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Digital gaming audiences: Awareness, without closeness

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ABSTRACT

Game streaming is emerging as an increasingly popular form of social gaming even among non-professionals. As such, players have to adapt to the presence of a digital gaming audience consisting of people who are either synchronously or asynchronously participating in their performance and engaging with them remotely via digital media. While individuals' experiences with physically collocated (non-digital) audiences is well-studied, it is still unclear whether digital audiences trigger similar socio-cognitive mechanisms or whether individuals process such audiences differently. The current research examined the potential impact of both synchronous and asynchronous digital gaming audiences on players' feelings of closeness, as well as the social demand these audiences elicit, across both US and German players in two separate studies. The second study was designed as an exact replication of the first, as a robustness check. Results indicate that while players could recall details of the conversations, synchronous streaming had no impact on feelings of propinquity with, or social demand from, the audiences.

1. Introduction

Video streaming services and broadcasting platforms, such as Twitch and YouTube, allow players to add a new layer of social engagement to their game-playing experience. Users flock to these platforms to consume, create, and share live and recorded videos of their own gameplay (as well as all manner of other topics and interests). Sharing gameplay experiences with others has been an integral piece of video games as a cultural phenomenon long before streaming technology was developed. Perhaps most obviously, multiplayer gaming has been a staple of video games since their inception—indeed, *Spacewar!*, often claimed as the first video game, was a multiplayer game [32]. However, interactions with physically collocated nonplayers (i.e., an audience) can also play an important role in shaping player experience, both in arcades [37] and at home [17]. Reasons for playing in the presence of others can vary, including teamwork on difficult challenges, providing guidance for novice players, or just the enjoyment of having others around while playing [18]. The presence of these audiences can also impact game performance [10].

The ease with which video content can be published on streaming platforms has granted anyone with a camera and an Internet connection access to potentially large audiences for their content. However, less is known about the psychological impacts of digital audiences on users compared to physical audiences. Hence, the present research aims to examine how digital audiences psychologically affect nonprofessional users, with a specific focus on how feelings of closeness and social demand might manifest in response to such audiences. Rather than examining game broadcasting/streaming as an idiosyncratic phenomenon (see, e.g., e.g., Sjöblom et al. [46]; or Taylor [51], for related work), the current studies focus on the means of how game streaming platforms allow digital gaming audiences to watch everyday players. The choice to prioritize non-professional players (rather than professional content creators) serves two important purposes. First, it allows insight into an under-researched streaming practice of producing and sharing content to a small audience. Particularly when starting out, Twitch users may end up broadcasting their gameplay to very low numbers of users [27], and the present research can explore the nature of these types of streaming experiences. Secondly, studying non-professional game streaming allows for an unbiased inquiry into social-cognitive mechanisms resulting from the awareness of a digital audience**.** That is, professional game streamers have substantial experience with digital audiences that may impact how they experience said audiences, limiting the generalizability of any results found; studying nonprofessionals avoids such biases. The goal of this research is to expand our understanding of audience effects to account for the socio-cognitive effects of non-collocated, digitally accessible audiences. Practically speaking, a better understanding of how digital audiences are experienced is an essential component for understanding the role

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that digital audiences play in motivating people to stream their video game play.

Through both broadcasting recorded gameplay and streaming live gameplay, video game players are able to share their playing experiences digitally with large, non-collocated audiences. These so-called *digital gaming audiences*, who watch players remotely through digital media and comment on their gameplay from outside of the game, can transform even single-player games into social experiences [38]. The term digital is used to describe the means by which audiences are accessible—the audiences themselves consist of flesh-and-blood human beings, who are digital in the sense that they are accessing the player and gameplay remotely via digital media. Digital gaming audiences are typically made manifest to players via text-based feedback, either in real-time (for live broadcasts) or time-delayed (for recorded broadcasts). Live feedback most closely mimics the type of interactions physically collocated audiences would provide. The player can monitor this chat and respond (or not) to the audience, just as a player can choose to respond or not to a physically collocated audience. However, monitoring a chat window and responding to text messages might produce different social-cognitive effects than engaging with a physically collocated audience—particularly when the audience is not being engaged during live gameplay. That is, streaming gameplay live versus recorded affords various types of audience interactivity [21], which can lead to outcomes such as an increased closeness with the audience and even extensive self-disclosure [46].

Additionally, the presence of social others has long been known to exert effects on people's performance at different tasks [54,59], including video games [10]. These audience effects even hold true when social others are not visibly present, especially if some sort of evaluation or social judgement can be anticipated [1,14] that creates an attentional conflict with the primary task [3,22]. In order for players to experience the social aspects of game broadcasting and streaming, they must balance the social demands associated with the digital audience against the cognitive and physical demands associated with progressing through the game itself [7]. This also means that the presence and anticipation of a digital audience might not matter if players are unable to attend to the fact that they are being (or will be) watched.

While extant literature has found engagement and performance is impacted by whether a player is streaming their gameplay [39], investigations directly linking the presence of a digital audience to socio-cognitive effects experienced by users remain limited. As mentioned above, playing games socially in the presence of others is not a new practice birthed by streaming technology, and spectators specifically have been an important aspect of gaming experiences since the dawn of the industry. That said, it cannot be assumed that digital audiences provide the same social augmentation to the gaming experience as their physical counterparts have done in the past. Whether those socio-cognitive effects persist when audiences are technologically mediated is an empirical question, the answer to which is important for any future work looking at the motivations behind, and gratifications obtained from, video game streaming. This research seeks to address this gap. Specifically, the present studies investigated whether non-professional players are aware of their synchronous and asynchronous digital gaming audiences during gameplay and how such digital audience awareness leads to feelings of closeness as well as additional social demands.

2. Literature review

2.1. Audience effects

The presence of audiences has been shown to impact people in a wide variety of contexts. Early work on mere presence effects demonstrated that a person's responses (i.e., attitudes, judgements) to a given event was influenced by a coviewing audience's visible affective responses to this event [30,31]. More recent research has demonstrated that the presence of coviewing others can both impact media enjoyment via emotional contagion [13] and heighten or lessen narrative transportation and character identification in different circumstances [50].

The presence of others has also been shown to affect performance on a variety of tasks. In one of the earliest observations of the phenomenon, Triplett [52] observed that cyclists who ride alone tend to be slower than those who ride in groups, although his work was later criticized for being anecdotal (see [48]). Nevertheless, this line of thinking evolved into the drive theory of social facilitation [59], which specifies that the presence of an audience causes people to increase the amount of effort they exert. For people skilled at a task, this increased effort will improve performance as compared to performing the same task in isolation. These predictions have held up in meta-analytic work [6].

Significant extensions of Zajonc's original theory by other researchers (e.g., [6,19,25]) suggest that one reason social facilitation effects function is because performers (i.e., those being observed) anticipate evaluation by audience members. This greater level of evaluation apprehension is positively connected with exerting dominant skills [15]. Conversely, eliminating the threat of a subsequent evaluation by the audience prevented those consequences [43]. Previous research has shown that these social facilitation effects hold even if audience members are not physically present [23,28,44].

2.1.1. Audience effects and video gaming

In video games, audiences can play an integral role in the gaming experience, enabling the exchange of gaming social capital [41], facilitating discussion of game strategies and tactics during even single-player games (tandem play; [17]), or simply providing additional spectacle to the game itself [47]. Specific to social facilitation effects, Bowman et al. [10], replicating earlier work by Kimble and Rezabek [33], demonstrated that when game challenge is low (manipulated using in-game difficulty settings), people playing a first-person shooter performed significantly better in the presence of a physically co-present audience. Little research has directly addressed anticipated audiences that game streamers might experience—a limitation self-acknowledged by Bowman et al. [10].

This research demonstrates that audiences can impact video game performance similar to other activities. However, these existing studies utilized a physically co-present audience in which awareness of this audience can be assumed. Performances that are broadcasted online involve physically distal audiences which players may be able, or even required, to tune out in order to attend to competing demands of the game.

