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Video Games as Demanding Technologies

Editors

Nicholas David Bowman

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Editorial

Editorial: Video Games as Demanding Technologies

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Abstract

From the middle-20th century to today, video games have grown from an idiosyncratic interest of computer programmers and engineers to a globally dominant form of media entertainment. Advances in technology and creativity have combined to present players with interactive experience that vary in their cognitive, emotional, physical, and social complexity. That video games constitute co-authored experiences—dialogues between the player and the system—is at least one explanation for their appeal, but this co-authorship brings with it an enhanced set of requirements for the player's attention. For this thematic issue, researchers were invited to debate and examine the cognitive, emotional, physical, and social demands of video games; their work (as well as the impetus for this work) is summarized below.

Keywords

interactivity-as-demand; media history; media psychology; video games

Issue

This editorial is part of the issue "Video Games as Demanding Technologies" edited by Nicholas David Bowman (Texas Tech University, USA).

1. Introduction

It could be said that a driving motivation behind the development of mediated technologies is to close myriad gaps between users and spaces, events, and agents (or some combination of each). Ancient stones allowed governments to communicate rules and regulations throughout their domains of influence (such as the Rosetta Stone; Bierbrier, 1999). Written and printed texts provided (depending on the medium, variably) permanent access to the stories and values of far-away and bygone generations (much to the chagrin of Socrates, who fears that mediation would remove the author from their work; Plato as translated by Jowett, 1999). Advances in broadcasting technologies (such as radio and television) allowed at-home audiences to follow their favorite sporting events happening hundreds of miles away, and social media allowing for nearly unfettered access to the athletes themselves (Bowman, 2013). In closing these gaps, emerging media technologies follow a similar pattern of evolution: First improving on existing media before emerging as (relatively speaking) "new" media of their own (Stober, 2004). To highlight one example, the earliest films began as technological demonstrations of "pictures in motion" (Leslie, 2001) before moving towards basic recordings of standard Vaudeville and other single-stage theatre performance. Decades would pass until film directors understood how to splice from several different film rolls (each recording their own scenes) to tell more compelling stories unique to the film medium: the theory of montage in film commonplace in modern cinema (Harrah, 1954).

The earliest video game technologies also began as technological demonstrations, largely designed as "interactive television" systems (U.S. Patent No. 2,455,992, 1948) in which users could exercise a degree of control over the form and content of what was portrayed on-screen: User input had a direct impact on on-screen output (Steuer, 1992). However, early game development quickly focused more on "interactive" than "television" and by the middle of the 20th century, video game designed operated on three principles: to tax computational resources; to generate a unique experience for each run; and to actively involve users in a pleasurable way (Graetz, 1981). By the start of the 21st century, video games had overtaken films and television (and other screen-based media) as the most profitable form of entertainment media. As described by Meier (2012), good video games provide players with "a series of interesting decisions.''

Here, video games break from contemporary film and television in that they shift authorial control to the players, or at least invite players to co-author variably unique experiences (Wellenreiter, 2015), and these pleasures of control are generally assumed to explain the popularity of video games (Grodal, 2000). Conversely, Bowman (2016) argued that although this authorial control is a potentially powerful source of entertainment, it could also be viewed as requirements—demands foisted on users that might not always be so well-received or, at least, not universally so. At least four sources of demand were proposed in Bowman (2016), refined in Bowman (2018), and examined empirically in Bowman, Wasserman, and Banks (2018): cognitive demands associated with understanding in-game challenges; emotional demands associated with investment into the game's unfolding narrative; physical demands associated with fine and gross motor control of the game's controls; and social demand associated with variable social relations with in-game characters and other players. From a nascent interactivity-as-demand model, these (at least) four sources of demand are proposed as critical mediators of interactive media content and their resultant effects (Figure 1).

In response to these notions, and using Bowman (2018) as animus, nearly three-dozen authorship teams submitted manuscript abstracts for potential inclusion in this thematic issue, and through several rounds of editor and peer review, nine manuscripts were retained for publication. Those manuscripts expanded demand concepts into empirical observations, critiqued conceptual shortcomings in nascent scholarship, and directly applied demand notions into models of game design.

