When a Pandemic Enters the Game: The Initial and Prolonged Impact of the COVID-19 Pandemic on Live-Stream Broadcasters on Twitch

Alexei Scerbakov
Graz University of Technology
alexei.scerbakov@student.tugraz.at

Johanna Pirker
Graz University of Technology
johanna.pirker@tugraz.at

Frank Kappe
Graz University of Technology
fkappe@tugraz.at

Abstract

The global COVID-19 pandemic has accelerated the popularity of video games and online-gaming platforms. However, little research is devoted to understanding how the pandemic has affected gamers, especially live-stream broadcasters. Therefore, our study aimed to evaluate the impact the COVID-19 pandemic has had on established streamers on Twitch. By using a longitudinal time-series design and focusing on a large sample (N = 23,019) of broadcasters, we were able to determine the initial as well as prolonged effects of the pandemic on their streaming behavior. Our results suggest that the pandemic was a "game changer" for the target group, especially in regard to their choice of game settings and their focus on non-gaming content. Relating the data obtained from the target group of established streamers to the general platform data, we discuss the pandemic-related platform dynamics.

1. Introduction

Pandemics are defined as large-scale outbreaks of infectious disease, with substantial health, social and economic implications. The World Health Organization (WHO) declared the outbreak of the 2019 novel coronavirus (COVID-19) a global pandemic on March 11, 2020. In order to minimize the spread of the virus, many countries introduced restriction/lockdown measures, including stay-at-home orders, quarantines, mobility restrictions, and physical (or social) distancing mandates [1].

Ko & Yen [2] argue that the distressing information about the pandemic in the media, as well as the governmental lockdown measures, have most likely had a profound psychosocial effect on the general population. For many people, the COVID-19 pandemic imposed a psychological burden, inducing feelings of social isolation and loneliness [3, 4]. Moreover, the pandemic generated a climate of emotional uncertainty, eliciting anxiety, fear and sadness [5, 6].

To alleviate these negative emotions, many people turn to video games and online-gaming platforms [7, 8]. Gaming can be an adaptive coping mechanism [9] and a useful tool for diminishing some of the negative impacts of the pandemic [10]. In the same way, online games can provide a means of socializing with others, and create a sense of community and well-being [11].

The perception of video game players as antisocial "loners" is no longer accurate, due to high engagement with others during gameplay [12, 13, 14]. Thus, gaming provides a social experience for players, which could be especially beneficial during pandemic lockdown measures. Notably, social media initiatives such as #PlayApartTogether encourage players to continue social engagement in video games, and promote gaming for socializing and stress reduction during the COVID-19 crisis [15].

Present-day gamers not only play the games, but broadcast their gaming sessions live online, sharing their gaming experience with the world. To better understand how the pandemic has affected (and continues to affect) the habits of video game broadcasters, we chose to focus our research on one specific platform, Twitch, which is currently the world's leading live-streaming platform that focuses on video game content. We centered our study on established streamers, a sample of Twitch broadcasters based on their pre-pandemic viewer numbers, as we consider audience size to reflect a certain degree of broadcasters' commitment to the platform [16].

The present study's focus on established streamers offers several advantages. First, it affords the possibility of examining Twitch as a platform in more detail, as the contribution of the target group of established streamers to the overall pandemic-related changes on the platform can be evaluated. Second, potential changes in content before and during the pandemic may indicate that gamers use content as a coping strategy, since evidence from the scholarly literature suggests that positive and negative effects of gaming on well-being depend on their content [17].

The following research questions were of particular interest:

RQ1: Did the COVID-19 pandemic affect the engagement in streaming (stream count, average stream length) of the target group of content creators (established streamers)?

RQ2: Did the COVID-19 pandemic affect the engagement in viewing (viewer count) of the content provided by the target group of content creators (established streamers)?

RQ3: Did the COVID-19 pandemic affect the content (categories, genres) broadcast by the target group of content creators (established streamers)?

The impact of COVID-19 on streaming (RQ1 + RQ3) and viewing habits (RQ2) was evaluated by using a pre–post–follow-up design. In this way, we were able to assess the initial effects as well as the follow-up effects of the pandemic.

2. Twitch

Twitch is currently the most widely used live video game-streaming platform, with almost 3 million viewers and over 106,000 broadcasts active on average at any time [18]. Live streaming differs in general from other user-generated content platforms, such as YouTube, due mainly to the possibility of active, simultaneous broadcast participation of both content creators (broadcasters or streamers) and the live-streaming audience (viewers) [19]. The chat feature allows the viewers to participate actively in the broadcast by interacting with the streamer and/or other viewers [20].