2.1.2. Digital gaming audiences

Digital gaming audiences are a relatively recent phenomenon which exists on numerous video streaming platforms that foster both synchronous and asynchronous audiences. As explained by Lin et al. [38], the variable of synchronicity is important in that it breaks from how we normally understand audience effects. That is, digital audiences not only allow for others to be present outside of physical space constraints, but they are also able to be present outside of temporal constraints. For this reason, a comprehensive approach to understanding digital audiences requires a more careful delineation of the potential effects of the audience's temporal connection with the player, which is independent from their physical distance. The asynchronous-synchronous distinction thus offers different contexts in which players may varyingly be able to engage with or ignore audiences [38]. Taking into consideration both of these contexts may be useful in furthering our understanding of the individual processing of digital audiences. Importantly, the focus of the study is not to precisely replicate the nuances of experiencing specific platforms, which can involve shared cultural elements that fall outside the scope of this study [24]. Rather, this research seeks to use these platforms' common audience interactivity features heuristically in order to better understand individuals' audience awareness, and its psychological implications, as a general phenomenon.

Twitch is a popular game streaming platform that boasted over two million unique monthly broadcasters and 355 billion minutes watched in 2017 [53]. Twitch allows users to broadcast their gameplay live online, while spectators communicate with one another (and potentially, with the player) in real time using text-based chat[1]. This chat can be used to voice praise or criticism of the streamer or provide helpful support—similar to what a physically co-present audience can do during a game session. Players are made aware of the audience via these communications, as well as by a numerical indicator of the number of current viewers. Importantly, a player must have the game and Twitch software open and visible simultaneously in order to be able to both play and have access to audience feedback—and these may compete for attention. In a sense, live Twitch streams provide the digital audience most analogous to the physically co-located audiences focused on by the aforementioned prior research, which are by definition synchronous.

YouTube is another platform on which players can perform for digital audiences, but these audiences are typically asynchronous. YouTube can be used to put up previously recorded gameplay videos for others to watch and comment on. Due to the difference in synchronicity, while live-streaming Twitch users *may or may not* be aware of an audience watching them during gameplay, non-live YouTube broadcasters *cannot* be aware of such an audience because it does not exist until post-gameplay (though they may be aware of an anticipated audience).

Outside of video games, digital audiences have been shown to influence people's performance in a similar way to collocated audiences [1]. In organizational settings, several studies found that electronic performance monitoring at employees' workplaces can influence their stress levels [2] and work performance [13,35]. Similarly, there is some evidence that anticipated evaluations in e-learning environments, in which audiences are similarly physically distal, can impact learners' task performance [55]. While these studies revealed digital audience effects in organizational and instructional contexts, similar findings are missing for less formal contexts such as playing a game. Moreover, none of these studies explicitly deal with the role that competing physical, cognitive, and emotional demands might have on the awareness of, social demand from, or perceived closeness with those audiences.

The lack of research on audience awareness in game streaming presents an interesting opportunity for researchers interested in studying digital audience effects, as one necessarily needs to be aware that there are audiences watching them to experience these socio-cognitive effects. This remains true regardless of whether audience effects are due to the mere presence of audience members (which seems more relevant to in-person audiences, such as [10]) or to the more presumed evaluative nature of the audience (which can be triggered without co-location; [55]). Looking at both synchronous and asynchronous audiences as representative of the two broad types of game streaming audiences [38], the key precondition of the present research is the extent to which video game players are aware of the audience's presence. Once players are aware of their digital audience, psychological implications of this awareness move to the fore. As has been previously alluded to, the present studies focus on two of these psychological implications: a player's perceived closeness with their audience and social demands that may result from digital audience awareness.

[1] Twitch also offers the ability to archive streams so that they may be viewed by audiences asynchronously, and YouTube also allows for live broadcasting; however, this research focused on Twitch's live-streaming functionality and YouTube's asynchronous broadcasting functionality.

2.2. Sensing the presence of digital audiences

If players are aware of digital audiences, they may develop varying levels of perceived closeness with those audiences. Electronic propinquity [34,56] may provide a helpful conceptual framework in understanding how players might be aware of and feel close to their audiences. Electronic propinquity describes a sense of perceived closeness to another person in a mediated interaction (similar to more traditional concepts such as social presence [58]). Propinquity can be experienced even in the cue-lean communication contexts of computer-mediated communication, so long as interactants perceive that there are no higher-bandwidth media available [56]. Synchronous audiences generally do not have higher-bandwidth alternatives for communicating with the player than the chat function. In a sense, this digitally located audience is as functionally close as it can be to the player. Thus, we predicted (**H1**) the presence of a synchronous digital audience will increase players' feelings of propinquity.

Competing demands on the player's attention may allow or prevent them from attending to a digital audience, given our limited capacity to process mediated stimuli (cf. [36]; updated by Fisher et al. [23]). Based on prior research, the different types of demands which may be in competition for players' limited information processing capacity can be categorized into cognitive, physical, emotional, and most importantly for this research, social demand. Social demand is broadly understood as the extent to which a video game environment triggers an implicit or explicit response in the player to the presence of other social actors [7]. This is most easily seen in the context of massive multiplayer online games, in which players are required to take advantage of the unique strengths of each player and constantly coordinate with one another. However, social demand can manifest in other ways, such as through the social responses players can exhibit towards other players and avatars due to their mere presence, independent of social interactions [7].

While a digital audience is not located within the game context, it presents players with a potentially socially demanding addition to the overall gaming experience. Because players that are performing in front of a synchronous audience have access to the communication occurring around their gameplay, they may feel obligated to respond or at least pay attention to these comments. This could create an attentional conflict [3]; one shown in previous research to potentially add to social demands of being evaluated [22]. Even the act of reading and comprehending others' messages as feedback can elicit social demand, especially since generally a player cannot pause the game to redirect attention to the audience and must engage the audience while playing. Conversely, playing without an audience does not require this diverting of attentional resources, which suggests comparatively less social demand for playing without an audience. With this in mind, we expect that (**H2**) playing a video game in front of a synchronous digital audience will result in increased social demands on the player.

Producing recorded videos of video game play for an anticipated digital audience may generate social demand as well, as audiences can still provide feedback through asynchronous comments and messages, causing similar levels of evaluation apprehension [55]. Drawing from research on anticipated audiences outlined earlier [6,19], this asynchronous digital audience might affect social demand similarly as long as players are reminded that their playing will later be viewed. Similar effects were found by Cohen [14] recording participants performance in a hidden word task or Feinberg and Aiello [22] using a computer-assisted word association task. On the other hand, asynchronous audiences might not generate social demand the same way a synchronous digital audience does, as players do not have to respond immediately (or at all) to audience feedback [22]. Thus, extant theory and data do not provide sufficient consensus for making directional hypotheses. As such, we decided to pose the following research question rather than offer a formal hypothesis: Do asynchronous digital audiences influence players' feelings of (**RQ1**) propinquity and (**RQ2**) social demand?

3. Study 1

3.1. Method

3.1.1. Participants

Participants consisted of undergraduate students ($n = 113$) recruited at a public university in the Mid-Atlantic United States via email invitation using mailing lists. No a priori exclusion based on participants' gaming or streaming experience was considered (though experience was measured and controlled for; see "Measures" section). However, seven participants did not answer all questionnaire questions and five participants experienced technical difficulties, leaving a remaining sample of $N = 101$ for analysis (age $M = 20.2$, $SD = 2.02$, 48.5% male, 62.2% white or Caucasian).

3.1.2. Stimulus

This study utilized multiplayer first-person shooter game *Call of Duty: Black Ops II* (*CoD*). Participants played against computer-controlled bots, with the objective to shoot the enemy team members while avoiding getting shot. The game was chosen primarily because it features extensive customization options; for example, match length, the presence/number of enemy bots, default starting weapons, and various other combat options are all manipulable. Two sets of game settings were created. The first was a three-minute practice round with no bots in the arena, allowing for participants to learn the controls. The second was a ten-minute team deathmatch (which placed the player on a team with four bots, fighting against five enemy bots, with the ability to cause damage to teammates deactivated). The game was played in a windowed mode on a 60-inch monitor, such that the game occupied roughly the left two-thirds of the screen. The remaining one-third of the screen was occupied with the chat window from Twitch, as the audience presence manipulation. No webcam images of participants' faces were displayed or recorded. Examples of this screen set-up, as well as sample images from the research lab, study materials (such as experimental confederate scripts), and data analysis files, are all included in an open-access supplemental folder: https://osf.io/jw3rb/.