2. Contributions to the Thematic Issue

Several of the manuscripts in this thematic issue expanded on one or more of the demand concepts. For example, in "Modality-Specific Effects of Perceptual Load in Multimedia Processing," Fisher and colleagues (2019) demonstrate the importance of a more nuanced approach to cognitive demands informed from a neural perspective, cleaving perceptual load (attentional demands placed on sensory systems, such as hearing and sight) from cognitive load (processing demands which involve higher-order systems, such as working memory; see Fisher, Huskey, Keene, & Weber, 2018). Their key finding suggested that while increased cognitive loads (more aligned with how cognitive demand was explicated in Bowman, 2018) depleted attentional resources in both auditory and visual channels, the influence of perceptual load was modality-dependent (in this study, restricted to visual systems). Given the multimodal nature of video games, Fisher et al.'s (2019) work speaks to the criticality of examining how gamers both perceive and process information. As an added bonus, this article—or rather, the proposed study—was also preregistered, with study predictions, materials, and data analysis files freely available at https://osf.io/as2u5.

Likewise, the work of Large and colleagues (2019), "Cognitive and Behavioral Correlates of Achievement in a Complex Multi-Player Video Game," found that experienced layers of the multiplayer online battle arena game League of Legends exhibited superior performance at a number of cognitive demand tasks that could be understood both in terms of perceptual load (speed of processing and object tracking tasks, among others) as well as cognitive load (deductive reasoning and a variety of learning tasks, among others). Both articles demon-

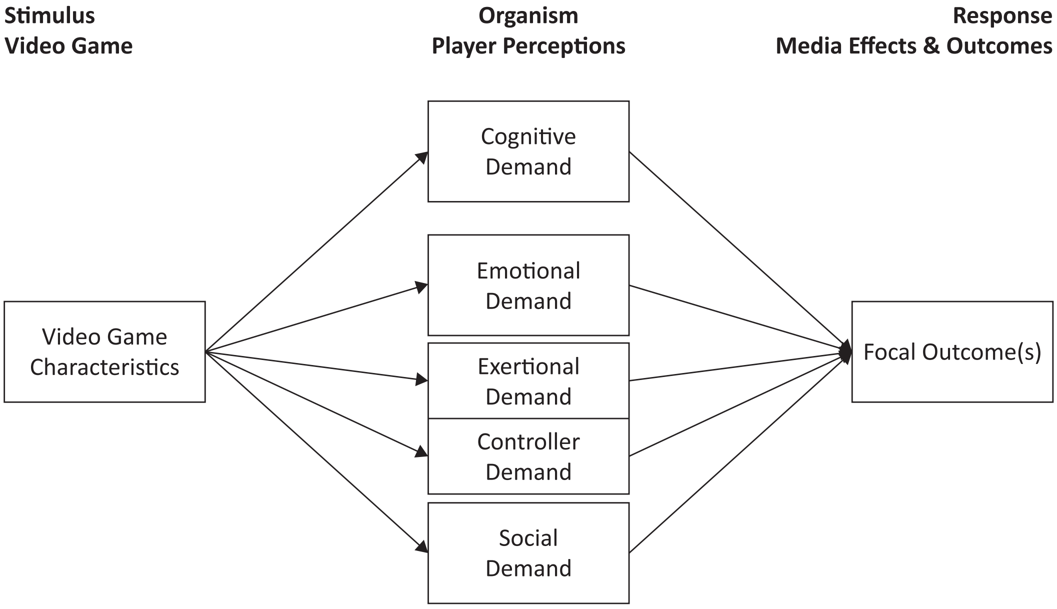

Figure 1. A conceptual model of interactivity-as-demand.

strate the importance of using behavioral and physiological measures to better understand and refine constructs, such as augmenting the self-report measure of cognitive demand reported in Bowman et al. (2018) that might have unnecessarily forwarded a definition focused on recollections of deliberative thought.

Of course, cognitive demand can still be directly tied to in-game challenges and difficulties, as demonstrated by Wulf and colleagues' (2019) "Harder, Better, Faster, Stronger? The Relationship between Cognitive Task Demands in Video Games and Recovery Experiences." In their work, playing the video game Tetris facilitated feelings of mastery and psychological detachment following an experimental induction designed to induce mild levels of fatigue—these effects were found regardless of how cognitively demanding (re: difficult) the game was. However, higher levels of cognitive demand diminished players' sense of control following the game, suggesting that the mental effort required of the harder game likely had a fatiguing effect on players (similar findings reported in Bowman & Tamborini, 2015). This article also made study materials and data analysis freely available at https://osf.io/jgp58, and the research provides additional data points for the broader literature focused on interactive media and psychological outcomes associated with well-being.