COVID-19 has had a substantial impact on Twitch as a platform in general. Data [21, 22] show that the number of streamers, as well as the number of viewers, experienced a tremendous increase in the course of the pandemic. More precisely, all metrics—namely, total hours streamed as well as total hours watched (Fig. 1), total unique channels and average concurrent viewers (Fig. 2)—experienced an enormous boost following the outbreak of the COVID-19 pandemic in the first quarter of 2020, and continued to increase over the course of the pandemic. In all of the relevant metrics, the increase from the first to the second quarter of 2020 was the greatest observed; in the following quarters, the increase continued, albeit at a slower pace. This suggests that the initial effects of the pandemic were far faster-paced (more profound increase) than the prolonged ones (less profound increase). Viewers per stream on the other hand declined during the pandemic until the third quarter of 2020, as can be seen in Fig. 3. This means that the increase in unique channels (streamers) outpaced the increase in viewer numbers.
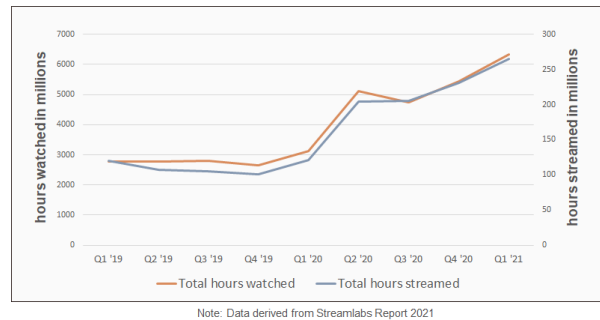

Note: Data derived from Streamlabs Report 2021

Figure 1.   Quarterly hours streamed and watched on Twitch

Note: Data derived from Streamlabs Report 2021
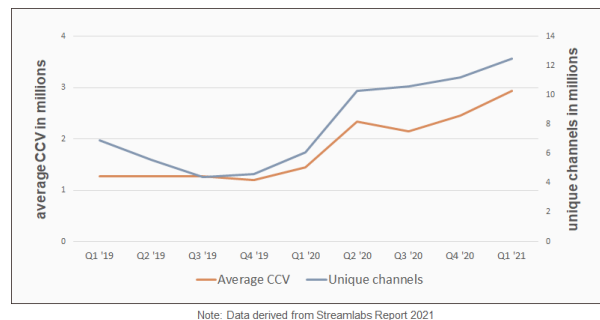
Figure 2.   Quarterly unique channels and average concurrent viewers on Twitch
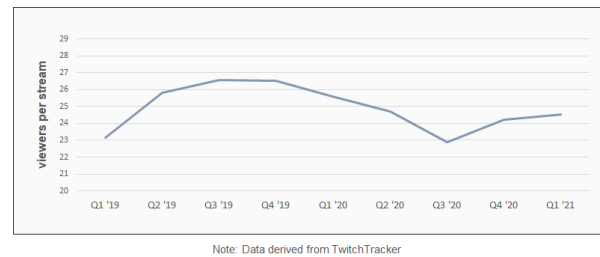

Note: Data derived from TwitchTracker

Figure 3.   Quarterly viewers per stream on Twitch

3. Related work and aim

With the rapid growth of video game live-streaming services, its users, as well as their motivations and behaviors, have become a popular topic of research. Previous studies have explored the relationship between gaming motives and genre preferences [23], the relationship of video game genres, content type and viewer gratification [24], the role of community in live streaming [20], players' motivations to engage in gaming [25, 26, 27] and viewers' motives in watching others play video games [28, 29, 30]. These studies' findings indicate that social interaction and social integration are strong motivators for streaming and viewing video game content.

We argue that the relevance of these socially oriented motives for engagement in video game live streaming

has most likely been elevated due to the COVID-19 pandemic and its containment policies, contributing to the attraction of Twitch and accelerating its growth. Consequently, many newcomers joined the platform, confronting its established users with new challenges. While Perks [31] has addressed the challenges of community managers within online communities such as YouTube and Twitch in times of the pandemic, little is known about the behavioral reactions of established streamers to the pandemic and the pandemic-related social alterations within their communities. Wollborn et al. [32] showed that established streamers on Twitch experienced an increase in viewership during the initial stages of the pandemic, which indicates that their communities are growing; however, with increasing viewer numbers, meaningful personal connections and social interactions are rather difficult to establish and/or maintain, as empirical evidence suggests that audience size can affect the form and quality of interactions [30, 20].

For the reasons provided above, viewers may become frustrated and less engaged, which is unfavorable for the channel/streamer because streamers themselves are interested in the social and psychological benefits of being part of a meaningful community. Hamilton et al. [20] report that many streamers, even those with larger viewer numbers and regardless of their Twitch Partner status, see their regular viewers as their friends, and enjoy interacting sociably with them while streaming. Our study aims to understand how established streamers on Twitch react to these challenges in terms of their streaming behavior (engagement in streaming).

Studies addressing the impact of COVID-19 on gamers originate primarily from psychology scholars and mainly examine the positive and negative effects of gaming on psychosocial well-being [10, 7, 15, 8, 33, 34, 11]. While these studies provide important insights into pandemic-related psychological burdens and discuss gaming as a possible coping mechanism, they are not focused on live-streaming gamers, who in turn are closely connected to their online communities. Hence, we argue that platform matters when evaluating pandemic-related outcomes.

