression using the method of the N-of-1 study of McDonald, Vieira, and Johnston (2020), no significant relationship could be found either. Up until now, no research has been conducted regarding binge-watching and mental health using this type of analysis. The current study, therefore, enables insight into the individual case differences among this association that reaches beyond a mere visual inspection of the data. As the analysis provides a different picture by making a regression line for each participant, possible effects that may be masked at the group level and might diminish or strengthen on an individual level are investigated. Results of the individual analysis show similar results to the group-level findings and therefore underline the notion that there is no teporal association between state depression and the number of VoD-hours watched among this sample. Due to the novel nature of this investigation, only four participants of the sample were used for exploration. It may be possible that effects between VoD-watching behavior on state depression may arise when investigating different participants. Despite this, the chosen participants were good representatives of the sample and were found to have great variability in VoD-watching hours. The individuals with the two highest values of VoD-hours watched were compared to the two with the lowest scores as previous research suggests that individuals may feel depressed after great and repeated exposure to entertaining media content (Reinecke, Hartmann & Eden, 2014).

In general, the explorative nature of the current study adds a more detailed picture of the (non-) association between VoD-watching behavior and state depression to research. No significant association could be found between higher VoD-watching behavior and higher levels of state depression as suggested by previous research papers (Ahmed, 2017; Wheeler, 2015). Thereby, the current study highlights potential problematic over-pathologizing of this behavior pattern. The study clearly and thoroughly explored the relationship between state depression and VoD-watching behavior over time, by investigating between- and within-

person- effects and lagged associations on the group level. Findings were additionally supported by means of novel N-of-1-study analysis, providing new evidence on the individual level results of this association. Despite results showing that female participants demonstrated slightly higher levels of state depression, male participants did show lower levels of depression when watching more hours. Those findings underline the conclusion drawn by Flayelle et al., (2020), stating that binge-watching may not represent a single and similar behavior but rather a complex pattern that manifests itself in two ways. First, being a highly rewarding and pleasurable experience fulfilling people's desires and needs, and secondly, a possible excessive and problematic watching pattern that may lead to hazardous consequences for an individual's health (Flayelle et al., 2020). There is a strong need for a definition and operationalization of the binge-watching phenomenon and its related assessment (Flayelle et al., 2020). The recurring discrepancies among study findings lead to an ill-defined construct and an inability to compare research results. Thereby, creating a strong need for further investigation into this behavior pattern to achieve consistency in understanding. A distinction between high VoD-watching and problematic binge-watching should be further investigated to avoid over-pathologizing this common behavior (Flayelle et al., 2020).

Strength and Limitations

The current study contributes to the literature on the relation between VoD-watching and state depression, especially in the context of daily life. The first advantage of this study is the use of ESM as a research design. As previous research mainly focused on cross-sectional studies, the current study provides unique insights into the real-life experiences of both variables. Thereby, increasing the ecological validity as assessments are made in participants' daily life and naturally occurring experiences (Verhagen, et al., 2016). Additionally, the nature of the ESM design reduces recall bias because momentary constructs are assessed and behaviors, as well as feelings, do not rely on participants' memory (Myin-Germeys, et.al, 2018). Furthermore, the study method of ESM allows the investigation of within-person associations. Therefore, providing new insights into individual differences among binge-watching that previous cross-sectional studies could not give (Verhagen, et al., 2016).

Nevertheless, the study also has some limitations that need to be acknowledged. The overall low score on state depression may indicate rather sensitive items. This might explain the lack of association between VoD-watching and state depression as the average depression score might have been too low to detect a relation. As the study was conducted throughout the Covid-19 pandemic, this could be expected to have increased the depression score even more. Studying at home and decreased social interactions might have influenced both of the

measured variables. Additionally, all the analyses assumed linearity of the associations. As outliers might have influenced the linearity of the data, results need to be addressed with caution. Further, the sample and sample size could be improved. Due to the limited number of participants, the study may be underpowered, especially while considering the between-person analysis and analysis concerning the moderating effect of gender. When splitting the sample, the respective groups might have too limited participants, and the study a not sufficiently large sample size to answer the research question. Also, participants were mostly university students. As previous research suggests an influence of educational level on binge-watching, the confounding aspects of this demographic variable should be considered (Flayelle et al., 2020). A higher level of education may lead to lower risks of loss of control among binge-watching, as individuals may be more reflective of one's behavior pattern. On the contrary, the college campus context was found to facilitate the practice of binge-watching as it constitutes a social activity that could lead to making new friends (Vaterlaus, Spruance, Frantz, & Kruger, 2019). Thus, exploring binge-watching behavior among different educational levels might evoke different results. Finally, ESM studies may induce reactivity among participants as research suggests that participants report increased awareness during ESM data collection (Verhagen, et al., 2016). Indicating the measurement nature of the study, participants might have been more inclined to increase or reduce their time spent watching VoD-streaming services when being reminded.

Future Research

To address the limitations of the current study, future research should test the constructed items measuring state depression in a pilot study. Employing this, the validity and sensitivity of the items could be tested and improved. Further, research should investigate the association of both constructs in a different sample. Thereby, it would be interesting to see whether similar results would hold for lower educated samples, leading to improved prevention and possible therapeutic care. In addition, studies should replicate the current study with a larger sample size. As the current study might be underpowered, future research needs to focus on providing a sufficiently large sample size to answer the research question, especially regarding the moderating effect of participants' gender and the between-person analysis. Future research should focus on providing a common evidence-based definition of binge-watching. Thereby, it could be possible to differentiate unproblematic from problematic watching behavior and prevent over pathologizing. Lastly, ESM research would greatly benefit from additional N-of-1 observational data analyses. This powerful new statistical technique enables new insights into individual-centered studies and could help individuals

struggling with the negative consequences of binge-watching employing tailored and individualistic insights to promote well-being.

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Appendices

Appendix A

Demographics & General Information

Collect basic information about the participants.

Questions

1 (Q#2): Welcome to our study about VoD watching behaviour! Thank you for your time and support! Before the daily questionnaires start, we would like to get some basic information about you.

2 (Q#3) Please indicate your gender.

1) ○ Male
2) ○ Female
3) ○ Other (or do not wish to answer)

3 (Q#4): How old are you?

4 (Q#6): What is your nationality?

1) ○ Dutch
2) ○ German
3) ○ Other, European
4) ○ Other, non-European

5 (Q#11): Please indicate your current occupation.