Three other manuscripts applied elements of the interactivity-as-demand to better understand critical issues in game studies associated with gender studies, trolling behaviors, and moral decision-making. Droumeva's (2019) "Audible Efforts: Gender and Battle Cries in Classic Arcade Fighting Games" used demands as a framework for understanding the gendered battle cries during gameplay—from her abstract, no-screen characters "constantly making sounds of strife, struggle, or victory while conducting surrogate labor for [the players]" (2019, p. 186). Battle cries are framed as reflective of physical and emotional demands, and her analysis reveals that these cries are decidedly gendered and trending such that female characters' cries have become louder and more intensely sexualized over time. Cook's (2019) "Between a Troll and a Hard Place: The Demand Model's Answer to One of Gaming's Biggest Problems" proposes that competing demands, both between a player and their game, and players and each other, might explain why some players engage in antisocial trolling behaviors. Put simply, trolling might be a maladaptive behavior that results from either: (a) Bored (under-demanded) or frustrated (over-demanded) players; or (b) is the consequence of balancing emotional and social demands of playing with others. Hodge and colleagues' (2019) "(A)morally Demanding Game? The Results and Implications of Moral Decision-Making in a Purpose Made Game" continues a line of research into gaming and morality with somewhat surprising findings—they failed to replicate prior work showing that gamers' "real world" and chronically accessible moral intuitions are predictive of observed in-game decisions (Joeckel, Bowman, & Dogruel, 2012; Tamborini et al., 2016). One suggestion offered by Hodge et al. (2019), informed in part by the observed time-lag for in-game decisions (four to six seconds, on average), is that players engaged in more deliberative and cognitively demanding decision-making; in past work, such decisions were more intuitive and based on what we might understand as emotional reactions. To this end, future work into moral decision-making might benefit from a dual focus on cognitive and emotional demands.

Two other manuscripts offered more direct constructive criticisms of interactivity-as-demand, one challenging a myopic view on social demand, and the other suggesting a focus on gaming infrastructures. Deterding's (2019) "Interaction Tension: A Sociological Model of Attention and Emotion Demands in Video Gaming" provides re-analysis of qualitative interviews with 19 German-speaking gamers and those in the gaming industry (transcripts and data analysis files available at https://osf.io/3w4js; transcripts in German). From this data, two critical trends are presented to game scholars: (1) Social demands cannot be treated as orthogonal from other sources of demand (such as cognitive and emotional demands); and (2) social demands are felt in advance of any exposure to gaming content and/or other gamers, given the social norms that surround video games. Mirowski and Harper's (2019) "Elements of Infrastructure Demand in Multiplayer Video Games" provides a novel operationalization of infrastructure demands (here, specific to online multiplayer games) guided by Star (1999). Through an analysis of the mundane and often invisible components of the macro-level systems that gird and support online gaming—using Blizzard Entertainment's Overwatch League as an example—the authors present a compelling case for how gaming infrastructures likely and jointly impact player experiences.

Finally, the authorship team of Agius and Daylamani-Zad (2019) break from their peers in the eight manuscripts summarized above by incorporating an interactivity-as-demand approach into a more comprehensive model of game design. In their work, "Reducing Extrinsic Burdens on Players of Digital Games: An Integrated Framework" (2019), the authors align rather strongly with the earliest arguments on co-creation put forth in Bowman (2016), suggesting that when games over-demand of players, they become burdensome. Their work explores gaming demands in terms of their interfaces, their interactions, and core gameplay mechanics, and they offer specific considerations at each later than can be taken by designers in order to lower unwanted demands on players.

Taken as a whole, these nine works both challenge and extend on the basic ideas presented in Bowman (2018), and collectively demonstrate how a more nuanced consideration of the numerous demands of interactive media—individually and jointly—can improve how we understand the medium's past, present, and future development. It was a pleasure and an honor to read and review each one, and I am eager to see the research inspired by the works presented herein.

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Conflict of Interests

The author declares no conflict of interests.

References

Agius, H., & Daylamani-Zad, D. (2019). Reducing extrinsic burdens on players of digital games: An integrated framework. *Media and Communication*, *7*(4), 247–259.

Bierbrier, M. L. (1999). The acquisition by the British Museum of antiquities discovered during the French invasion of Egypt. In W. V. Davies & T. G. H. James (Eds.), *Studies in Egyptian antiquities* (pp. 111–114). London: British Museum Publications.

Bowman, N. D. (2013). Social media, spaghetti westerns, and modern spectator sports. In D. Coombs & B. Batchelor (Eds.), *American history through American sports* (Vol. 3, pp. 31–48). Santa Barbara, CA: Praeger.