Considering that a sense of community has been shown to be an important contributor to the engagement in live streaming on Twitch [20], we propose that the following scenarios are possible: broadcasters could increase the time invested in streaming, to offer themselves more time frames to engage with their growing communities. Time invested in content creation has been shown to be positively associated with motivation for social interaction and intention

to continue video content production [26]. Another possibility would be to alter the time invested in streaming certain categories/genres, by, for example, increasing the stream lengths of non-gaming categories. Leith [35] states that the non-gaming category *Just Chatting* generally refers to broadcasts in which the streamer focuses primarily on communication with other streamers or with their viewers. Therefore, non-gaming categories could enable streamers to have deeper conversations surrounding, for example, important social topics with their audiences.

Previous research addressing live-streaming engagement on Twitch [26, 28, 30] relied primarily on subjective survey methods. Our research offers an objective and more reliable approach for gathering data, which was previously used by Wollborn et al. [32] to evaluate pandemic-related outcomes on Twitch. However, the authors only determined the initial effects of the pandemic, and did not evaluate the prolonged impact on established streamers. Our study aims to address this gap by investigating pandemic-related responses of established Twitch streamers and their viewers over a long observational period, and with a large sample of broadcasters.

4.   Data and methodology

To address our research questions, we selected a data-driven approach by collecting Twitch data via a serverless infrastructure. Data were collected beginning with the start of the previous year (2020) up to April 1, 2021.

Data and pre-processing We used the present technical possibilities offered by Twitch to access platform data. Twitch offers a manifold application programming interface (API), as well as webhook-based data-collection possibilities. Various platform-specific data can be accessed. We gathered the required data by subscribing to webhooks for the top 50,000 (out of 3,353,608) Twitch streamers (based on their viewer counts for December 2019), covering 1.49% of the total active channels on Twitch. The list of channels was exported from the service Sullygnome [1].

A serverless infrastructure was used to keep hardware setup and maintenance effort as low as possible and to guarantee minimal downtime. An AWS lambda function was deployed and handled incoming webhooks by persisting the incoming stream-specific Twitch metadata to a MongoDB database. The database was hosted on a cloud service provided by MongoDB itself (called Atlas), rendering the entire data-collecting and persisting processes cloud-based (serverless). With

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[1]https://sullygnome.com/

Table 1. Metrics

metric	description
Stream count (SC)	SC is the total number of streams[2] SC was calculated per day (24h)
Viewer count (VC)	VC is the total number of viewers VC was calculated per day (24h)
Stream Length (SL)	SL is the difference between end time and start time of a stream
Average stream length (ASL)	ASL is the ratio of summed SL to SC
Average viewer numbers (AVN)	AVN is the ratio of VC to SC
Percent change in streamed content (PCSC)	$PCSC = SL_{follow-up1}*100/SL_{baseline}-100$ PCSC is measured in % and was calculated per category
Percent change in viewer count (PCVC)	$PCVC = VC_{follow-up1}*100/VC_{baseline}-100$ PCVC is measured in % and was calculated per category

this approach, we were able to build a database consisting of 19,145,474 streams.

We used a within-subject design to evaluate the impact of the pandemic on the established streamers. In this way, we focused our research on streamers who were regularly active on Twitch before the outbreak of the pandemic (baseline), and who continued streaming during the course of the pandemic. Therefore, we filtered the full set of streamers to a subset containing only broadcasters who had at least one active stream every month in 2020 (i.e., a minimum of twelve streams in 2020). This resulted in a final set of 23,019 broadcasters.

Tab. 1 describes the calculation behind the metrics referenced in this paper. To evaluate the impact of the pandemic restrictions on the dependent variables (SC, ASL, AVN, PCSC, PCVC), we segmented the data into four time periods (Fig. 4), based on the public announcement of the pandemic by the WHO on March 11, 2020, revealing four conditions for further statistical analysis:

period 1: baseline (January 1–March 11, 2020)

period 2: initial effects (March 12–March 30, 2020)

period 3a: follow-up$_1$ effects (January 1–March 11, 2021)

period 3b: follow-up$_2$ effects (March 12–April 1, 2021)

The baseline condition represents the period of time before COVID-19 was declared a global pandemic by the WHO, while the other three conditions refer to time frames after the announcement of the pandemic, revealing its effects. We are well aware that splitting period 3 in two separate subconditions (3a and 3b) is artificial, but believe it to be necessary in order to compare the exact same periods of time in both years statistically, and therefore to avoid—or at least to reduce—bias (e.g., from seasonal fluctuations in streaming behavior).