5) ○ Pupil
6) ○ Student
7) ○ Apprentice
8) ○ Employed full-time
9) ○ Employed part-time
10) ○ Unemployed
11) ○ Other

6 (Q#7): As you were informed beforehand, we would like to investigate your video-on demand (VoD) watching behaviour. This does not mean linear television, but streaming platforms such as, for example, Netflix. The following questions are meant to explore your usage of these services to watch series, shows or/and movies.

7 (Q#8): Please mark the VoD streaming services that you usually use to watch series, shows, or/ and movies. Multiple answers are possible.

1) ○ Netflix

2) ○ Amazon Prime Video

3) ○ Hulu

4) ○ Disney+

5) ○ Maxdome

6) ○ Sky Home

7) ○ Youtube

8) ○ Other

8 (Q#9): Do you use one of these services at least once a week?

1) ○ Yes

2) ○ No

Appendix B

Behaviour Assessment

When and how much VoD.

Questions

1 (Q#22): Hey there! Now we'd like you to answer some questions concerning your video-on- demand watching behaviour.

2 (Q#13): Did you watch a series on a video-on-demand platform such as Netflix or Amazon Prime Video **yesterday**?

4) ○ Yes

5) ○ No

3 (Q#2): At what time of the day did you watch the series? Multiple answers are possible. For example: You watched from 6 p.m. until 11 p.m., mark evening and night. But: The times only serve approximate orientation. If you started watching at 5:55 p.m., for example, you do not have to mark *afternoon*.

1) ○ Morning (6 a.m. - 12 p.m.)

2) ○ Afternoon (12 p.m. - 6 p.m.)

3) ○ Evening (6 p.m. - 11 p.m.)

4) ○ Night (11 p.m. - 5 a.m.)

4 (Q#12): Did you watch for more than 1 hour?

1) ○ Yes

2) ○ No

5 (Q#26): Please indicate the number of hours you watched.

6 (Q#15): Please indicate how many episodes you watched. If you watched more than 20 episodes, choose *21.*

7 (Q#27): What type of content did you watch?

1) ○ Comedy

2) ○ Thriller

3) ○ Documentary

4) ○ Horror

5) ○ Action

6) ○ Drama

7) ○ Romance

8) ○ Adventure

9) ○ Animation

10) ○ Mystery

11) ○ Science-Fiction

12) ○ Fantasy

13) ○ Other

8 (Q#20): What was your reason for watching?

1) ○ Entertainment

2) ○ Boredom/nothing else to do

3) ○ Stress

4) ○ Interest/Curiosity

5) ○ Escape from reality/distraction

6) ○ Procrastination/Avoidance of other responsibilities

7) ○ Information seeking

8) ○ Peer activity (watching with friends/family)

9) ○ Relaxation/taking a break

9 (Q#28): In what kind of context did you watch?

1) ○ Alone

2) ○ With friends

3) ○ With family

4) ○ With partner

10 (Q#23): After that, did you feel guilty about watching?

1) ○ Yes

2) ○ Not at all.

11 (Q#29): To what extent did you feel guilty?

1) ○ Slightly guilty

2) ○ Moderately guilty

3) ○ Very guilty

4) ○ Extremely guilty

12 (Q#24): Please mark the reason for your guilty feeling.

1) ○ I watched more episodes or for a longer time than I wanted / planned to.

2) ○ I neglected other obligations that I should have fulfilled.

3) ○ I neglected other free-time activities that I wanted to pursue.

4) ○ I neglected bodily needs, for example sleep.

5) ○ I think that I wasted time or could have spent that time more

wisely/ useful.

6) ○ Other

13 (Q#30): Other:

Please explain why you felt guilty.

14 (Q#17): Thank you for answering the questions. See you later!

Appendix C

Morning State Assessment

Wellbeing, Stress, Guilt, Depression, Anxiety

Questions

1 (Q#7): Good Morning! We'd just like you to answer some questions about your recent moods and feelings. Have a nice day!

2 (Q#6): On a scale of 0 to 10, with 0 being no stress and 10 being the worst stress possible, what number best describes your level of stress **right now**?

3 (Q#22): Please indicate to what extent you experienced the following feelings within the past hour.

4 (Q#21): Low/sad mood

14) ○ Not at all

15) ○ Slightly

16) ○ Moderately

17) ○ Strongly

18) ○ Extremely

5 (Q#23): Low energy/fatigue

1) ○ Not at all

2) ○ Slightly

3) ○ Moderately

4) ○ Strongly

5) ○ Extremely

6 (Q#24): Feelings of guilt

1) ○ Not at all

2) ○ Slightly

3) ○ Moderately

4) ○ Strongly

5) ○ Extremely

7 (Q#25): Problems with concentration

1) ○ Not at all

2) ○ Slightly

3) ○ Moderately

4) ○ Strongly

5) ○ Extremely

8 (Q#26): Sleeping problems in the last night

1) ○ Not at all
2) ○ Slightly
3) ○ Moderately
4) ○ Strongly
5) ○ Extremely

Appendix D

Evening State Assessment

Wellbeing, Stress, Guilt, Depression, Anxiety

Questions

1 (Q#7): Hey! We'd again like you to answer a few questions concerning your current moods and feelings. Thank you!

2 (Q#6): On a scale of 0 to 10, with 0 being no stress and 10 being the worst stress possible, what number best describes your level of stress **right now**?

3 (Q#8): Please indicate to what extent you experienced the following feelings within the past hour.

4 (Q#17): Low/sad mood

19) ○ Not at all
20) ○ Slightly
21) ○ Moderately
22) ○ Strongly
23) ○ Extremely

5 (Q#18): Low energy/fatigue

6) ○ Not at all
7) ○ Slightly
8) ○ Moderately
9) ○ Strongly
10) ○ Extremely

6 (Q#19): Feelings of guilt

6) ○ Not at all
7) ○ Slightly
8) ○ Moderately
9) ○ Strongly
10) ○ Extremely

7 (Q#20): Problems with concentration

6) ○ Not at all
7) ○ Slightly
8) ○ Moderately
9) ○ Strongly
10) ○ Extremely

8 (Q#16): Next, there are some statements about feelings and thoughts. Please tick the box that best describes your experience of each **during the day**.

9 (Q#12): Today, how often have you felt nervous, anxious or on edge?

1) ○ Not at all
2) ○ Several times
3) ○ More than half of the day
4) ○ Nearly all day

10 (Q#13): Today, how often have you not been able to stop or control worrying?