3.1.3. Procedures

Participants arrived at the lab during a designated time slot, read and signed a consent form, and were advised they will be playing *CoD*. Prior to arrival, participants were assigned to one of three conditions, which dictated the briefing they received prior to playing the game. In one condition participants were told they would be playing by themselves (*isolation condition*), in a second condition participants were told that their gameplay would be later broadcast on YouTube (*asynchronous audience condition*), and in a third condition participants were told that they would be playing on Twitch.tv in front of a live audience (*synchronous audience condition*). Random assignment to experimental conditions resulted in $n = 33$ in the isolation condition, $n = 32$ for the asynchronous condition, and $n = 36$ for the synchronous condition.

Participants in all conditions played a brief practice session (in which they explored the game map without any enemy combatants present, as described above), and then the experimenter reset the game to the ten-minute customized game mode created for the study. All players in the study were assigned the same weapons at the start of each session. Both the practice and the actual match were preset to take place in a level modeled after a luxury cruise ship. The level is small and was chosen to provide an easily navigable (i.e., few areas to be lost in) space, to accommodate novice players.

After resetting the game settings following the practice round, the experimenter instructed participants to start playing and left the room. While the participant played the game, lab workers who were logged in as spectators for the live stream posted in the chat box, with each post appearing in sequence on the right third of the screen while the player played the game in the left two-thirds of the screen. This occurred in all conditions, but the content of this chatbox was varied to be either an automated program (for the isolation and asynchronous audience conditions) or random users on Twitch (for the synchronous audience condition)—detailed in "Manipulations" below. When the game was finished, the screen was immediately turned off by the experimenter remotely, ensuring that recollections of the chat content were confined to information seen during active gameplay. After completing the match, participants were given a tablet and asked to answer several questionnaire items about their experience, outlined below, then debriefed and dismissed.

3.1.4. Manipulations

The presence of an audience was manipulated first through the briefing provided to participants (described above), and then through the content of the chat window on the right side of the screen. Notably, a chat window was present in all three conditions to rule out the possibility that any effects found for the synchronous audience condition might be due to the presence of a (potentially) distracting stimulus. During briefing, the experimenter explained the purpose of the streaming software differently depending on condition. Participants in the isolation condition (a comparison group meant to represent the common practice of playing without an audience, which served as the control condition for the experiment), were told the program monitored and recorded the performance of the PC. In the asynchronous audience condition, participants were told that the program recorded their gameplay onto a lab computer, to be posted later on the lab YouTube page. In the synchronous audience condition, participants were told that the program will broadcast their gameplay live for others to watch online via the lab Twitch page.

The content of the chat window provided our primary manipulation. In the isolation and asynchronous audience conditions, the experimenter advised participants that they may see an automated program posting about the performance of the PC. In actuality, lab workers typed comments from a script written to mimic periodic systematic updates that a computer might display, e.g. "RAM functioning." These comments were designed to be technical and nonsocial information, while still maintaining the presence of accumulating text on screen (see Fig. 1). In the synchronous audience condition, lab workers typed comments from two different Twitch user accounts using a script designed to mimic natural commentary about the gameplay. The screennames "user33434" and "twitchfan888" were used to mirror typical Twitch usernames. Most comments consisted of banter related to the game match in general—for example, comments on the setting (e.g. "Man Disney cruises have really gone downhill"). A few comments were written specifically to be triggered by certain inevitable game events, such as the participant being killed (e.g. "Yikes better luck next time"). These were intended to provide just enough reactivity to convince participants that the Twitch users were indeed watching them, while also ensuring the overall content remained largely uniform and applicable to a broad range of player performance (see Fig. 2). While it may be the case that certain games, genres, and types of audiences produce comments that are quite different from the content of our experimental manipulations, more generalized comments were chosen here because the goal was to signal the presence of a digital audience, more so than to accurately recreate a streaming experience. The comments ranged in valence from neutral to slightly encouraging, and approximately two comments (one by each user) were made per minute of gameplay. The rate of two comments per minute was chosen due to concerns that more frequent messages might come across as overly and artificially verbose, given that there were only two users viewing the stream. Instructions did not specify whether and how participants have to respond to what they may notice in the chat window.

No participants made any attempt to type responses into the chat window. This indicates that any effects found can be attributed to the presence of an audience, rather than interacting with said audience.

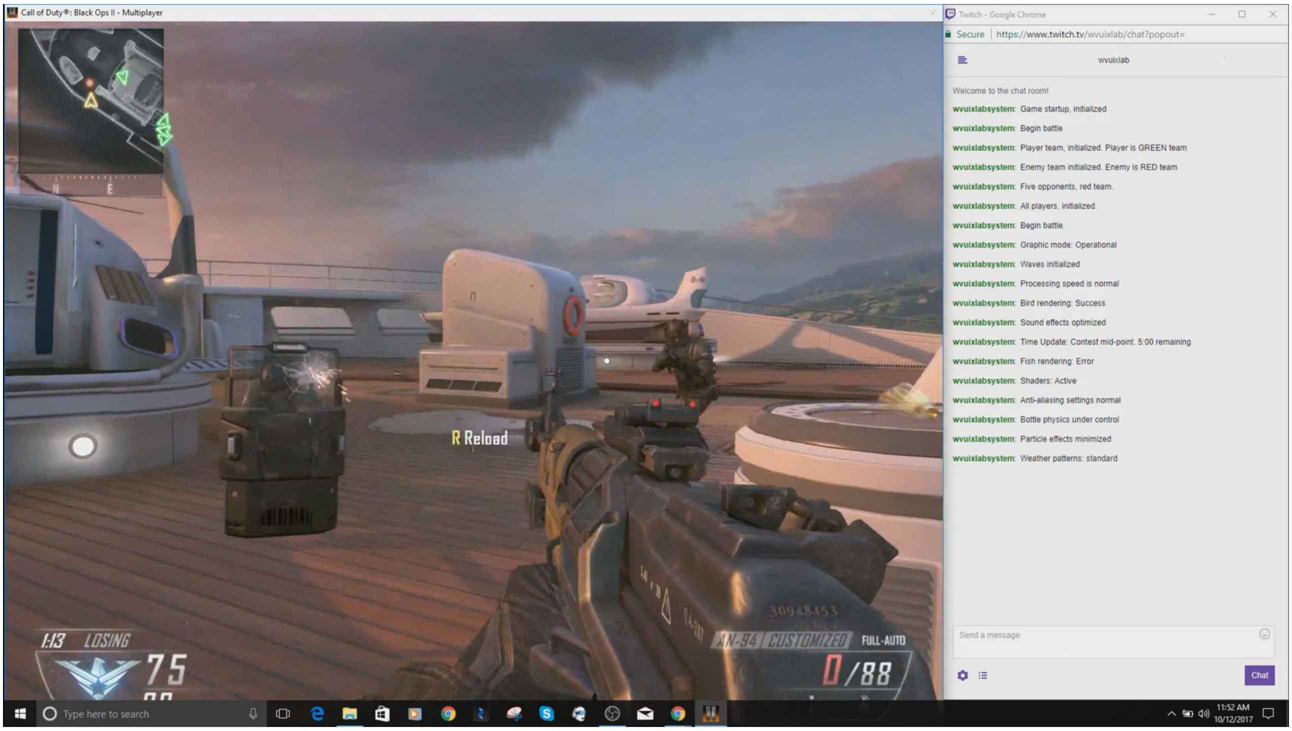

Fig. 1. Game window setup with artificial bot updates (isolation and asynchronous audience conditions).

Again, this study sought specifically to study these digital audience effects, and both Twitch and YouTube offer means by which this can be done. However, it should still be acknowledged that this setup is perhaps not the most representative of Twitch interactions as they occur on the platform—nor does it address the importance of the culture on these platforms in shaping how they are experienced[24]. We argue that the sacrifice in realism allowed for the independent variable of interest (the presence of a synchronous or asynchronous a digital audience) to be isolated and more cleanly manipulated. Such a tradeoff was deemed acceptable because this experiment was designed to better understand a single aspect of the streaming experience: digital audience awareness.