Bowman, N. D. (2016). Video gaming as co-production. In R. Lind (Ed.), *Produsing 2.0: The intersection of audiences and production in a digital world* (Vol. 2, pp. 107–123). New York, NY: Peter Lang Publishing.

Bowman, N. D. (2018). The demanding nature of video game play. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 1–24). New York, NY: Routledge.

Bowman, N. D., & Tamborini, R. (2015). "In the mood to game": Selective exposure and mood management processes in computer game play. *New Media & Society*, *17*(3), 375–393. https://doi.org/10.1177/1461444813504274

Bowman, N. D., Wasserman, J., & Banks, J. (2018). Development of the video game demand scale. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 208–233). New York, NY: Routledge.

Cook, C. L. (2019). Between a troll and a hard place: The demand model's answer to one of gaming's biggest problems. *Media and Communication*, *7*(4), 176–185.

Deterding, S. (2019). Interaction tension: A sociological model of attention and emotion demands in video gaming. *Media and Communication*, *7*(4), 226–236.

Droumeva, M. (2019). Audible efforts: Gender and battle cries in classic arcade fighting games. *Media and Communication*, *7*(4), 186–197.

Fisher, J. T., Hopp, F. R., & Weber, R. (2019). Modality-specific effects of perceptual load in multimedia processing. *Media and Communication*, *7*(4), 149–165.

Fisher, J. T., Huskey, R., Keene, J. R., & Weber, R. (2018). The limited capacity model of motivated mediated message processing: Looking to the future. *Annals of the International Communication Association*, *42*(4), 291–315. https://doi.org/10.1080/23808985.2018.1534551

Goldsmith, J. T., Ray, M. E. (1948). U.S. Patent No. 2,455,992. Washington, DC: U.S. Patent and Trademark Office. Retrieved from https://patents.google.com/patent/US2455992A/en

Graetz, J. M. (1981). The origin of spacewar. *Creative Computing*, *7*(8), 56–67. Retrieved from http://www.wheels.org/spacewar/creative/SpacewarOrigin.html

Grodal, T. (2000). Video games and the pleasures of control. In D. Zillmann & P. Vorderer (Eds.), *Media entertainment: The psychology of its appea*l (pp. 197–213). Mahwah, NJ: LEA.

Harrah, D. (1954). Aesthetics of the film: The Pudovkin-Arnheim-Eisenstein theory. *The Journal of Aesthetics and Art Criticism*, *13*(2), 163–174. https://doi.org/10.2307/425910

Hodge, S. E., Taylor, J., & McAlaney, J. (2019). (A)morally demanding game? The results and implications of moral decision-making in a purpose made game. *Media and Communication*, *7*(4), 213–225.

Joeckel, S., Bowman, N. D., & Dogruel, L. (2012). Gut or game: The influence of moral intuitions on decisions in virtual environments. *Media Psychology*, *15*(4), 460–485. https://doi.org/10.1080/15213269.2012.727218

Large, A. M., Bediou, B., Cekic, S., Hart, Y., Bavelier, D., & Green, C. S. (2019). Cognitive and behavioral correlates of achievement in a complex multi-player video game. *Media and Communication*, *7*(4), 198–212.

Leslie, M. (2001). The man who stopped time. *Stanford Magazine*. Retrieved from https://stanfordmag.org/contents/the-man-who-stopped-time/

Meier, S. (2012). *Interesting decisions*. Paper presented at the Game Developers Conference, San Francisco, California, USA. Retrieved from https://www.gdcvault.com/play/1015756/Interesting

Mirowski, A., & Harper, B. (2019). Elements of infrastructure demand in multiplayer video game. *Media and Communication*, *7*(4), 237–246.

Plato. (1999). *Phaedrus* (B. Jowett, Trans.). Salt Lake City, UT: Project Gutenberg. Retrieved from http://www.gutenberg.org/files/1636/1636.txt

Star, S. L. (1999). The ethnography of infrastructure.