1) ○ Not at all
2) ○ Several times
3) ○ More than half of the day
4) ○ Nearly all day

11 (Q#14): Today, how often have you felt down, depressed or hopeless?

1) ○ Not at all
2) ○ Several times
3) ○ More than half of the day
4) ○ Nearly all day

12 (Q#15): Today, how often did you have little interest or pleasure in doing things?

1) ○ Not at all
2) ○ Several times
3) ○ More than half of the day
4) ○ Nearly all day

13 (Q#22): Next, there are five statements that you may agree or disagree with. Please indicate your agreement with each item by choosing the answer that suits your agreement on the statement based on your **momentary feeling** the most. That means your answer should reflect how you feel about a particular statement **right now**. Please be open and honest.

14 (Q#23): In most ways my life is close to my ideal.

1) ○ Strongly disagree
2) ○ Disagree
3) ○ Slightly disagree
4) ○ Neither agree nor disagree
5) ○ Slightly agree
6) ○ Agree

7) ○ Strongly agree

15 (Q#27): The conditions of my life are excellent.

1) ○ Strongly disagree
2) ○ Disagree
3) ○ Slightly disagree
4) ○ Neither agree nor disagree
5) ○ Slightly agree
6) ○ Agree
7) ○ Strongly agree

16 (Q#26): I am satisfied with my life.

1) ○ Strongly disagree
2) ○ Disagree
3) ○ Slightly disagree
4) ○ Neither agree nor disagree
5) ○ Slightly agree
6) ○ Agree
7) ○ Strongly agree

17 (Q#25): So far, I have gotten the important things I want in life.

1) ○ Strongly disagree
2) ○ Disagree
3) ○ Slightly disagree
4) ○ Neither agree nor disagree
5) ○ Slightly agree
6) ○ Agree
7) ○ Strongly agree

18 (Q#24): If I could live my life over, I would change almost nothing.

1) ○ Strongly disagree
2) ○ Disagree
3) ○ Slightly disagree
4) ○ Neither agree nor disagree
5) ○ Slightly agree
6) ○ Agree
7) ○ Strongly agree

Appendix E

Preliminary Analyses of the N-of-1 Study

Missing Data Imputation

Investigating individual cases of the sample in the light of VOD-watching behavior on state depression, the method of N-of-1 study was used and the 10-step procedure of McDonald, Vieira & Johnston (2020) followed. First, missing data were identified and imputed for state depression and VOD-hours watched using the mean of the respective variable. Experiencing less than 10% missing data, according to McDonald, Vieira & Johnston (2020) a simple imputation rule would be sufficient. The descriptive statistics of the four participants on both variables can be seen in Table 1.

Table 1.

Minimum, maximum, means, and standard deviations for the four participants on state depression and VOD-hours watched.

Participant	Variable	Minimum	Maximum	M (SD)
A	State depression	1.35	3	2.14 (0.59)
	VOD-hours	0.25	2.5	1 (0.64)
B	State depression	1	1.93	1.45 (0.33)
	VOD-hours	1	5	2.63 (0.98)
C	State depression	2.15	3.4	2.58 (0.37)
	VOD-hours	0.75	6.75	2.95 (1.5)
D	State depression	1	1.78	1.43 (0.22)
	VOD-hours	0.75	12	4.88 (3.25)

Variability of the Data

Time plot graphs were produced to inspect the data of each participant visually. All four participants demonstrated overall sufficient variability in the data of both variables. Thus, providing the path for further exploration of the association between state depression and the number of VOD-hours watched on an individual level. Participant A demonstrated the greatest variability in state depression over the time points (Figure 1.), whereas participant D showed the highest variability on the number of VOD-hours watched (Figure 8.)

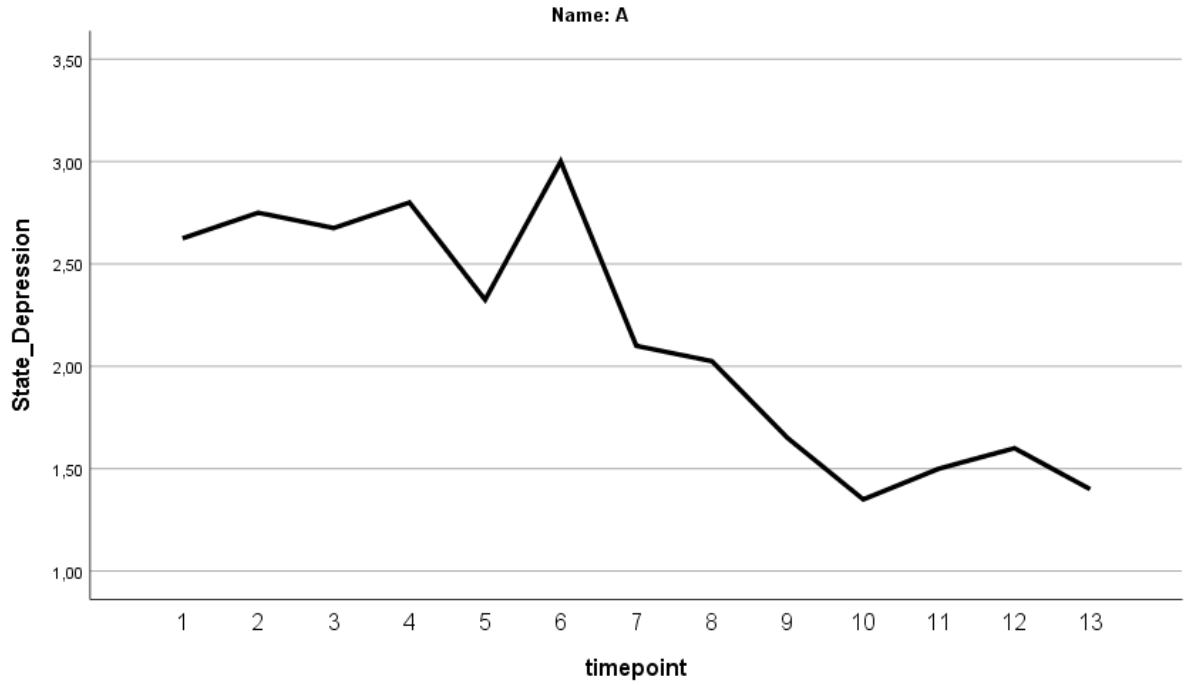

Figure 1. *Time plot demonstrating the variability of the variable state depression of participant A.*