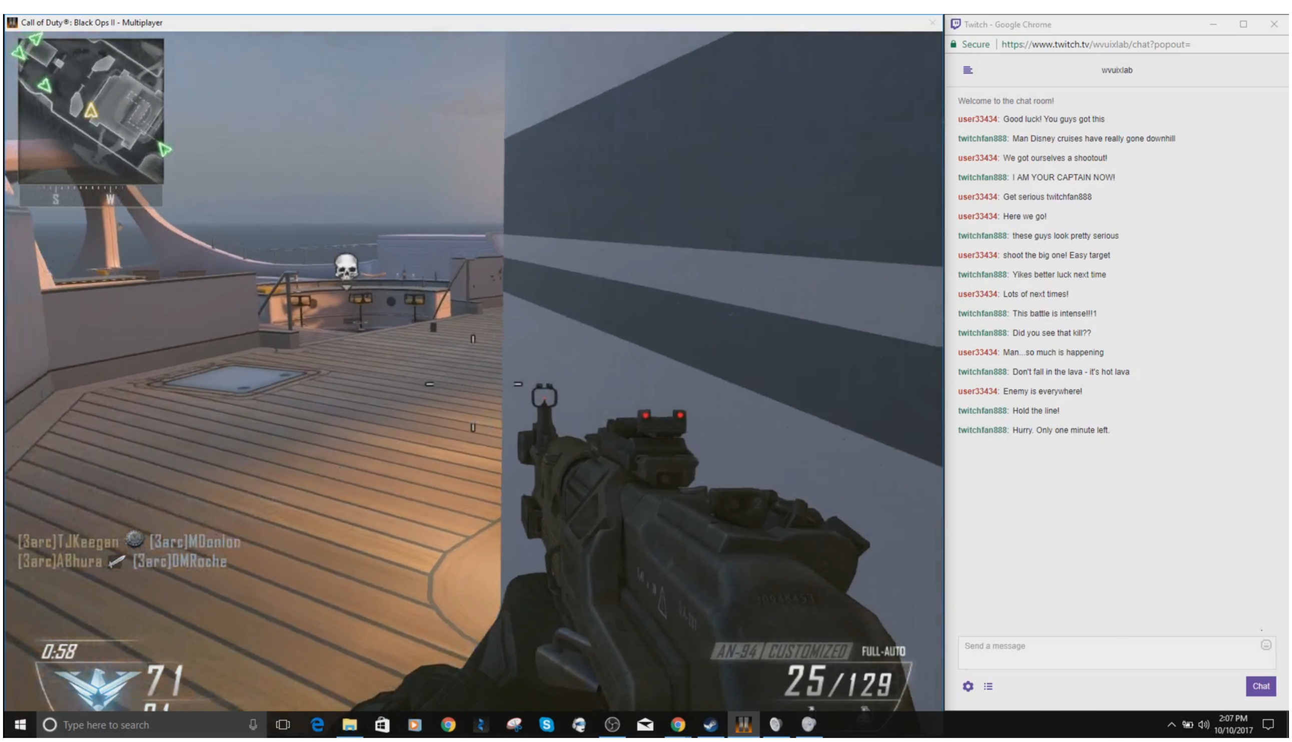

Fig. 2. Game setup with digital audience chat (synchronous audience condition).

3.1.5. Measures

Propinquity was measured using Walther and Bazarova's [56] propinquity scale, consisting of five semantic differential items which asked participants about their "awareness of others" while they were playing and included such items as "distant-nearby" and "disconnected-connected" (five-point, $M = 3.02$, $SD = 1.18$, $\alpha = 0.83$)

Video game demand was measured using Bowman, Wasserman, and Banks [9] seven-point Likert type scales that assessed both the focal construct of social demand (10 items, $M = 3.06$, $SD = 1.17$, $\alpha = 0.87$), as well as feelings of cognitive demand (7 items, $M = 4.13$, $SD = 1.12$, $\alpha = 0.75$), emotional demand (10 items, $M = 3.19$, $SD = 1.34$, $\alpha = 0.90$), and physical demand (4 items, $M = 2.19$, $SD = 1.29$, $\alpha = 0.85$)[2].

Due to difficulties encountered by previous research in measuring attentional conflict [3], we opted to measure attention to chat stream using both closed- and open-ended items. For the closed-ended items, participants answered three seven-point, Likert-style items devised by the researchers which attempted to directly assess their self-reported attention to the stream. The three items were: "During the game, I paid attention to the text scrolling on the right side of the screen," "The text on the side of the screen was distracting," and, "I did not notice the text on the side of the screen while I played the game" (reverse-coded), $M = 3.29$, $SD = 1.74$, $\alpha = 0.76$. In addition to these items, participants were also given an open-ended item that asked them to recollect what was happening in the chat box (word count: $M = 20.63$, $SD = 17.16$, $Mdn = 17$).

Several items assessed gaming experience on seven-point, Likert-style scales, including experience with video games in general ($M = 4.83$, $SD = 1.81$), games played on computer ($M = 3.19$, $SD = 1.95$), gaming with a mouse and keyboard ($M = 3.02$, $SD = 1.88$), playing first-person shooters ($M = 4.33$, $SD = 2.01$), and playing *CoD* ($M = 3.85$, $SD = 2.21$). Participants also self-reported their level of perceived video game skill, using ten items from Bracken and Skalski [60] (2006); sample items include "I have good video game playing skills" and "I can easily figure out how to play new games" ($M = 4.53$, $SD = 1.73$, $\alpha = 0.97$). In addition, we assessed participants performance at the game itself, using both their total number of kills ($M = 18.5$, $SD = 13.1$) and ratio of kills to deaths ($M = 1.55$, $SD = 1.51$). These measures were used as control variables in hypothesis testing.

3.2. Results

3.2.1. Manipulation check

Although the three audience conditions were directly controlled by the researchers and our manipulations were thus prima facie successful, we used self-reported attention paid to the chat window as proxy measures to understand the extent to which participants in our study were aware of the presence of an audience. A one-way ANOVA with condition (isolation, asynchronous audience, synchronous audience) as the independent variable and the attention composite as the dependent variable showed expected significant differences in attention between conditions, $F(2,98) = 9.18$, $p < .001$, $\eta^2 = 0.158$. Post hoc Scheffé tests showed that participants in the synchronous audience condition ($M = 4.20$, $SD = 1.77$) were significantly more likely to have paid attention to the chat window than participants in isolation condition ($M = 2.88$, $SD = 1.62$, $p = .004$, Cohen's $d = 0.78$) or the asynchronous audience condition ($M = 2.68$, $SD = 1.39$, $p = .001$, $d = 0.95$). Participants in the isolation and asynchronous audience conditions did not differ in their attention to the chat window ($p = .875$, $d = 0.13$). These results indicate that the manipulation was successful.

We also checked to see if the experiences of players were similar across conditions, with respect to the elements of demand not focal to this study—cognitive (which would relate to the on-screen challenges), physical (associated with the controller mechanisms), and emotional (concerned with the on-screen narrative). Mean comparisons demonstrated that these scores did not differ significantly across experimental conditions, Wilks' $\Lambda = 0.991$, $F(6, 192) = 0.15$, $p = .989$, $\eta^2 = 0.005$. Thus, the conditions did not differ in terms of how much they challenged, emotionally impacted, or required players to engage the controls.

3.2.2. Hypothesis testing

Our study hypotheses and research questions were concerned with the impacts of both live-streaming (H1 and H2) or asynchronous streaming (RQ1 and RQ2) on feelings of propinquity and social demand. First, given the conceptual similarity between these two measures, their correlation was analyzed, $r(99) = 0.334$, $p = .001$. Given this significant correlation, H1 and H2 were then tested in the same multivariate analysis of covariance (MANCOVA) model, with prior gamer experience and in-game performance measures entered as control measures. In order to prevent multicollinearity and reduce the statistical complexity of our model, we followed Park, Dailey, and Lemus' [42] recommendations and performed a principal components analysis (PCA) on our control variables concerning participants' in-game performance (total number of kills and kill-death ratio) as well as their prior gaming experience (gaming in general, gaming on PC, gaming with mouse and keyboard, playing first person shooters, playing *CoD*) and self-attributed gaming skill. Assumptions of sampling adequacy were met, Kaiser-Meyer-Olkin = 0.831, Bartlett's $\chi^2(28) = 704.41$, $p < .001$, and the analysis reported two underlying components that explained 81.4% of variance in the latent construct: gamer performance broadly (perceived gaming skill, prior experience gaming, playing first person shooters, *CoD*, and performance at *CoD*) and PC-specific gaming experience (gaming on PC, gaming with mouse and keyboard). The measures shared a moderate correlation, $r(99) = 0.342$, $p = .001$. Factor loadings were all above 0.700 on home factors, with no cross loadings greater than 0.250. These two standardized factor scores (regression method) were used as covariates (see supplemental files for complete PCA output).