American Behavioral Scientist, *43*(3), 377–391. https://doi.org/10.1177/00027649921955326

Steuer, J. (1992). Defining virtual reality: Dimensions determining telepresence. *Journal of Communication*, *42*(4), 73–93. https://doi.org/10.1111/j.1460-2466.1992.tb00812.x

Stober, R. (2004). What media evolution is: A theoretical approach to the history of new media. *European Journal of Communication*, *19*(4), 483–505. https://doi.org/10.1177/0267323104049461

Tamborini, R., Prabhu, S., Bowman, N. D., Hahn, L., Klebig, B., Grall, C., & Novotny, E. (2016). The effect of moral intuitions on decisions in video-game play: Temporary and chronic intuition accessibility. *New Media & Society*, *20*(2), 564–580. https://doi.org/10.1177/1461444816664356

Wellenreiter, M. (2015). Screenwriting and authorial control in narrative video games. *Journal of Screenwriting*, *6*(1), 343–361. https://doi.org/10.1386/josc.6.3.343_1

Wulf, T., Rieger, D., Kümpel, A. S., & Reinecke, L. (2019). Harder, better, faster, stronger? The relationship between cognitive task demands in video games and recovery experiences. *Media and Communication*, *7*(4), 166–175.

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Article

Modality-Specific Effects of Perceptual Load in Multimedia Processing

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Abstract

Digital media are sensory-rich, multimodal, and often highly interactive. An extensive collection of theories and models within the field of media psychology assume the multimodal nature of media stimuli, yet there is current ambiguity as to the independent contributions of visual and auditory content to message complexity and to resource availability in the human processing system. In this article, we argue that explicating the concepts of perceptual and cognitive load can create progress toward a deeper understanding of modality-specific effects in media processing. In addition, we report findings from an experiment showing that perceptual load leads to modality-specific reductions in resource availability, whereas cognitive load leads to a modality-general reduction in resource availability. We conclude with a brief discussion regarding the critical importance of separating modality-specific forms of load in an increasingly multisensory media environment.

Keywords

media psychology; modality; multimedia processing; perceptual load; resource availability

Issue

This article is part of the issue "Video Games as Demanding Technologies" edited by Nicholas David Bowman (Texas Tech University, USA).

1. Introduction

Using media is often a rich, multisensory experience. Video games, movies, and other digital environments contain numerous streams of audiovisual information that must be processed quickly and simultaneously (Fisher, Huskey, Keene, & Weber, 2018; Lang, 2000). As such, interacting with these media often requires that an individual engage both visual and auditory processing systems at the same time. Each of these systems contains spatial, temporal, and physical constraints that circumscribe the quantity and quality of information that an individual can effectively process (Buschman, Siegel, Roy, & Miller, 2011; Franconeri, Alvarez, & Cavanagh, 2013; Kahneman, 1973; Marois & Ivanoff, 2005).

Within the media psychology literature, these limitations are often referred to using the language of resources (Fisher, Huskey, et al., 2018; Lang, 2000, 2006). Humans dynamically allocate limited processing resources to encoding, storing, and retrieving information in an environment (Lang, Bradley, Cuthbert, & Simons, 1997; Lang, Sanders-Jackson, Wang, & Rubenking, 2013) and the resources that are allocated are required (consumed) at a rate commensurate with the complexity of the information. This resource allocation process has been shown to predict message processing outcomes like memory, enjoyment, and learning (for a recent review and meta-analysis, see Fisher, Keene, Huskey, & Weber, 2018; Huskey, Wilcox, Clayton, & Keene, 2019). Because of this, understanding resource allocation is critical for understanding how individuals process multimedia messages as well as how alterations in resource allocation processes influence outcomes of interest.

An open question in media psychology research concerns the extent to which resource allocation depends on the modality in which information is presented. Theories and models in the literature frequently describe media as multimodal (recruiting both the visual and auditory processing systems, see e.g., Basil, 1994a; Geiger & Newhagen, 1993; Lang, 2000; Lee & Lang, 2015), but there is a current lack of clarity as to the extent to which information presented in different modalities loads the processing system in different ways. Some models assume that processing resources exist in one central modality-independent pool (e.g., Lang, 2000, 2009). In this case, information presented within one modality should affect resource availability as measured in other modalities. Others, though, propose that at least some forms of media processing may draw from modality-specific resource pools (Basil, 1994a, 1994b; Fisher, Huskey, et al., 2018), meaning that information presented in one modality may not necessarily reduce resource availability as measured in another. Empirical investigations have long reported modality-specific effects associated with structural (e.g., brightness, contrast, information density, etc.) and content features (e.g., violence, morality, etc.), but a sizeable subset of these findings are conflicting or ambiguous between studies (Fisher, Huskey, et al., 2018). This ambiguity limits our understanding regarding the specific effects of modality in multimedia processing.