Statistical analysis The study objectives were analyzed using Microsoft Excel and IBM SPSS

Figure 4. Study design

Statistics for Windows. Excel was used for the calculation of the relative data, means and standard deviations, while SPSS was used to analyze the data distribution as well as the significance of differences. Since no violations from normality were detected (Kolmogorov Smirnov test, $p > 0.05$), paired-sample t-tests were used to assess differences between period 1 (baseline) and period 3a (follow-up$_1$ effects), as well as between period 2 (initial effects) and period 3b (follow-up$_2$ effects). A p-value below 0.05 was considered statistically significant. All p-values are based on 2-tailed tests of significance. Effect size was determined by calculating Cohen's d statistic.

We used different methods to visualize our results. Line charts were used to visualize the course of the metrics SC, ASL and AVN in year-over-year comparison (Fig. 5 – 7). The x-axis represents the days starting from January 1 (for both years), with the day highlighted when the pandemic started (day 71). The y-axis was represented by either absolute numbers or percentages, where a natural growth aside from COVID-19 could be expected (viewer numbers). Bar charts were used to highlight changes between time periods in all relevant variables (Fig. 8). Data are presented as means and standard deviations or percentages.

5. Results

Stream count The daily number of streams (stream count, SC) over the time period of 90 days (January–April) in the course of two years (2020 and 2021) is demonstrated in Fig. 5. It can be observed that there was a prominent increase in SC after the pandemic was publicly announced by the WHO on March 11, 2020 (day 71). In 2021, no noteworthy differences in

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[2]Twitch webhooks handle restarted streams by providing an ID when the webhook is triggered. Consequently, if a stream was restarted it was only counted once in our database.
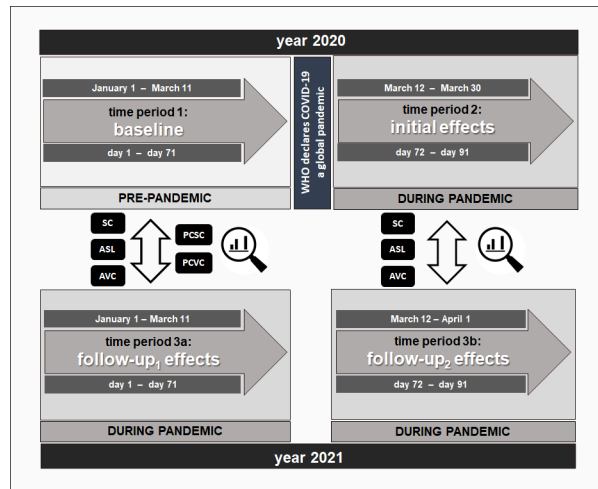
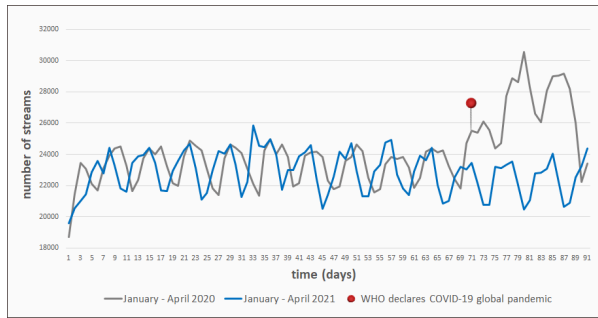SC in comparison to pre-pandemic levels are evident.

Figure 5. Daily stream count

Descriptive results segmented in time periods are displayed in Tab. 2 and visualized in Fig. 8. There was a significant difference ($p < 0.001$) between the initial and the follow-up$_2$ effects on SC, indicating that the number of streams was significantly higher after the announcement of the pandemic in 2020 than in the same time period in 2021. However, no statistically significant difference ($p = 0.194$) was evident between period 1 (baseline) and period 3a (follow-up$_1$ effects), which suggests that after the initial "pandemic boost", the number of broadcasts reached baseline levels in 2021 (Tab. 3).

Average stream length The average stream length (ASL) over the time period of 90 days (January – April) in the course of two years (2020 and 2021) is demonstrated in Fig. 6. It can be observed that ASL values were significantly lower and had more fluctuations in 2021, compared to 2020.
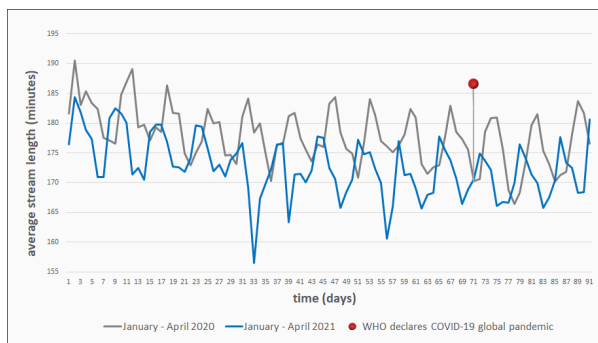

Figure 6. Daily stream length

Descriptive results stratified by time periods are shown in Tab. 2 and displayed in Fig. 8. Paired samples t-test results revealed that there was a significant difference ($p < 0.001$) between period 1 (baseline) and period 3a (follow-up$_1$ effects) in ASL, indicating that streams were, on average, significantly longer before the announcement of the pandemic in 2020 than in the same time period in 2021.