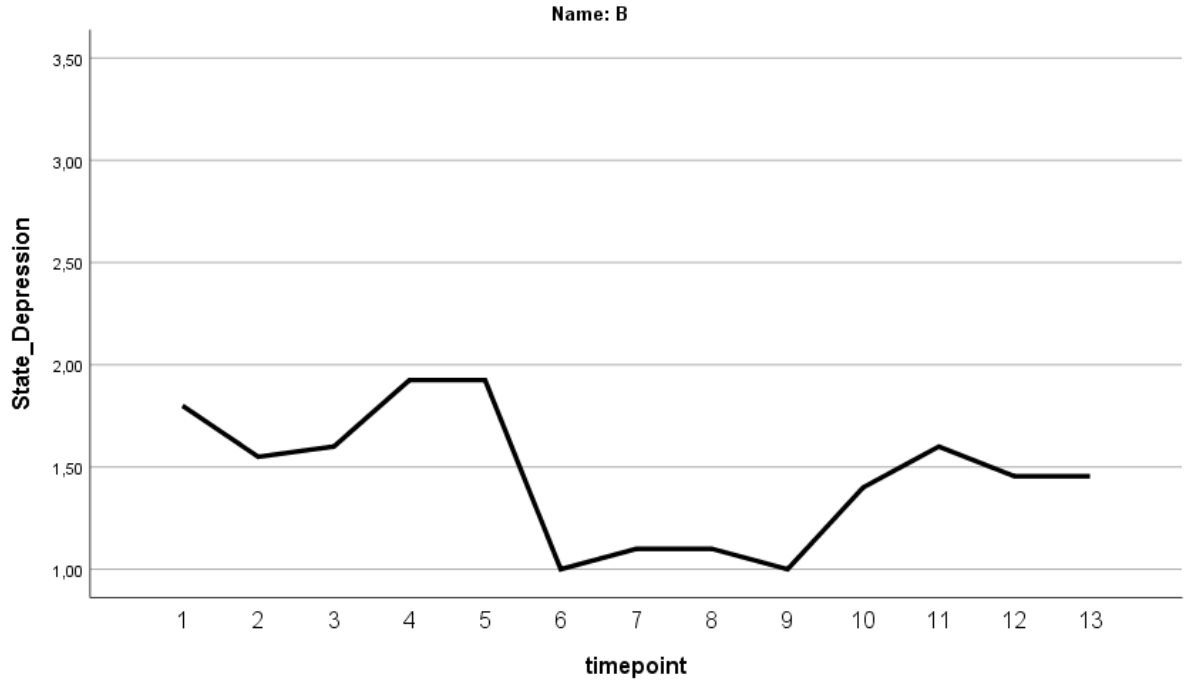

Figure 2. *Time plot demonstrating the variability of the variable state depression of participant B.*

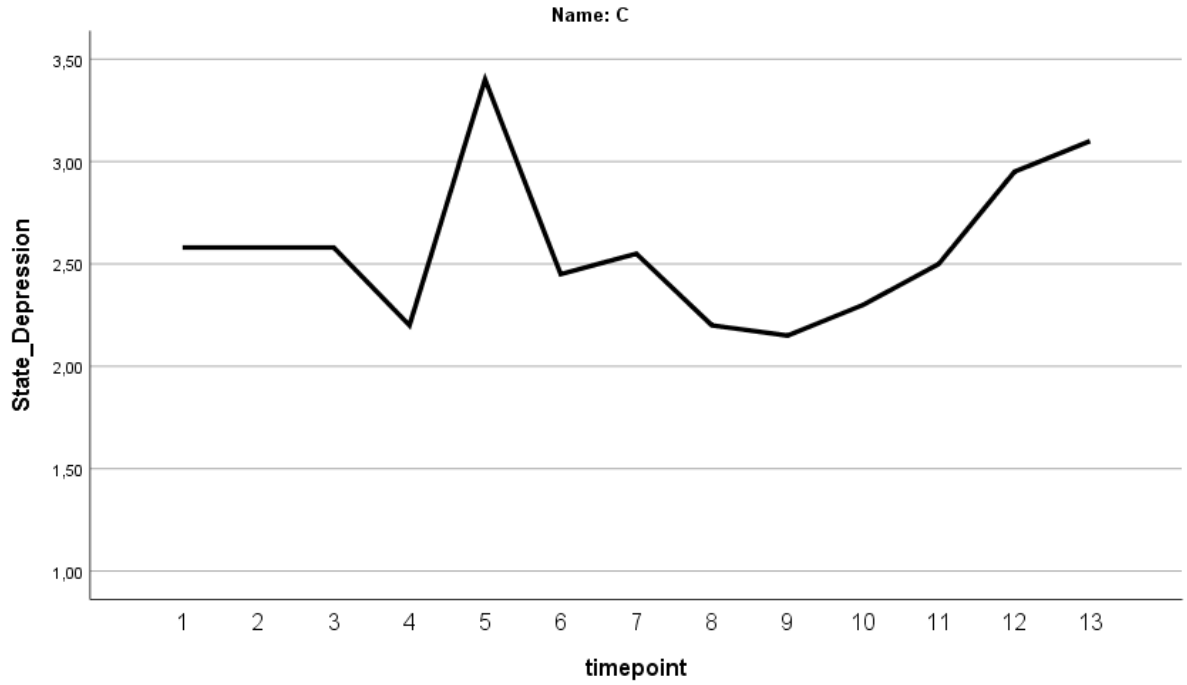

Figure 3. *Time plot demonstrating the variability of the variable state depression of participant C.*