The omnibus MANCOVA did not reveal significant mean differences between experimental groups, Wilks' $\Lambda = 0.955$, $F(4, 186) = 1.07$, $p = .371$, $\eta^2 = 0.023$, and neither set of control variables had a significant impact on the model (gamer performance, Wilks' $\Lambda = 0.991$, $F(2, 93) = 0.44$, $p = .648$, $\eta^2 = 0.005$; PC-specific gaming experience, Wilks' $\Lambda = 0.986$, $F(2, 93) = 0.66$, $p = .520$, $\eta^2 = 0.007$, respectively). Neither between-subjects effects of condition on propinquity or social demand were significant, although the means did trend in the expected direction for social demand (see Table 1). These data do not support H1 or H2, and suggest the absence of both effects suggested in RQ1 and RQ2. Replication without control variables (MANOVA) reproduced these results. These data suggest a nonsignificant and nominal influence of audience presence type on either feelings of propinquity or perceptions of social demand.

3.2.3. Open-ended thematic analysis

Given the successful induction of audience presence (increased attention towards the chat in the synchronous audience condition), yet the non-significant influence of this live-streaming audience on both propinquity and social demand, we probed participants open-ended recollections of the experience using a grounded theory approach [26]. The first author of our manuscript randomized all participant responses before reading them for emergent themes and coded the sample to

[2] This version of the VGDS scale was an early iteration of the factor analysis presented in Bowman et al. [10] that did not include the bifurcated physical demand dimensions of physical exertion and controller naturalness, outlined in the referenced manuscript. The revised and current version of VGDS was used in the replication (Study 2 of this manuscript), and both scales are included in the supplemental space for comparison.

Table 1
Mean differences on propinquity and social demand by condition in Study 1.

	Twitch	YouTube	Isolation	Between-Subjects ANOVA
Propinquity	3.17 (1.10)	2.96 (1.26)	2.88 (1.20)	$F(2, 98) = 0.415, p = .662, \eta^2 = 0.009$
Social demand	3.37 (1.22)	2.99 (1.12)	2.80 (1.14)	$F(2, 98) = 2.17, p = .120, \eta^2 = 0.044$

theoretical saturation using a constant comparison method, with theoretical saturation defined *a priori* as when five percent of the data ($n = 5$ cases) failed to produce a unique theme (reached at $n = 24$ participants). The remaining data was inspected for the presence or absence of these themes. Themes were identified at the utterance level, defined as a word or phrase articulating a complete thought. Each utterance could only be assigned one theme, but a participant response could contain more than one utterance (i.e., more than one mutually-exclusive theme).

A total of five repeating themes were found (see Table 2).[3] Chi-square tests comparing the distribution of these themes across conditions found that the distribution of game details, $\chi^2(2) = 17.72$, $p < .001$, Cramer's $V = 0.439$, audience commentary, $\chi^2(2) = 41.76$, $p < .001$, Cramer's $V = 0.670$, and minimal chat attention, $\chi^2(2) = 6.18$, $p = .046$, Cramer's $V = 0.258$ had significant differences. Post hoc analyses (using Bonferroni correction) revealed that the number of mentions of audience commentary (e.g., "chatting about strategy') was highest in the synchronous audience condition, and the number of mentions of our faux program details ("everything was operational") and minimal chat attention ("did not once actually glance over") was lowest in that condition.

4. Study 2

The results of Study 1 indicated that participants were aware of their audiences, but did not experience any closeness or social demand as a result of this awareness. That said, there exists the possibility that these results could have been influenced by sampling error or be otherwise the result of chance. Replication of findings is essential for gaining confidence in the veracity and generalizability of obtained results [5,40]. Hence, Study 2 consisted of an exact replication of Study 1, utilizing a novel population and employing the same predictions and methods.

4.1. Methods

4.1.1. Participants

The replication included 107 participants ($n = 101$ students, $n = 6$ employees) recruited via email invitation distributed across a public university community in Germany. Again, we did not exclude participants based on their video game or streaming experience. Five participants who experienced technical difficulties and one participant who experienced a health problem during the study were excluded from analysis, leaving a final sample of 101 participants (age $M = 24.09$ years, $SD = 3.78$, range: 18–43 years) with 29 individuals identifying themselves as male (28.7%) and 72 as female (71.3%).

4.1.2. Stimulus, procedures, and manipulation

The second study replicated the experimental conditions of the initial study as closely as possible. However, based on experiences during the first study as well as additional test trials, we decided to perform a few minor modifications. The experimental setup was downsized from the 60-inch monitor in Study 1 to a 27-inch monitor, while keeping the 2:1 ratio between the game and chat window—similar to what we might expect in a naturalistic gaming setting, such as playing games on one's personal computer. Also, while participants had a three-minute practice period in Study 1, we allowed participants between three and ten minutes of practice in the second study to ensure that ample time was allowed to have a felt competency with the game. This was also to allow for the possibility that null findings in Study 1 might have been due to an unexpectedly high cognitive demand that might have pulled player's attention away from the streaming audience (in Study 1, cognitive demand scores, while not significantly higher than moderate on the scale, were significantly higher than the other three demand sources, i.e. emotional, physical, and social, Wilks' $\Lambda = 0.317$, $F(3, 98) = 70.29$, $p < .001$, $\eta^2 = 0.683$). Lastly, we changed the screen-names of our confederate Twitch users to "mediapsychology2" and "mediapsychology3", instructing participants that due to new data protection regulations in Germany, we were obliged to anonymize Twitch users as we recorded their comments. Aside from these slight modifications and the change of language, our second study was identical to Study 1 with respect to stimulus usage, manipulation of experimental conditions, study measures, and study procedure. As with Study 1, no participants attempted to type responses into the chat window. Random assignment to experimental conditions resulted in $n = 35$ in the isolation condition, $n = 34$ for the asynchronous audience condition, and $n = 32$ for the synchronous audience condition.

4.1.3. Measures

Participants completed the same scales as in Study 1, which were carefully translated to German by the second author and two student assistants with highly proficient language skills and no further information about the study. Accordingly, propinquity was measured using five semantic differentials (five-point; $M = 2.70$, $SD = 0.96$, $\alpha = 0.90$). Participants' attention to the chat stream was again measured via three closed-ended items (seven-point Likert scale; $M = 2.47$, $SD = 1.54$, $\alpha = 0.87$) as well as an open-ended item asking what was happening in the chat window during the game session (word length: $M = 9.65$, $SD = 7.70$, $Mdn = 7$).

Gaming experience was measured via single closed-ended, seven-point, Likert-style items on experience with video games in general ($M = 3.81$, $SD = 1.75$), games played on computer ($M = 3.73$, $SD = 1.64$), gaming with mouse and keyboard ($M = 3.55$, $SD = 1.75$,), playing first-person shooters ($M = 2.73$, $SD = 1.75$), and playing *CoD* ($M = 1.64$, $SD = 1.12$). Self-reported video game skill was measured using ten closed-ended items ($M = 3.42$, $SD = 1.54$, $\alpha = 0.95$). We assessed participants' demand during gameplay via the German version of the video game demand scale by Bowman and Koban [8]. The scale applies seven-point Likert scales to measure social demand (6 items, $M = 2.81$, $SD = 1.03$, $\alpha = 0.71$), cognitive demand (7 items, $M = 3.93$, $SD = 1.09$, $\alpha = 0.78$), emotional demand (5 items, $M = 2.75$, $SD = 1.20$, $\alpha = 0.80$), as well as controller demand (3 items, $M = 4.56$, $SD = 1.35$, $\alpha = 0.79$) and exertional demand (4 items, $M = 3.03$, $SD = 1.41$, $\alpha = 0.83$). This scale replicates the revised scale in Bowman et al. [9].[4]

[3] In addition to these five, an initial read revealed three additional themes, but these themes occurred in insufficient quantities (three times or less, sample-wide) to be included in the analysis.