Furthermore, there was a significant difference ($p = 0.025$) between the initial and the follow-up$_2$ effects on ASL, revealing that, under pandemic restrictions, streams were, on average, significantly shorter in period 3b (follow-up$_2$ effects) than in period 2 (initial effects) (Tab. 3). Overall, the average length of broadcasts on Twitch was shorter in all conditions/time periods after the pandemic announcement than before (baseline), indicating that streamers produced on average 5.5 minutes' less content per broadcast during the pandemic, in comparison to baseline (time period before the pandemic announcement).

Average viewer numbers Overall, the average viewer numbers (AVN) of broadcasts on Twitch were higher in 2021 than in 2020, indicating that there were no noteworthy initial effects of the pandemic on AVN, but significant follow-up effects, with an average increase of 205.41 (+70.93%) viewers in 2021, in comparison to baseline. This is also evident in Fig. 7, which shows normalized percentage changes (relative to day 1 of each year) in viewer numbers.

Descriptive results subdivided according to time periods are shown numerically in Tab 2 and graphically in Fig. 8. In comparison to baseline, AVN per stream were significantly ($p < 0.001$) higher during the time period 3a (follow-up$_1$ effects), indicating that, on average, broadcasts of the established streamers on Twitch were watched by significantly fewer viewers before the announcement of the pandemic in 2020 than in the same time period in 2021. Furthermore, there was a significant difference ($p < 0.001$) between the initial and the follow-up$_2$ effects in AVN, indicating that, during the pandemic, significantly more viewers consumed content in period 3b (follow-up$_2$ effects) than in period 2 (initial effects) (Tab. 3).
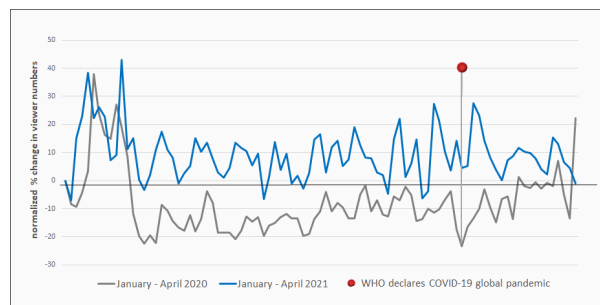

Figure 7. Daily viewer percentage change

Streamed content To evaluate the impact of the pandemic on streamed content on Twitch, we identified the 100 most-broadcast categories before the pandemic was publicly announced by the WHO (baseline), based on stream length (SL). Then we retrieved the SL of these 100 categories for the time period 3a, which was after

Table 2. Descriptive statistics of the study variables

| | time period 1 | | | time period 2 | | | time period 3a | | | time period 3b | | |
| | baseline | | | initial effects | | | follow-up$_1$ effects | | | follow-up$_2$ effects | | |
Variables	Mean	SD	time streamed	Mean	SD	time streamed	Mean	SD	time streamed	Mean	SD	time streamed
SC	23,232.31	1,199.80	4,150,910.63	26,838.95	2,162.20	4,698,875.22	22,970.69	1,345.43	3,977,544.21	22,408.24	1,207.18	3,838,253.32
ASL	178.67	4.35		175.08	5.16		173.16	5.21		171.29	4.03	
AVN	289.62	37.26		299.61	30.26		495.99	44.05		494.06	31.82	

Table 3. Results of paired t-tests

| Time periods | Varibales | Paired differences | | | | | | | |
| | | Mean | SD | SEM | 95% CI of the Difference | | t | Sig. | Effect Size |
					Lower	Upper		(two-tailed)	d_{Cohen}
	SC	-261.63	1,667.68	199.33	-659.27	136.02	-1.31	0.194	0.16
1 vs 3a	ASL	-5.51	5.98	0.71	-6.94	-4.09	-7.71	0.000	0.92
	AVC	206.38	42.33	5.06	196.29	216.47	40.80	0.000	4.88
	SC	-4,430.71	2,875.36	627.45	-5,739.56	-3,121.87	-7.06	0.000	1.54
2 vs 3b	ASL	-3.79	7.18	1.57	-7.06	-0.52	-2.42	0.025	0.53
	AVC	194.46	47.24	10.31	172.95	215.96	18.86	0.000	4.12