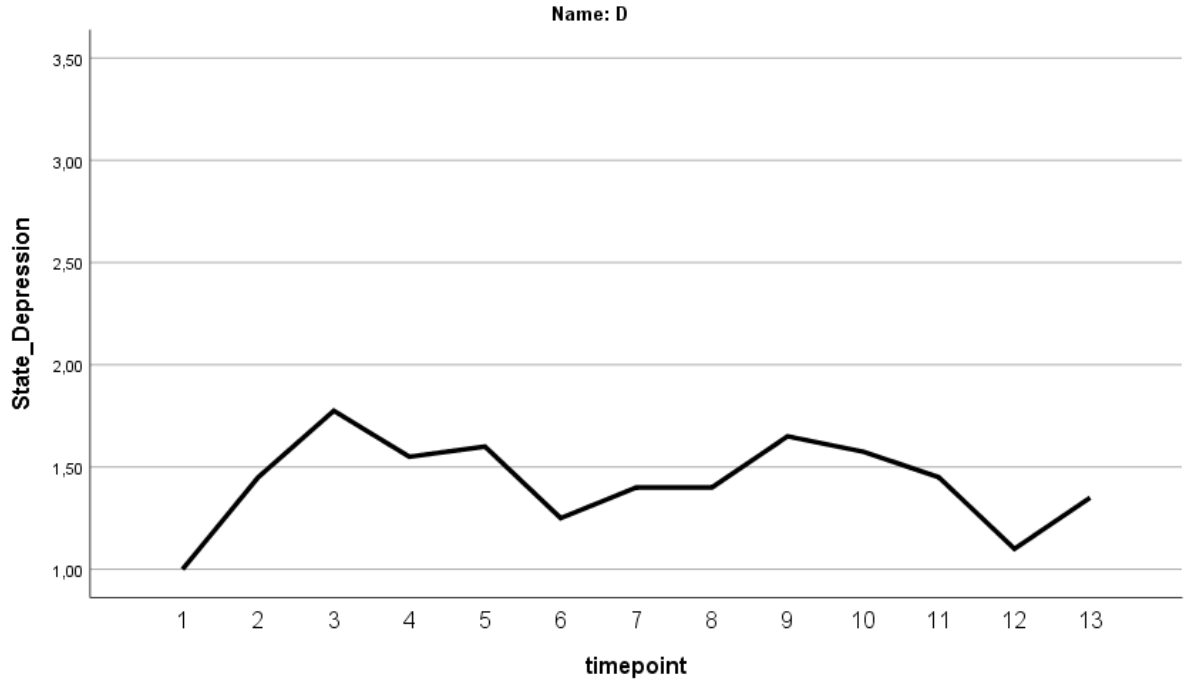

Figure 4. *Time plot demonstrating the variability of the variable state depression of participant D.*

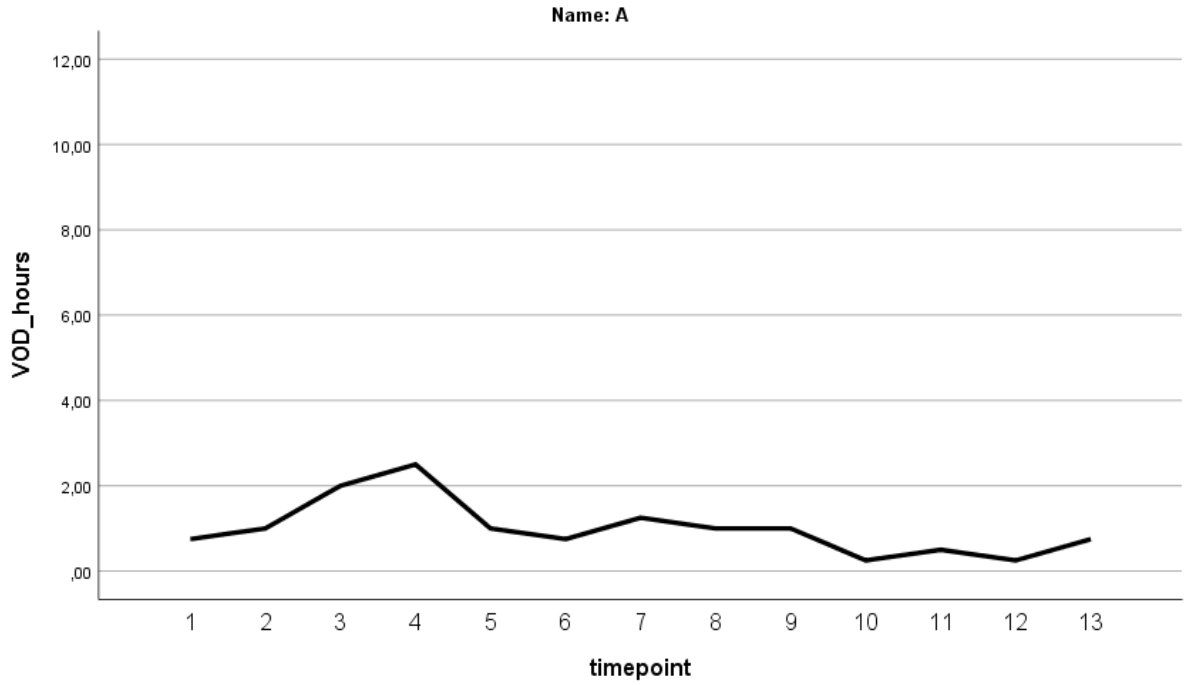

Figure 5. *Time plot demonstrating the variability of the variable of VOD-hours watched of participant A.*

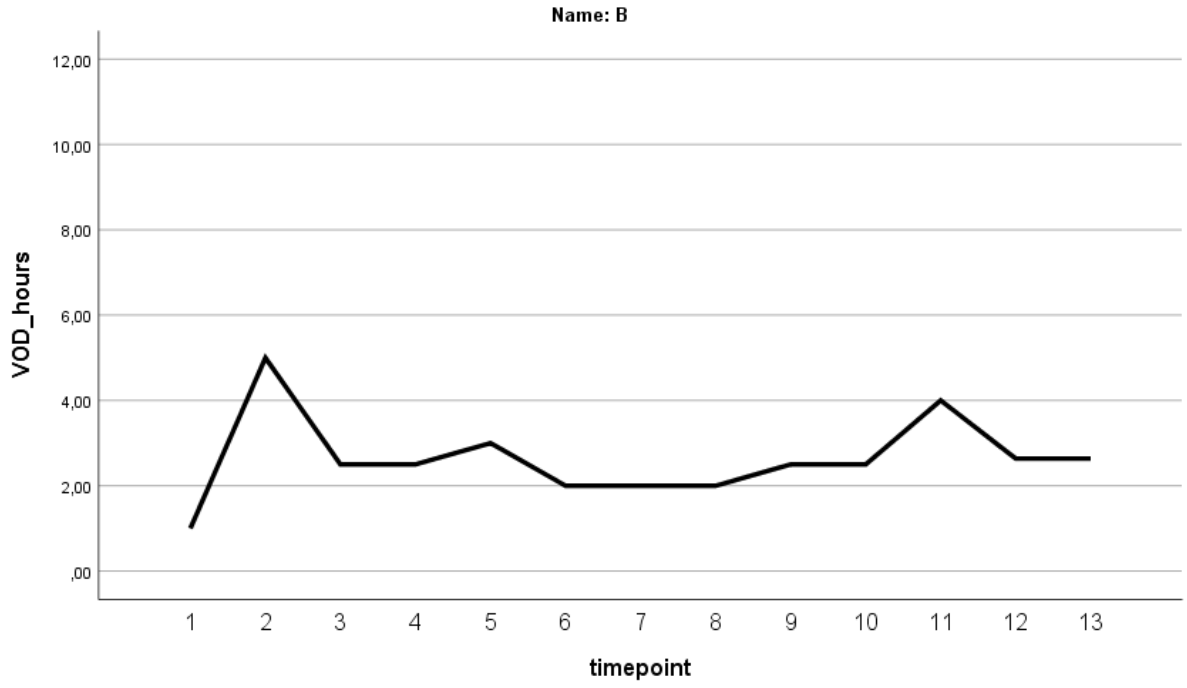

Figure 6. *Time plot demonstrating the variability of the variable of VOD-hours watched of participant B.*