[4] The revised demand scale was used because it has been recently validated in both English and German. However, all items from the original scale were also retained in the Study 2 questionnaire as well. No substantive differences were found in the results when using the original versus the revised scale. The analysis using the original demand items for Study 2 can be found in our supplemental OSF online files.

Table 2
Emergent themes from open-ended recollections in Study 1.

Theme	Definition	Sample	Freq. (isol.)	Freq. (stream)	Freq. (YTube)	$\chi^2(2)$ [Cramer's V]
(Faux) program details	Details or game events not directly tied to either team's performance	"Scanning the commands to make sure everything was operational"	13_a	2_b	16_a	17.721, p < .001 [0.439]
Audience commentary	Mentions an audience making comments about the game	"I think they were chatting about strategies and just having conversation"	4_a	24_b	1_a	41.76, *p* < .001 [0.670]
Minimal chat attention	Explicit statement of paying little or no attention to the chat window	"I did not once actually glance over to it."	12_a	5_a	12_a	6.18, *p* = .046 [0.258]
Focused on the game	Indicates being focused on the game	"…all my attention was on the game."	6_a	1_a	5_a	4.50, *p* = .106 [0.220]
Do not know	Participant indicates they simply don't know	"I have no idea"	5_a	3_a	4_a	0.734, *p* = .693 [0.089]

Note: Frequencies with different subscripts differ at the p < .05 level or greater (Bonferroni).

We also assessed participants' performance at the game, via their total number of kills (M = 15.36, SD = 12.62) and their kill/death ratio (M = 1.34, SD = 1.45). Additionally, we asked participants via two single seven-point Likert-type items about their game streaming experience as a viewer (M = 1.92, SD = 1.50) and as a streamer (M = 1.20, SD = 0.65); these measures were not taken in Study 1.

4.2. Results

4.2.1. Sample comparisons

While both studies sampled from college campuses, measures from both studies were directly compared to identify potential variance on focal variables. With respect to demographics, the German replication sample was significantly older, Welch's $t(153) = 9.12$, $p < .001$, $d = 1.28$, and had more females, $\chi^2(1) = 9.08$, $p = .002$, $\phi = 0.21$.

The German sample also scored lower on propinquity overall, Welch's $t(192) = 2.11$, $p < .001$, $d = 0.30$ and reported paying less attention overall to the chat stream as compared to the US sample, Welch's $t(197) = 3.55$, $p < .001$, $d = 0.50$. The German sample also wrote significantly less when describing the on-screen chat, $t(139) = 5.87$, $p < .001$, $d = 0.83$.

With respect to gaming experience, the German sample reported lower scores on: overall gaming experience, Welch's $t(200) = 4.07$, $p < .001$, $d = 0.57$; playing first-person shooters, Welch's $t(196) = 6.03$, $p < .001$, $d = 0.85$, playing *CoD*, Welch's $t(148) = 8.96$, $p < .001$, $d = 1.26$, and video game skills, Welch's $t(197) = 4.83$, $p < .001$, $d = 0.68$. German participants were significantly more experienced playing games on a computer, Welch's $t(194) = 2.13$, $p = .034$, $d = 0.30$, and gaming with mouse and keyboard, Welch's $t(199) = 2.07$, $p = .039$, $d = 0.29$. Notably given variance in items used for video game demand from Study 1 and Study 2, direct mean comparisons are not made here.

With respect to in-game performance, the samples did not differ in total number of kills recorded, $t(200) = 1.73$, $p = .084$, $d = 0.24$, or in the ratio of kills to deaths, $t(200) = 1.01$, $p = .314$, $d = 0.14$.

4.2.2. Manipulation check

Similar to Study 1, we first conducted a one-way ANOVA with condition (no audience vs. asynchronous audience vs. synchronous audience) as the between-subjects factor and participants' attention to the chat window as the dependent variable. Results showed a significant difference in attention between conditions, $F(2,98) = 5.78$, $p = .004$, $\eta^2 = 0.106$, with post hoc Scheffé tests demonstrating that participants in the synchronous audience condition (M = 3.19, SD = 1.60) paid significantly more attention to the chat than participants without an audience (M = 2.26, SD = 1.65, $p = .043$, $d = 0.57$) or participants in the asynchronous audience condition (M = 2.02, SD = 1.12, $p = .007$, $d = 0.85$). No difference was found between participants with no audience and participants with an asynchronous audience ($p = .787$, $d = 0.17$) and, as with Study 1, these results indicate that our manipulation was successful.

Again, we also tested via a MANOVA whether participants' cognitive, emotional, controller and exertional demand during the game was similar across conditions. Unlike Study 1, multivariate testing revealed a significant effect across experimental conditions, Wilks' $\Lambda = 0.85$, $F(8, 190) = 1.99$, $p = .049$, $\eta^2 = 0.078$. Subsequent univariate tests showed significant effects for both forms of physical demand, namely controller demand, $F(2, 98) = 3.94$, $p = .023$, $\eta^2 = 0.074$, and exertional demand, $F(2, 98) = 3.71$, $p = .028$, $\eta^2 = 0.070$. Post hoc Scheffé tests reported that participants in the asynchronous audience condition experienced more controller demand (M = 5.06, SD = 1.48) than participants in the synchronous audience condition (M = 4.19, SD = 1.29, $p = .029$, $d = 0.63$), with no other differences reported at the $p < .05$ level. Despite the significant univariate test, no significant differences between experimental conditions were found regarding exertional demand ($ps \geq 0.058$, $d \leq 0.67$). Moreover, no differences in cognitive demand, $F(2, 98) = 1.59$, $p = .210$, $\eta^2 = 0.031$, or emotional demand, $F(2,98) = 1.90$, $p = .156$, $\eta^2 = 0.037$, were found.

4.2.3. Hypothesis testing

As in Study 1, we analyzed whether a synchronous (H1 and H2) or an asynchronous audience (RQ1 and RQ2) influence participants' feelings of propinquity and social demand using a MANCOVA since both dependent variables were significantly related to each other, $r(99) = 0.325$, $p = .001$. In order to prevent multicollinearity, we again performed a PCA on our control variables concerning in-game performance and prior gaming experience (eight total measures). Assumptions of sampling adequacy were met, Kaiser-Meyer-Olkin = 0.867, Bartlett's $\chi^2(28) = 841.88$, $p < .001$. In contrast to the two-component solution in Study 1, PCA resulted in a single underlying component with an eigenvalue over one, explaining 72.10% of variance of the latent construct. Communalities were above 0.400 as well as factor loadings above 0.700 for each control variable, except for participants' prior experience with playing *CoD* (communality = 0.352, factor loading = 0.593), which was therefore excluded. A second PCA with seven control variables (Kaiser-Meyer-Olkin = 0.874, Bartlett's $\chi^2(21) = 794.35$, $p < .001$) again found a single underlying component that explained 77.93% of variance of the latent construct with communalities above 0.696 and factor loadings above 0.834 for all indicators (see supplemental files for complete PCA output). Thus, the MANCOVA was conducted with the standardized factor score (regression method) as a single covariate.

Similar to Study 1, the omnibus MANCOVA did not reveal significant differences between conditions, Wilks' $\Lambda = 0.977$, $F(4, 192) = 0.51$, $p = .687$, $\eta^2 = 0.012$. The amalgamated covariate representing gaming experience did not have a significant impact on the model, Wilks' $\Lambda = 0.968$, $F(2, 96) = 1.56$, $p = .215$, $\eta^2 = 0.016$. Even though means did indicate a slight trend in the expected direction for social demand (as in Study 1), neither univariate effect of condition on propinquity or social demand reported a significant result, and both reported negligible effect sizes (see Table 3). These data do not support H1 and H2 and indicate the absence of both effects assumed in RQ1 and RQ2, replicating the results of Study 1. Results remained unchanged without control variables (MANOVA) as well as after controlling for experience with Twitch (a variable added for Study 2).