Note: Data was obtained from N = 23,019 steamers within an observational period of 91 days for the years 2020 (period 1, period 2) and 2021 (period 3a, period 3b)
Statistical analysis: paired t-test at (global) significance level α = 0.05, statistically significant if p < 0.05
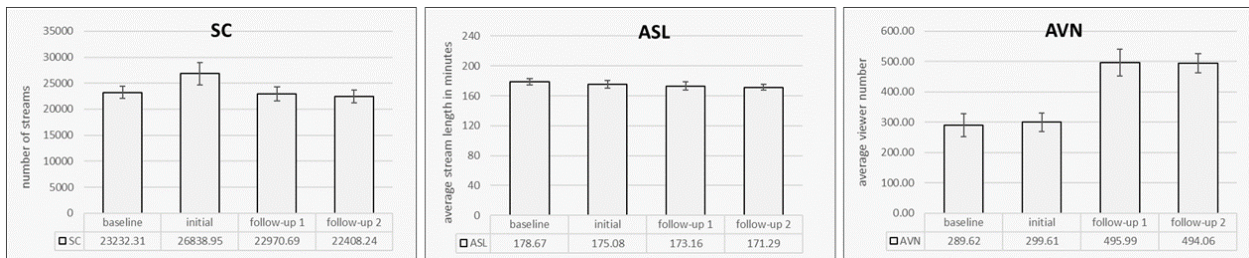Cohen's d effect size = 0.20 small, 0.50 medium, 0.80 large

Figure 8. Streaming (SC, ASL) and viewing (AVN) behaviour within time periods

the announcement of the pandemic (follow-up$_1$ effects). By calculating the baseline/follow-up$_1$ ratios in SL for each category, we were able to evaluate the changes in SL (percent change in streamed content, PCSC). The same procedure was carried out for the viewer count (percent change in viewer count, PCVC).

Using the procedures described above, we were able to determine that 90 of 100 categories had a positive change in VC, while only 19 categories had a positive change in SL. We looked at these 19 categories in more detail. By classifying the categories in terms of gaming and non-gaming content we could determine that non-gaming content gained on average 12.35% in SL. This indicates that established broadcasters on Twitch were more interested in certain content outside of the traditional gaming format during the pandemic than before (Fig. 9). Given the fact that neither SC nor ASL increased during the pandemic in 2021 (in comparison to the pre-pandemic announcement), this observation is even more remarkable.

Of course, gaming content remains relevant during the pandemic, with an average gain of 39.08% in SL. However, a question that is basic and fundamental to understanding the impact of the pandemic on
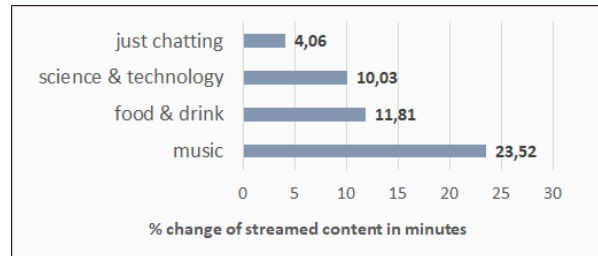

Figure 9. Non-Gaming categories

broadcasters entails evaluating the change in content being broadcast by them. By collecting game data from the 'GiantBomb' API [3], (an open, online database for video games) and by using Apperley's classification [36], we classified the content into game genres.

The *action* genre included the most categories (6 of 15), and had the most prominent average gain in SL (52.67%), followed by *simulation* (2 of 15 categories; +44.62% in SL), *role-playing* (5 of 15 categories; +33.63% in SL), and *other* (2 of 15 categories; +6.36% in SL). Within the *action* genre, we observed that three out of six categories with the most significant increase in SL (Rust, Call of Duty: Modern Warfare, DayZ) were

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[3]https://www.giantbomb.com/api/

shooter video games with either a *survival setting* (Rust, DayZ) or a *war setting* (Call of Duty: Modern Warfare). Given the fact that COVID-19 can be considered a huge worldwide stressor, triggering fears and uncertainties [40], our findings suggest that a association between real-life stressors and settings chosen in video games could be present.

Within the *role-playing* genre, we observed that three out of five categories with the most significant increase in SL (Stardew Valley, Lost Ark, Path of Exile) were either MMORPGs (Lost Ark, Path of Exile) or else had a nostalgic setting (Stardew Valley) [41]. While MMORPGs are purposefully designed to encourage interactions among users (which are otherwise highly restricted in real life due to the pandemic), choosing nostalgic settings could provide nostalgic reverie, which in turn could be positively connected to resiliency [42, 43], and therefore be beneficial, especially during the pandemic. The increased interest in nostalgic settings during the pandemic is also supported by the average gain (+6.36%) in SL of the two categories (Retro and Super Mario World) present in the genre, *other*.

The remaining two categories (*Slots* and *Chess*) could be classified as *simulation* games. The *simulation* genre includes video games that simulate real-life activities, such as—in our case—gambling (*Slots*) and strategy board-gaming (*Chess*). While *Slots* gained 8.69% in SL during the pandemic, the change in SL for *Chess* was even more remarkable: *Chess* gained a total of 80.55% in SL during the COVID-19 pandemic and was, overall, the category with the second highest gain in SL (after Rust).