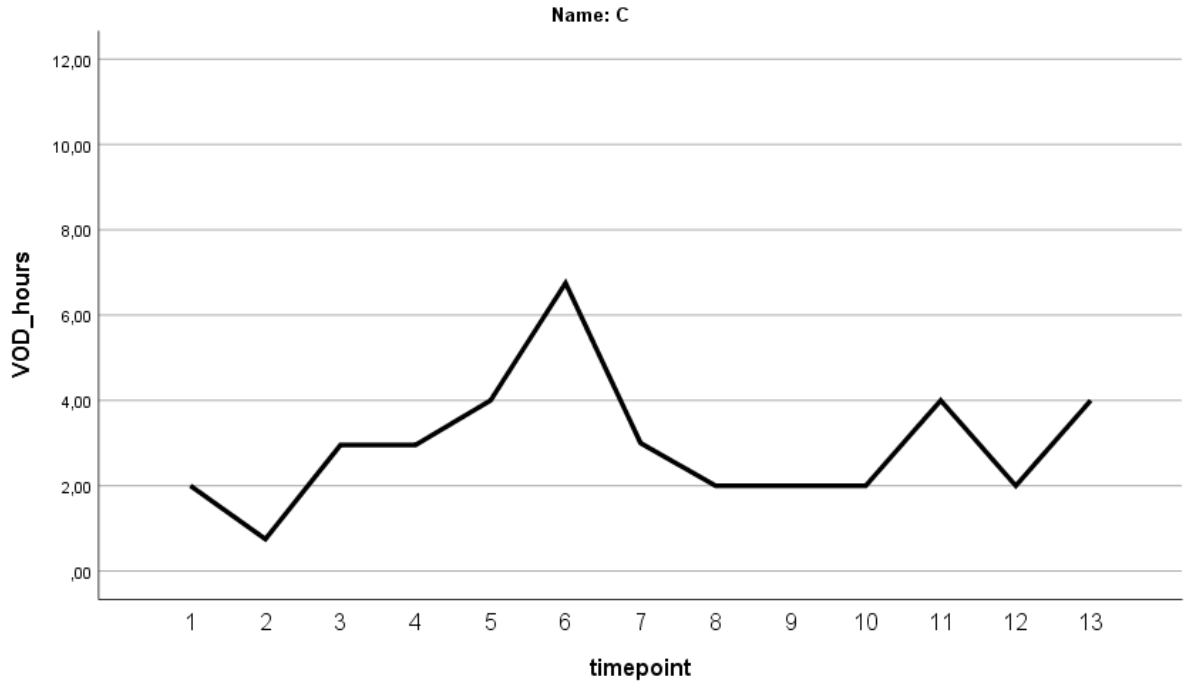

Figure 7. *Time plot demonstrating the variability of the variable of VOD-hours watched of participant C.*

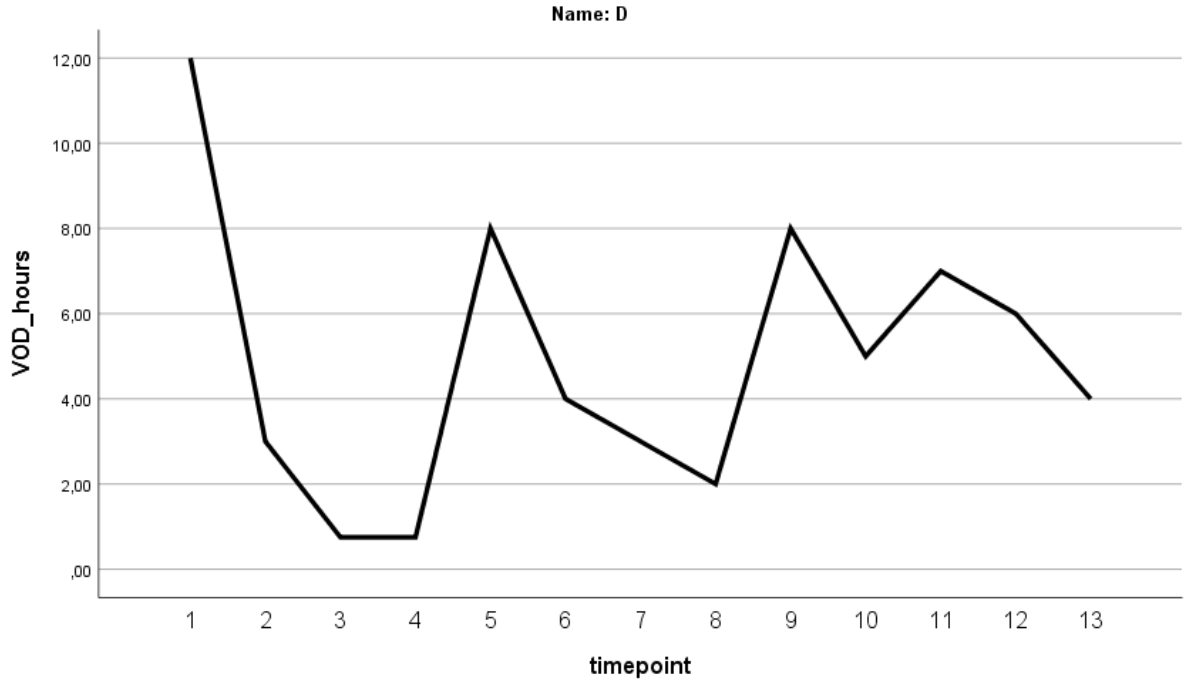

Figure 8. *Time plot demonstrating the variability of the variable of VOD-hours watched of participant D.*

Stationary of the Data

To assess the stationary of the data on the outcome variable of state depression, a partition of the time series was calculated. According to McDonald, Vieira, and Johnston, (2020), a stationary time series of the data is necessary for dynamic regression modeling and thus needs to be investigated. The time series of the current study was partitioned into two equally sized partitions. The shorter duration of the current study specified the need for only two partitions (McDonald, Vieira & Johnston, 2020). The average score of state depression over both partitions was relatively stationary for all four participants. Participant A´s score on state depression in the first partition was higher by almost 1 point, whereas participant B scored .33 points higher in the first partition, participant C scored .1 points lower in partition two and lastly, participant D scored .02 points lower in partitions two (table 2.). Thus, the data could be considered stationary over the timepoints for all four participants.