In this article, we argue that a clearer explication of the concepts of perceptual and cognitive load can engender substantial progress toward understanding and predicting modality-specific message processes and effects, contributing to further precision in our understanding of the demanding nature of multimedia processing (Bowman, Banks, & Wasserman, 2018). Drawing from the cognitive neuroscience of attention, we provide a discussion of the nature of perceptual load and its relevance to media scholarship. We present a model based on processing hierarchies in the human brain predicting that the effects of perceptual load should be largely modality-dependent whereas the effects of cognitive load should be largely modality-independent. In addition, we report findings from an experiment providing strong support for this hypothesis. In this experiment, we manipulated cognitive load and (visual) perceptual load within a video game and measured how long it took participants to respond to a secondary task that was presented in either the visual or auditory modality. As predicted, perceptual load only influenced reaction times within the modality in which it was introduced whereas cognitive load influenced reaction times across both modalities. We conclude with a brief discussion regarding the critical importance of understanding modality-specific forms of load in an increasingly multisensory media environment.

2. Modality Effects in Multimedia Processing

Research into the influence of modality in processing messages and digital environments spans at least five decades (Hsia, 1968; Severin, 1967). This work clusters into several primary domains: 1) how processing differences between visual and auditory modalities may help inform or optimize multimedia design (Grabe, Bas, & van Driel, 2015; Grabe, Lang, & Zhao, 2003; Keene & Lang, 2016; Lang, Potter, & Grabe, 2003; Moreno, 2006); 2) the effects of redundancy within and between auditory and visual modalities on outcomes of interest (Drew & Grimes, 1987; Fox, 2004; Grimes, 1990; Lang, 1995; Lee & Lang, 2015); and 3) the extent to which structural and content features presented to one modality interfere with processing in another (Bolls, 2002; Bolls & Muehling, 2007; Thorson, Reeves, & Schleuder, 1985).

A wealth of studies report differences between visual processing and auditory processing in a multimedia context (Basil, 1994a; Lang, 1995; Lang, Potter, & Bolls, 1999). In one study, Lang and colleagues (1999) show that message pacing (the number of camera changes within a given time window) and arousal differentially influence cued recall for visual and auditory content. As message pacing increases, memory for visual content (measured using a cued recall task) stays constant or increases for both arousing and calm messages. In contrast, memory for auditory content decreases as pacing increases in arousing messages. In other work, valence is shown to differentially influence visual and auditory processing (Lang, Newhagen, & Reeves, 1996; Newhagen & Reeves, 1992). This work shows that negative visual content tends to be better remembered than positive (Lang et al., 1996; Newhagen & Reeves, 1992). A recent study replicates this finding, but finds that the opposite pattern is true for auditory content—positive auditory content tends to be better remembered than negative (Keene & Lang, 2016). Taken together, these findings suggest that there may be important differences between visual and auditory resource allocation processes that are contingent on the nature of the content that is presented, but it remains unclear exactly what types of content may elicit differential resource availability across modalities and what types of content may influence both modalities in a similar way.

Another area of research concerns the effects of redundancy between auditory and visual channels in messages. Messages that are redundant across modalities (e.g., subtitles that match the words being spoken) seem to be better remembered than those that are non-redundant or conflicting across modalities (Drew & Grimes, 1987; Grimes, 1990; Lang, 1995; Lee & Lang, 2015; Wember, 1983). This effect is especially strong whenever visuals are highly attention-grabbing or emotional (Brosius, 1993). It has been suggested that non-redundancy between modalities (may) lead to cognitive overload, resulting in reduced memory for message content (Grimes, 1991). Whenever information is non-redundant or conflicting across modalities, auditory memory consistently suffers the most (Brosius, 1989; Drew & Grimes, 1987; Grimes, 1990, 1991; Lang et al., 1999). This effect has been highlighted as especially problematic in news and educational settings, as the presentation of complex or otherwise attention-grabbing visuals may interfere with encoding of the auditory track—typically the location of the bulk of important content in both news and educational messages (Brosius, 1989, 1993; Grabe et al., 2003; Thorson & Lang, 1992; Wember, 1983).