6. Discussion

With this study, we aimed to evaluate the impact of the COVID-19 pandemic on live-stream broadcasters on Twitch. By using a longitudinal time-series design and focusing on a large sample (N = 23,019) of broadcasters based on their pre-pandemic viewer numbers (established streamers), we could determine the initial as well as the prolonged effects of the pandemic on their streaming behavior. Our variables of interest were *stream count* (SC), *average stream length* (ASL), and *type of streamed content* (based on PCSC) which, in our opinion, best represent streaming behavior. Furthermore, we included the variable *average viewer numbers* (AVN) and *type of viewed content* (based on PCVC) in our analysis, in order to examine the engagement in viewing before and during the pandemic.

Engagement in streaming After the pandemic announcement by the WHO, there was a profound increase in SC (+15.52%, compared to baseline),
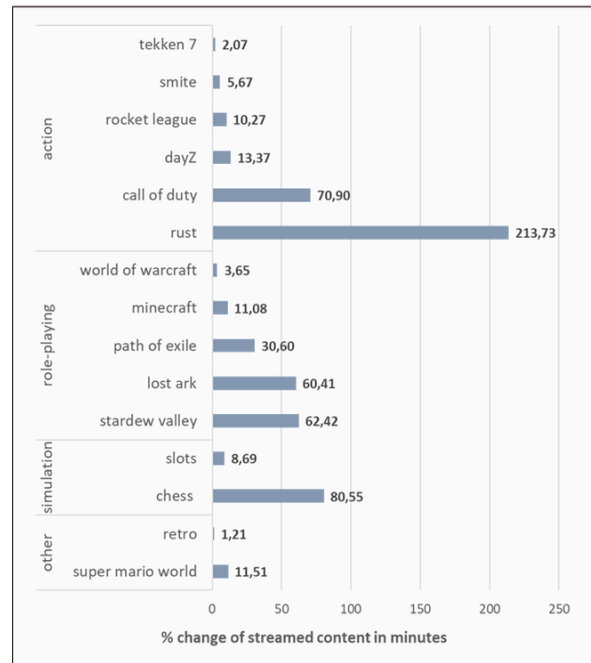

Figure 10. Gaming categories

indicating that the initial reaction of the established streamers to the pandemic was to produce a higher amount of content. However, SC returned to baseline values in 2021, indicating that the initial change in behavior following the pandemic announcement did not persist in the long term. More precisely, after the initial "boost" in the amount of content broadcast by the target group in the first weeks following the pandemic announcement, pre-pandemic habits were resumed and maintained in the following year.

ASL decreased during the pandemic and remained below baseline levels in all time periods/conditions during the pandemic, indicating that the content broadcast by the established streamers in the course of the pandemic was shorter in length: On average, streamers broadcast 5.5 minutes' less content per broadcast during the pandemic in comparison to baseline. The differences in ASL between 2020 and 2021 were significant ($p < 0.001$; $p = 0.025$). In contrast to SC, this behavioral change seems to be persistent.

In comparison to the general platform data [37], which show a profound increase in broadcast content (hours streamed) on Twitch during the pandemic (Fig. 1), our findings indicate that the established streamers contributed to the overall platform growth to a relatively small extent, due merely to the increase in SC in time period 2 (initial effects). What contributed the most were, most likely, new broadcasters who joined the platform during the pandemic. This assumption is supported further by the overall increase in unique channels (Fig. 2).

Engagement in viewing Significantly more (+70.93%) viewers were watching content broadcast by the established streamers in 2021 compared to the previous year ($p < 0.001$), indicating that the pandemic and its measures have influenced engagement in viewing during the pandemic. General platform data show that the overall viewer numbers on Twitch experienced a profound increase during the pandemic (Fig. 2). However, the AVN per stream declined, indicating that more content was broadcast on the platform. As our target group gained significantly more viewers during the pandemic, it is evident that the established streamers, unlike new broadcasters, benefited strongly from the overall viewer increase on the platform.

Type of streamed content One of the most interesting observations of the present study was the gain in SL from baseline to follow-up$_1$ time-period of the non-gaming content, particularly in the categories *Just Chatting* (+4.06%), *Science & Technology* (+10.03%), *Food & Drink* (+11.81%) and *Music* (+23.52%). What makes this observation remarkable is the fact that only 19 out of 100 categories had positive baseline/follow-up$_1$ ratios, indicating that these categories indeed may reflect a pandemic-related behavioral change. Of course, there was an enormous increase in new broadcasters on Twitch, as entertainment, educational and cultural activities were forced to move online in 2020 due to the pandemic. According to the Streamlabs Report [37], the number of unique channels on Twitch doubled (from 6.1 million to 12.5 million) in Q1 2021 compared to Q1 2020. Thus, an increase of non-gaming content on Twitch in the course of the pandemic seems obvious. However, what makes our findings extraordinary is their focus on the established streamers, who were (according to their viewer numbers) present and established on the platform before the pandemic occurred. In other words, the target group of established streamers was evidently changing their behavior in the course of the pandemic by focusing more (in terms of SL) on the non-gaming content than they had prior to the pandemic. Taking into account that the ASL decreased in the course of the pandemic and that the SC returned to its pre-pandemic levels in 2021, the increased SL of non-gaming content could indicate that COVID-19 was indeed a "game changer" [45] for the established broadcasters in terms of spending more time with their (real-life) activities online (*Music*, *Science & Technology*, *Food & Drink*), or coping with the pandemic measures in a socially distanced world by increased engagement in *Just Chatting*.