4.2.4. Open-ended thematic analysis

To analyze participants' open-ended recollections about what had happened in the chat window during their game sessions, we applied the same thematic classifications as in Study 1 to identify the presence or absence of these themes at the utterance level. Unlike in Study 1, only four themes were found repeatedly (see Table 4). We compared the distribution of these four themes across experimental conditions (no audience vs. asynchronous audience vs. synchronous audience) by calculating chi-squared tests. Similar to the results of the first study, we found that the distribution of '(faux) program details', $\chi^2(2) = 29.84$, $p < .001$, Cramer's $V = 0.544$, and 'audience commentary', $\chi^2(2) = 70.90$, $p < .001$, Cramer's $V = 0.838$, differed between conditions, though no significant differences were found for 'minimal chat attention', $\chi^2(2) = 5.12$, $p = .077$, Cramer's $V = 0.225$, or 'do not know', $\chi^2(2) = 1.64$, $p = .441$, Cramer's $V = 0.127$. Post hoc analyses (using Bonferroni correction) again revealed that the number of mentions of audience commentary was significantly higher and the number of mentions of details of our faux program was significantly lower in the synchronous audience condition compared to both other conditions.

5. Discussion

The purpose of our studies was to explore whether synchronous and asynchronous digital audiences impact video game players in a similar manner to forms of co-located social gaming—specifically by raising perceived propinquity and social demand. Much evidence from social facilitation literature [6,19,59] has demonstrated that the presence of such audiences can impact performance at different tasks, and video games specifically [10], but these effects rest on the assumption that players are aware that they are being watched and can attend to this fact.

Results of both studies indicate that players are aware of synchronous audiences during gameplay. The studies were successful at using scripted confederates to simulate a digital gaming audience, as evidenced by higher ratings in players' attention to the chat and the higher number of participants who explicitly mentioned the audience in the chat window in the synchronous audience condition. The open-ended data was particularly telling, as not only did participants recall that the chat window contained an audience, but several of them mentioned explicit lines of dialogue from the chat transcripts (e.g., "silly joke about how 'Disney cruises have really gone downhill'") or the specific user names and personalities of the fictitious Twitch users ("twitchfan888 was being a jokester"). Participants in Study 1 mentioned devoting minimal attention to the chat significantly less when they were told there would be an audience watching them than when they were told the chat box would contain only technical information. Taken together, there is strong evidence here that people in both studies were consciously aware of their digital audience while they were playing the game. At the same time, players in all conditions were able to recall with equal frequency the content of their respective chat

Table 3
Mean differences on propinquity and social demand by condition in Study 2.

	Twitch	YouTube	Isolation	Between-Subjects ANOVA
Propinquity	2.67 (0.96)	2.75 (0.97)	2.68 (0.98)	$F(2, 97) = 0.05$, $p = .947$, $\eta^2 = 0.001$
Social demand	2.94 (1.06)	2.83 (1.05)	2.66 (0.99)	$F(2, 97) = 0.97$, $p = .382$, $\eta^2 = 0.019$

Table 4
Emergent themes from open-ended recollections in Study 2.

Theme	Definition	Freq. (isol.)	Freq. (stream)	Freq. (YTube)	$\chi^2(2)$ [Cramer's V]
(Faux) program details	Details or game events not directly tied to either team's performance	21a	1b	21a	29.84, $p < .001$ [0.544]
Audience commentary	Mentions an audience making comments about the game	1a	27b	1a	70.90, $p < .001$ [0.838]
Minimal chat attention	Explicit statement of paying little or no attention to the chat window	5a	4a	11a	5.12, $p = .077$ [0.225]
Do not know	Participant indicates they simply don't know	4a	1a	3a	1.64, $p = .441$ [0.127]

Note: Frequencies with different subscripts differ at the $p < .05$ level or greater (Bonferroni).

windows (faux program details in the isolation and asynchronous audience conditions, and audience commentary in the synchronous audience condition). This might suggest that the text-based commentary was seen as impersonal, across the board—comments adding to atmospheric nature of the online gaming experience, but not being particularly relevant or consequential for the player. Notably, this contrasts with the types of social interactions that we might expect to occur with physically collocated spectators, particularly when those spectators are friends and family members or otherwise have some tie to the player.

Although participants reported being more attentive to the chat streams in the synchronous audience condition, this increased attention did not impact their feelings of closeness to the audience, nor did it elicit significant feelings of social demand (although means trended in that direction, effect sizes were nominal). Notably, and with the exception of a slight increase of controller demand for Study 2 participants in the asynchronous audience condition (which we are unable to offer explanation for), all other demands were equal across conditions. Though the effects on both social demand and propinquity were non-significant, the sample size of $n = 101$ in both studies could have resulted in Type II error. Yet, only about 4% of the variance in social demand was explained by presence of an audience in the first study, and this variance was reduced to 2% in the second study. Even smaller effects (with below 1% of variance explained) were found for participants' feelings of propinquity. Based on these effect sizes, which would require large samples of around 500–1000 players to achieve sufficient test power, we would argue that streamers' awareness of their digital audience might influence them to a very limited extent, if at all. This leads to the rather surprising finding that cognizance of a digital audience does not appear to generate the same effects seen in the presence of physically co-present audiences.

One reason propinquity did not vary across conditions could be that participants had a lower motivation to engage with the audience. Predicted outcome value theory holds that anticipated future interactions are key in determining whether interactants engage with one another [49]. Participants likely did not anticipate any such future interactions. This explanation might also explain the lack of difference in social demand, as the relevance of this chat might have been insufficient to elicit any effortful processing [7]. Stemming from this, it may be the case that the audiences being strangers could have had an effect on the results, limiting the amount of closeness and social demand experienced by the player. Previous work has shown that prior relationships between players and audience members can change the dynamic of how the two interact in tandem play [18]. In this research, players either had no audience or an audience of strangers, but future work could benefit by manipulating the prior relationship between player and audience and evaluate this variable's effect on propinquity and social demand.

An alternative explanation could be that participants in the study were induced into flow states [20]. Characteristic of flow is a loss of awareness of cues external to the task at hand. Players in a flow state might be unable to attend to extraneous audience cues. This explanation might be valid even though participants in both studies were able to recall specifics from audience commentary, as gameplay included brief periods of downtime after each death. Specifically, during these periods players might have been pulled out of the flow state for a short moment to focus on the chat window only to be induced into flow again once the game resumes. Players may even choose to purposely engage with the chat or choose not to engage with it in order to dynamically maintain the optimal cognitive challenge necessary to maintain a flow state [11]. Alternatively, it is plausible that the social aspects of streaming are *part* of the experience, and contribute to an overall state of flow (such as the synchronization perspective of flow put forward by [57]. Given that flow is strongly associated with enjoyment and with optimized performance [20,45], the fact that enjoyment scores and performance scores (kill/death ratios) were correlated in both studies (Study 1, $r(98) = 0.337$; Study 2, $r(99) = 0.445$) suggests at least trace evidence that participants might have experienced flow states—a question for future research.

Though our null results for propinquity and social demand were surprising, they have interesting implications for future work looking at digital audience effects. A fitting interpretation of these results is that people might be able to "tune out" digital audiences to a greater extent than can be done with a physically co-present audience, even if they are explicitly aware of the digital audience's presence. Hence, while physically co-present evaluative audiences are typically appraised as either challenge or threat [22], neither of these appraisals might be salient with digital audiences. If a player can tune out the commentators altogether, it makes sense that they would feel little closeness with the audience or social obligations to respond to them. One theme in the open-ended data that emerged in Study 1 was that players focused their attention on their own performance. Such an effect speaks to an active directing of attention to the primary cognitive and physical challenges of the game, and the intentional reallocation of attention away from social demands [7]. While this theme was mentioned a relatively low number of times, and only in Study 1, the idea that players may be focused on performance regardless of audiences is corroborated by explorative MANCOVAs which demonstrated that performance was unaffected by the presence of an audience, as measured by either kill/death ratios or overall point totals (both output by the game), Study 1: Wilks' $\Lambda = 0.948$, $F(4, 178) = 1.21$, $p = .307$, $\eta^2 = 0.026$; Study 2: Wilks' $\Lambda = 0.967$, $F(4, 180) = 0.75$, $p = .559$, $\eta^2 = 0.017$). Controlling for skills and experience, people tend to focus on their primary task of playing the game. This data effectively rules out the potential for a mere (digital) presence explanation of social facilitation to take place, as participants were clearly aware of audiences in the synchronous audience condition and yet, there was no impact on performance. However, this claim should be qualified in that the current study did not assess players' cognitive abilities (such as mental rotation ability), and audience presence effects should be particularly relevant for players with superior skills. This is an area for future research, although we point out that Bowman et al. [10] did not find audience presence to hinder performance for low-skill players. Notably, our observed null findings took place in a sample of experienced players (Study 1) and comparatively inexperienced players (Study 2), which might suggest gaming-relevant skill to be less relevant here. Incorporating more nuanced measures of player skill is suggested for replication of this work.