One conclusion that has been drawn from this work is that visual processing is more automatic (e.g., less resource-intensive) than auditory processing, making it more robust in the face of increasing message complexity and leaving more resources available in the visual channel than the auditory channel as complexity increases (Lang et al., 1999). Ultimately though, the interpretability of these data regarding resource availability at encoding is limited. This is primarily due to the fact that each of these studies tested memory using cued recall tasks (e.g., multiple-choice questions or fact-recognition). These measures are more accurately connected to information storage and retrieval of information (not encoding Fisher, Keene, et al., 2018; Lang, 2009). Another important factor may be the generally semantic nature of auditory content in messages, requiring individuals to engage in much more processing for the same memory outcome. As such, it is clear that in order to understand the modality-specific effects of message content on resource availability at encoding, researchers must use more direct measures of resource availability at encoding than cued-recall measures. These include secondary task reaction times (STRTs; Lang & Basil, 1998; Lang, Bradley, Park, Shin, & Chung, 2006), or encoding measures such as forced-choice audiovisual recognition tasks (see e.g., Keene & Lang, 2016; Lang et al., 2015; Yegiyan, 2015).

Only a small number of studies in the communication literature to date meet these criteria. In a pair of early studies, Thorson et al. (1985, 1987) manipulated visual and auditory complexity while participants viewed (and/or listened to the audio tracks from) television messages and responded to a visual or auditory STRT probe. This study reported that visual and auditory STRTs depend on both: a) the modality in which message content is introduced, and b) the modality in which STRTs are measured. If it were the case that visual and auditory resources draw from the same pool, visual or auditory message complexity would be expected to influence STRTs irrespective of the modality in which information is presented or the modality in which the STRT is measured. In finding modality-specific effects, these studies cast doubt on the idea that capacity limitations in a central resource pool solely determine message processing performance across modalities, and provide initial support for the idea that visual and auditory resources may be at least partially separable.

In another study, Basil (1994b) manipulated the modality in which information was presented and the modality in which the STRT probe occurred. This study found that visual probes were responded to more quickly overall than auditory probes and that STRTs were faster in both modalities whenever the bulk of message information was contained in the auditory modality. This study provides unclear support for either a modality-specific or a modality-general resource pool. A final study—although not directly measuring resource availability—investigated visual task performance in the presence of high- and low-imagery audio tracks, finding that listening to an audio track only interferes with visual task performance whenever the audio track is high in imagery (presumably loading visual processing resources; Bolls, 2002). This provides preliminary support for the idea that processing resources may be separable by modality—at least to the extent that processes within one modality do not require processing in the other modality.

Since this spate of early studies, no further evidence within communication research has demonstrated the modality-specific effects of message complexity on resource availability. As such, the picture is still quite unclear as to whether different forms of visual and auditory complexity in media content require modality-specific or modality-independent processing resources. Early theorizing regarding the modality-specific effects of message complexity hints at the idea that perceptual processes may be differentiable from “meaning-level” (cognitive) processes (see e.g., Thorson et al., 1987) and that each may affect processing in different ways. In later work, though, this idea was largely abandoned—possibly due to the aforementioned ambiguity in findings regarding the independent influence of these processes. Although more than 30 years have passed since this initial work, recent developments in communication and cognate fields both allow for and necessitate the re-opening of this question. Most pressingly, mounting evidence from neuroscience research suggests that perceptual load has largely modality-dependent effects whereas the effects of cognitive load are largely modality-general (Hasson, Chen, & Honey, 2015; Murray et al., 2014; Regev et al., 2018; Wahn & König, 2017). Thus, it is likely that currently ambiguous findings regarding modality differences, redundancy, and modality-specific resource availability can be resolved when considering the relative contributions of perceptual and cognitive load to the overall complexity of a message.

3. What Is Perceptual Load?

Perceptual processing can be defined as any of the operations that must be performed in order to select, encode, and identify stimuli transmitted to the brain from the external world via the sensory systems (Broadbent, 1958; Schneider & Shiffrin, 1977; Treisman, 1969). Although these operations are undeniably guided by memory and influenced by conscious attention (see e.g., Chen & Hutchinson, 2018), evidence suggests that they largely rely on their own “pools” of resources that are separable from each other and from the resource pool that subserves higher-order functions like cognitive control (Alais, Morrone, & Burr, 2006; Alais, Newell, & Mamassian, 2010; Arrighi, Lunardi, & Burr, 2011; Duncan, Martens, & Ward, 1997; Franconeri et al., 2013; Marois

& Ivanoff, 2005; Winkler, Czigler, Sussman, Horváth, & Balázs, 2005). Furthermore, a growing body of literature suggests that perceptual resource requirements and cognitive resource requirements have independent and largely opposite effects on attentional selection processes (Lavie, 1995; Lavie, Hirst, de Fockert, & Viding, 2004; Murphy, Groeger, & Greene, 2016).