Table 2.

Scores of the partitions of each participant on the outcome variable of state depression.

Participant	Partition	N	Minimum	Maximum	Mean	Std. Deviation
A	1	6	2.33	3	2.7	.22
	2	7	1.35	2.3	1.66	.29
B	1	6	1	1.93	1.63	.35
	2	7	1	1.6	1.3	.23
C	1	6	2.2	3.4	2.63	.40
	2	7	2.15	3.1	2.54	.37
D	1	6	1	1.78	1.44	.28
	2	7	1.1	1.65	1.42	.18

Further exploring the stationary of the data of the four participants, the time trends of state depression over the different time points were assessed. A standard linear regression model demonstrated no periodic time trends for participants B, C, and D (see figure 10 - 12). Results on Participant A (figure 9) suggest a trend of decreasing state depression over time. Therefore, the variable of timepoints was included in the later regression analysis for participant A.

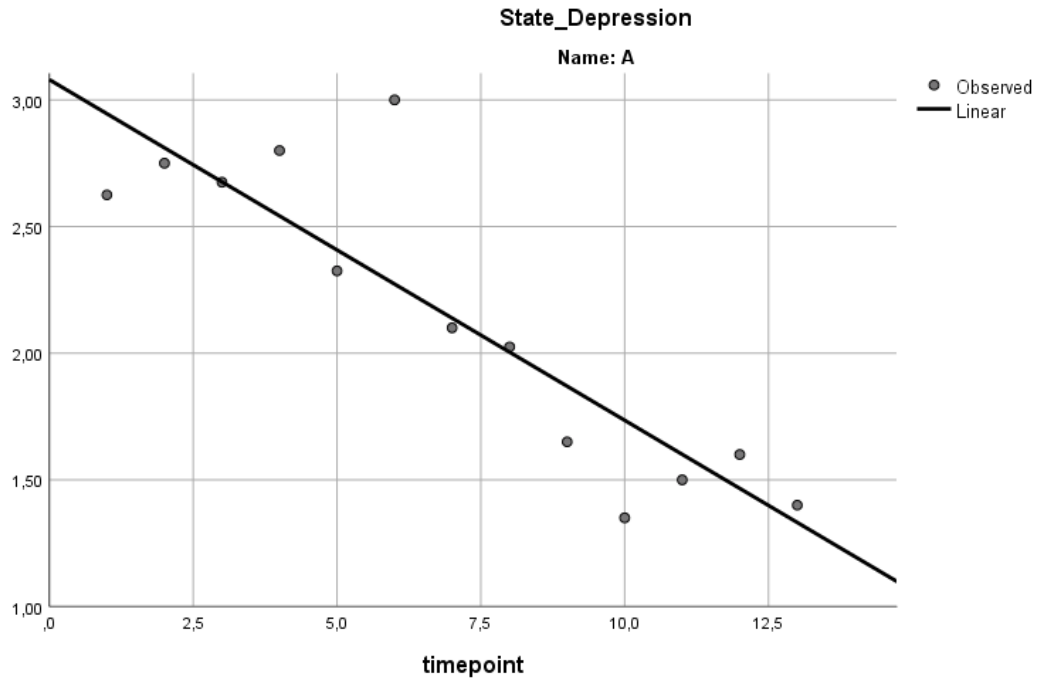

Figure 9. *Visible time trend of state depression of Participant A.*

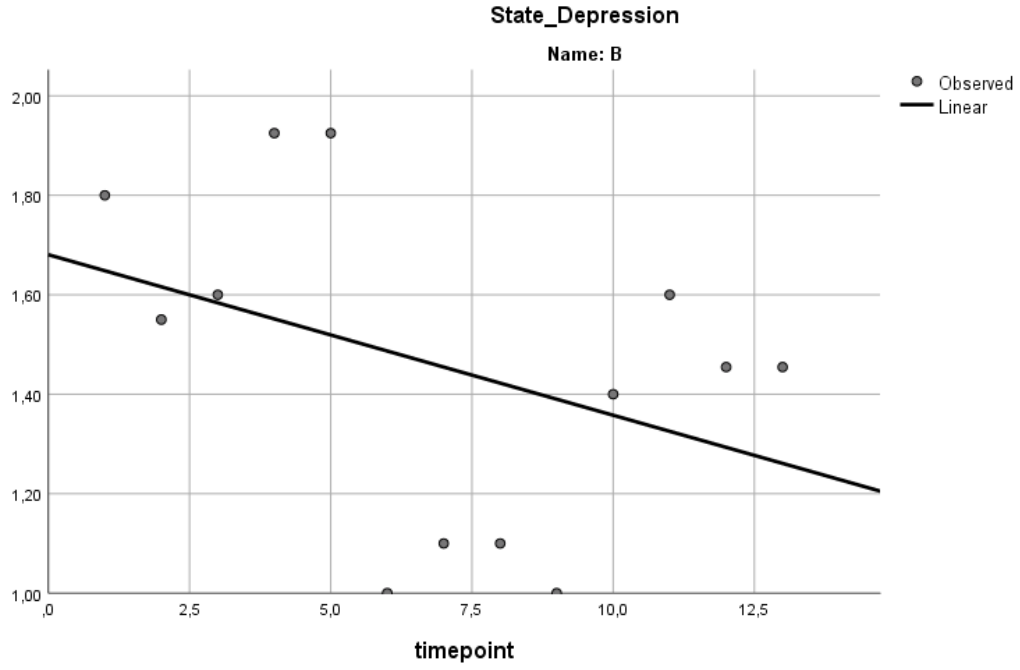

Figure 10. *No visible time trend of state depression of Participant B*

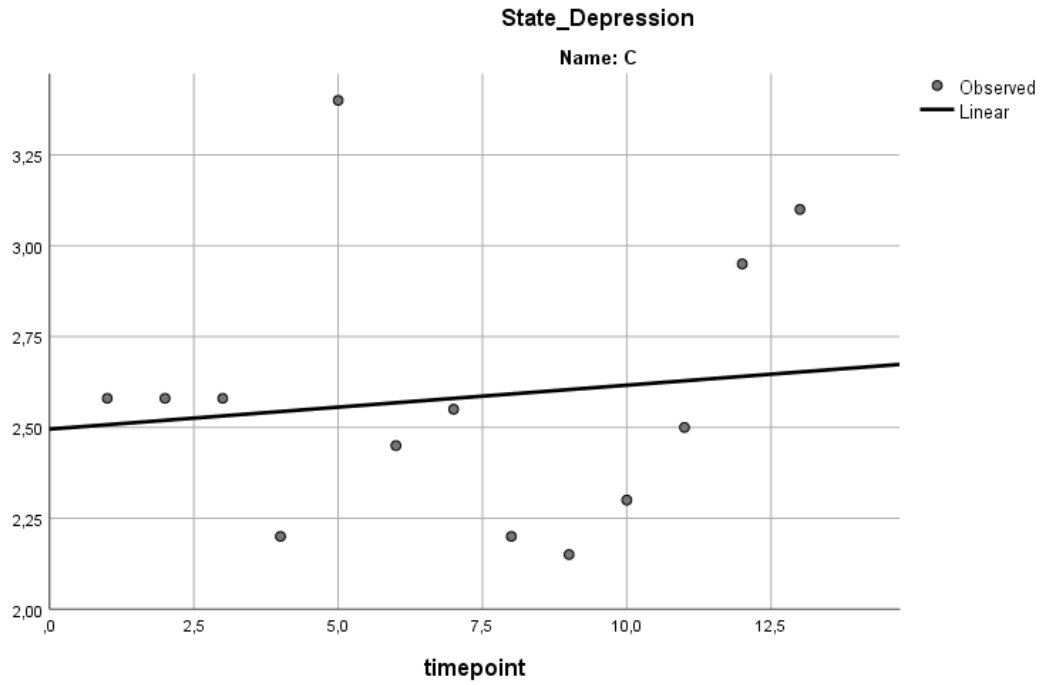

Figure 11. *Scatterplot showing time trend patterns of state depression for participant C.*

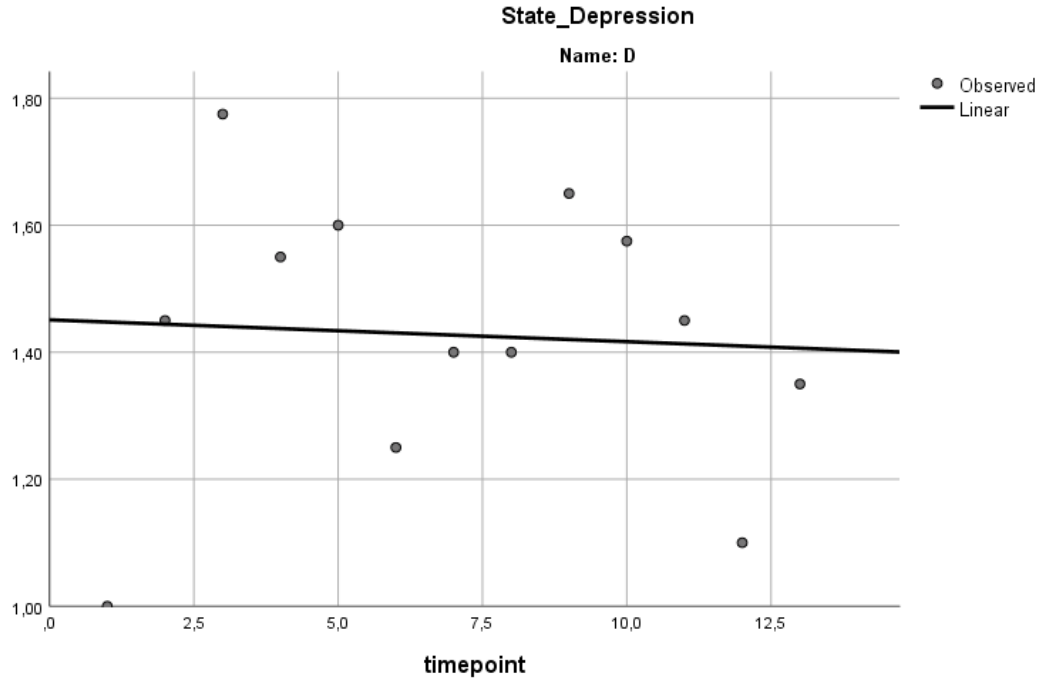

Figure 12. *Scatterplot showing time trend patterns of state depression for participant D.*

As time series data may contain periodic variation, translating into cycles that repeat regularly over time, for the current study the periodicity of weekdays was taken into account. It was suspected that there may be an association between which weekday it was, and the number of VOD-hours watched. Regression analysis showed no evidence of periodicity for