Of course, gaming content remains relevant during the pandemic. However, the pandemic has indeed served as a game changer for gaming content as well. The choice of game settings (or themes) seems especially to have been affected by the pandemic. In the action genre, the shooter game *Rust*, which has a *survival setting*, had the most prominent gain in SL (+213.73%) during the pandemic. In the role-playing genre, *Stardew Valley*, which has a *nostalgic setting*, had a leading role with regard to SL (+62.42%) (see [38] for further information on how the rural idyll of farming computer games is connected with nostalgia). The nostalgic setting was also present in the genre, *other*, which consisted of *Super Mario World*, a game with a "retro" style, and the category *Retro*. As mentioned by Pearson & Tranter [39] the "nostalgia that Mario games produce, right down to the iconic theme tune and in-game sounds, colours, shapes, all come at the price of being tethered to the past". The same applies to other retro games [40, 41]. In the simulation genre, *Chess*, simulating a real-life activity online (*real-life activity setting*), was a definite winner in terms of gain in SL (+80.55%).

Research evidence suggests that games can be used as a coping mechanism, and that playing video games during the COVID-19 pandemic can indeed have a positive impact on players' well-being by providing cognitive stimulation and opportunities to socialize, as well as a variety of benefits related to mental health, including reduction in anxiety and stress [11, 42, 8]. Several cognitive benefits of gaming are mentioned by Granic et al. [14], one of which is developing problem-solving skills. Choosing a *survival setting* in an action game and solving in-game survival problems by exploring a wider range of possible solutions can promote problem-solving skills in the reflective sense—such as, for example, "taking time to gather information, evaluate various options, formulate a plan, and consider changing strategies and/or goals before proceeding further" [14], which may be especially beneficial in the emotional climate of uncertainty due to the pandemic.

Another benefit of gaming is its positive impact on well-being. Choosing a *nostalgic setting* in video games or playing retro games may be connected to nostalgia. Nostalgia is predominantly a positive, social and past-oriented emotion [43], which is also positively associated with well-being [44]. Nostalgia is triggered primarily when social support is required [45], countering the negative impact of loneliness and/or social exclusion [46]. As the COVID-19 pandemic imposed a psychological burden on many people, feelings of social isolation, loneliness and anxiety increased [3, 4]. Wulf et al. [40] suggest that "people who are currently in need of social support and

relatedness may seek out a nostalgic gaming experience to feel socially connected". This may explain the popularity of retro games during the COVID-19 crisis, as well as the choice of *nostalgic settings*.

The popularity of the *Chess* category on Twitch during the pandemic could have resulted from the streaming collaboration between Grand Master Hikaru Nakamura (a five-time US chess champion) and Felix Lengyel ("xQc" one of the top broadcasters on Twitch) in April 2020, which attracted millions of viewers. Nakamura continued to collaborate with other well-known streamers, and the popularity of the *Chess* category on Twitch grew quickly. However, while such collaborations may broaden the appeal of a category, we argue that a category can remain relevant or expand its popularity only if there is an underlying interest in the category itself. As the COVID-19 pandemic and its prevention measures have drastically reduced social connection and cognitive stimulation [47], the increased engagement in chess (streaming as well as viewing) may be linked to its impact on certain needs that became relevant or increased their relevance due to the pandemic. Chess is an intellectually complex, strategically demanding and highly competitive game [48] with cognitive, social and psychological benefits (see [49] for a broad overview). Aciego et al. [50] examined the benefits of playing chess regularly, for its cognitive and socio-emotional enrichment. In contrast to the comparison group, chess players improved their cognitive abilities, coping and problem-solving capacities, and even socio-affective skills—all of which may be beneficial during the uncertainties of the COVID-19 pandemic.

7. Conclusion

The gaming industry seems to be one of the economic sectors that has benefited considerably from the COVID-19 pandemic and its prevention measures. In the course of the pandemic, a substantial boost in the online activity of players and viewers was recorded for the live-streaming platform, Twitch. However, our results indicate that the streaming behavior of the established broadcasters on Twitch barely contributed to the overall growth of the platform. For this reason, we assume that the increased amount of content on Twitch during the pandemic is attributable primarily to newcomers. With regard to the increase in viewer numbers on the platform in the course of the pandemic, our findings suggest that the established streamers benefited more strongly than did the newcomers from this dynamic. We also observed a change in broadcast content during the pandemic, as more non-gaming content was aired. However, the gaming content changed as well, with regard mainly to its theme/setting. Games with a *survival setting*, *nostalgic setting* or *real-life activity setting* gained popularity during the pandemic. We therefore posit that an association between real-life stressors and the choice of setting in video games could be present.

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