Taken together, our findings provide evidence that streaming gameplay to digital audiences, seemingly a digital extension of longstanding social gaming practices, may not be quite as social of an experience as it appears. This is an important step in understanding the processes underlying non-professional players' streaming experience as well as motivations and gratifications that drive them to broadcast their own gameplay online. If people can be aware of, and then tune-out, a digital audience, it raises questions about why users (in particular, non-interactive streamers) would seek out audiences at all. It may be that the technologically mediated nature of digital audiences provides these users greater leeway in terms of mentally prioritizing different aspects of their social gaming experience. That is, with a physically collocated audience actively communicating tips, feedback, etc. during gameplay, the audience's immediacy (along with social norms and expectations) might lead a player to feel that such communications should be attended to and responded to right away (thereby increasing the social demand and perceived closeness of those interactions). When the audience is digital, the player may feel less of a requirement to respond, and thus more free to choose to attend to either the audience or gameplay, or both. Hence, game streaming, and digital audiences in general, may represent a more controlled means by which players can experience social gaming, managing their engagement to be only as social as they wish it to be. Such an interpretation is consistent with the findings of the present research, and empirical groundwork is laid here from which these questions can be further explored. From a practical standpoint, this conclusion may also encourage game developers to further implement easily accessible gateways into streaming and broadcasting for everyday players due to the low-risk/high-reward character of playing in front of small digital audiences. To connect this to our broader focus, the notion of digital audiences being more amenable to mental reprioritization would have implications well beyond game streaming, and could help explain the appeal of live streaming across and digital audiences in a variety of domains—also directions for future work.

5.1. Limitations and future research directions

There are several limitations to both studies that must be acknowledged, along with those already mentioned. Even though our studies did not focus on game broadcasting/streaming per se, one such limitation is that player's experience with game streaming (as streamers or as players) was not assessed in Study 1. This limitation was remedied in Study 2, which did include Twitch experience as a covariate, and this covariate had no appreciable impact on the observed results (albeit Twitch experience was overall low in Study 2). We reiterate that ours was not a study on professional game streamers or streaming culture, and we intentionally did not purposely sample game streamers because we wanted to avoid conflating digital audience presence with players who actively and commonly (and sometimes professionally) seek out those audiences. That said, different effects for a sample of more experienced streamers might be plausible. Previous research has indicated that popular streamers engage in social behaviors in order to bond with their digital audience [46]. Professional streamers are aware that a primary motivation for engaging their streams (a precondition or monetizing the streams) is that audiences seek out these social interactions [29]. Experienced streamers, who are more used to playing with a digital audience, might not be willing—or, by habit, able—to tune out an audience. Even without interacting with audience members, these individuals might experience both a closer connection with their viewers and higher social demands. Other work utilizing active streamers which demonstrated that players who stream their gameplay perform worse than players who do not stream their gameplay [39] lends some credence to the idea that experienced game streamers may be affected by audiences more so than our relatively inexperienced sample of gamers. Honing in on the role of experience and familiarity with game streaming platforms as both an audience and a streamer are goals of future work. All that being said, while our sample may not be representative of the most active game streamers, not all streamers on these platforms are highly active and experienced. Choosing not to specifically sample frequent streamers or gamers means that the obtained results from Studies 1 and 2 can shed light on the experiences of some of the more casual, novice, or infrequent streamers on these platforms—a portion of the market that should probably not be ignored.

Furthermore, digital audiences can be substantially larger than two people (even though many people happen to play in front of similar small digital audiences). Beyond the numbers, digital audiences are rarely limited to solely neutral-to-positive content and can often be characterized as toxic [16]. These stimuli characteristics were considered appropriate for our general psychological interest, and they replicated the physical audience conditions from Bowman et al. [10]. However, they may represent a limitation for an applied perspective as both studies' conditions were (intendedly so) not representative of the range of digital gaming audiences that exist on platforms such as YouTube or Twitch. Addressing larger and more naturalistic digital audiences is the logical next step in both directions. Audience awareness may be more effective psychologically once the audience exceeds a certain threshold of active or passive audience members, and exploring this threshold might help expand knowledge about the audience's role in the appeal of game streaming and game broadcasting.

Another potential limitation is that our studies, following Bowman et al. [10], used a first-person shooter game, which may have unique properties that draw attention away from audiences. The fast-paced nature and first-person perspective of the game may limit overall the amount of attention that can be allocated to audiences, drawing attention to other, nonsocial aspects of the game. Future research should replicate these procedures using other, less intensive game genres to see if audience effects might then emerge.

Additionally, playing with teammates, even non-player characters, might add another layer to the social demand dynamics, as might playing against human-controlled opponents. In this study, computer-controlled bots were used rather than pairing participants against online opponents in order to control the level of difficulty faced by participants. Such human participants might themselves be considered an audience of sorts in a gaming experience. Future research could investigate whether human-controlled opponents or teammates contribute to increased social demand and propinquity. Furthermore, increases in propinquity might play a role in fostering collaboration, competition, or just the overall enjoyment of the experience (or lack thereof). Collaboration and competition are central mechanics underlying many popular video games, and it behooves researchers to look further into how propinquity and social demand can elicit these experiences. The results presented here demonstrate that just being aware of social others in a digital audience is not enough to generate propinquity or social demand, at least for casual gamers. However, future research could examine the relationships between awareness of other in-game players, propinquity, and social demand, and the role that these experiences play in collaboration, competition, and enjoyment. Research should also replicate our procedures using games without team dynamics, in case the computer-controlled teammates themselves have some kind of influence on social demand and propinquity. Knowledge of this kind can not only aid researchers, but also game designers who are interested in building games that foster specific types of experiences, such as closeness with other players or characters.

Future research might also begin to assess whether the results found here generalize to digital audiences outside of the gaming context. Popular streaming and broadcasting platforms host a number of video genres that involve performing tasks that are not game-related, such as cooking and live music performances. It could be that some types of content lend themselves more towards audience awareness than others, and that features unique to different genres of content might impact one's ability to experience closeness and social demand from a digital audience. For example, content which centers around explaining a process to an audience or instructing audiences in a skill may place the audience much more at the forefront of the producer's mind than at least some types of gaming sessions (e.g., those that are centered more around showcasing one's own skill than instructing audiences). Additional research could help flesh out unique content features that impact the relative salience of digital audiences.

Lastly, it must also be noted that our studies implemented a commenting instead of a silent digital audience. Therefore, the study cannot easily distinguish between effects of simply the presence of a digital audience, and effects which arise from the (here, typed) commentary of said audience. As our studies (unexpectedly) revealed that players are very much aware of their digital audiences but without experiencing audience effects, this conceptual limitation appears unproblematic—if not beneficial. Compared to the mere presence of passive viewers who might have been easier to tune out, an active audience implies that viewers are attentive and evaluative. By demonstrating no audience effect, our results indicate that digital audiences can be processed differently than collocated audiences.

5.2. Conclusion

Both studies set out to see whether video game players who performed in front of either a synchronous or asynchronous audience are actively aware of their audience, and how this awareness might impact their perceived closeness and social demand. The evidence presented demonstrates that while players pay attention to a live digital audience and are even able to recall audience commentary, they did not feel any increased sense of closeness with or social demand from that audience. This provides valuable insight into the potential differences between digital and physical audiences and their effects—crucial for further exploring social processes in video games such as social facilitation. Indeed, the results do not mean that digital audiences cannot have effects on gameplay, but rather suggest that they might need to compete with other processes more so than was perhaps thought, especially for causal players or those who do not stream with regularity. Game streaming may be a social activity that provides for a new type of digital audience presence, but the extent to which players experience it as social while they are playing is only beginning to be understood.

Declaration of Competing Interest

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

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