the different weekdays for all participants as the 95% confidence intervals did include 0 (Participant A: F (1,11) = .007, *p = .937*; 95% CI [-.176, .189], Participant B: F (1,11) = 1.34, *p = .272*; 95% CI [-.145, .045], Participant C: F (1,11) = 1.64, *p = .226*; 95% CI [-.168, .004], Participant D: F (1,11) = 1.03, p = .332; 95% CI [-.034, .093]).

Investigation of Autocorrelation

Investigating the presence of autocorrelation in the outcome variable of state depression, the correlograms demonstrated that there was autocorrelation present for the data of participant A. Autocorrelation for lag1 has shown to be outside the bounds of the 95% confidence interval and thereby needed to be controlled for in the later regression model. Therefore, a lagged variable with the value of 1 was created for the state depression variable of participant A. Controlling the residuals of a regression model with the lagged variable confirmed that there was no remaining significant autocorrelation present in the variable of state depression. Assessing autocorrelation in the predictor variable of the number of VOD-hours watched significant autocorrelation could be found for participant C. Therefore, a lagged variable number of VOD-hours watched with the value of 2 and with the value of 4 was created. Controlling the residuals of a regression model with the lagged variable confirmed that there was no remaining significant autocorrelation present in the variable and the lagged variables of the predictor needed to be included in the final regression model.