In order to understand and make predictions regarding the unique role of perceptual operations in multimedia processing, it is necessary to briefly review the anatomy and physiology of the sensory processing pathways in the brain and body and to discuss the neural mechanisms of perception (space does not permit an in-depth discussion of these pathways and processes; interested readers are encouraged to consult Bear, Connors, & Paradiso, 2015, or Woolsey, Hanaway, & Mokhtar, 2017, for detailed treatments of these important topics). Audition and vision involve converting variations in air pressure (sound waves) and light (electromagnetic waves) into neural signals. For audition, this conversion process takes place in a collection of specialized organs in the inner ear that encode the intensity and frequency of sound stimuli into temporal and spatial patterns of neural firing. Different receptors fire in response to different frequencies and intensities. Firing patterns are transmitted along a series of pathways from the inner ear to the auditory cortex within the temporal lobes of the human brain. The auditory cortex—like all cortical regions—is arranged in layers from the interior of the brain to the exterior. A neural signal arrives from the inner ear at the deepest layer, and it is further processed in each successive layer as it moves to the outer layer of the cortex (Nelken & Bar-Yosef, 2008).

For vision, this conversion process takes place in the retina. Specialized receptor cells in the retina detect light, dark, color, and other visual features, such as borders between light and dark areas of the visual field. This information is transmitted through the optic nerves and along a series of pathways to the visual cortex within the occipital lobes of the brain. Different cells in the visual cortex are specialized for detecting different visual features (e.g., orientation, motion, color, shape). The visual cortex, like the auditory cortex, is arranged in hierarchical layers. These layers allow incoming information to be integrated across short timescales (tens to hundreds of milliseconds) in order to form identifiable objects, entities, and events that can be used to guide behavior (Hasson et al., 2015). Within a mediated environment, these perceptual operations could be as varied as identifying a new item that has appeared within the environment, differentiating a target item from a sea of similar stimuli in a visual or auditory stream, or processing the contents of a new scene introduced by a structural feature. The amount of processing resources that these basic operations require can be thought of as perceptual load.

Perceptual load increases whenever more items need to be identified in the sensory field, or when the number (or difficulty) of perceptual operations required to identify target items increases. These perceptual operations are myriad, but the most commonly investigated are filtering, de-distortion, mental rotation, perspective changing, individuation (recognizing unique features of a target object), and integration of disparate features into a coherent whole (Elliott & Giesbrecht, 2010; Fitousi & Wenger, 2011; Murphy et al., 2016). Some of these operations are only meaningful for visual processing (such as rotation, and perspective changing), whereas others can occur in either the visual or auditory processing streams (e.g., individuation, integration). Although there is still active debate, a formidable body of evidence suggests that the brain perceptually processes all items in the sensory field provided there are enough resources to do so (Lavie, 1995; Lavie et al., 2004). As resources begin to be exhausted (e.g., perceptual load increases), fewer and fewer items in the sensory field are able to be processed at any given time, reducing the influence of peripheral stimuli (Murphy et al., 2016). As perceptual load increases in a given channel, orienting responses attenuate to additional stimuli in that channel (Cosman & Vecera, 2009, 2010a, 2010b; Santangelo & Spence, 2008) and interference effects of irrelevant stimuli are reduced (Forster & Lavie, 2008; Fu et al., 2009).

If it is the case that "resources" as traditionally discussed are related to temporal, spatial, and physical constraints within brain regions and their connecting pathways (Fisher, Huskey, et al., 2018; Franconeri et al., 2013; Marois & Ivanoff, 2005), the fact that visual and auditory processing take place in largely separate regions and along parallel pathways strongly suggests that each may have their own "pool" of processing resources that is at least in some ways unaffected by activity in the other modality. In this framework, it is assumed that a process shares resources to the extent that it recruits brain regions and pathways that overlap with those recruited by another process (Franconeri et al., 2013). In view of these findings, we predict that an induction of perceptual load in a given modality will reduce resource availability only within the modality in which it is introduced, slowing responses to a secondary task in the same modality, but not responses in another modality.

4. Perceptual Load versus Cognitive Load

To review, perceptual processing involves the filtering, detection, and integration of object features from the sensory environment. These processes take place over short timescales (i.e., within milliseconds), are predominantly stimulus-driven, and are largely outside of conscious awareness and control. In contrast, cognitive processing involves operations such as goal-directed control of attention, sense-making/learning, and maintenance of relevant items in working memory (Lavie, 2010). Cognitive processes integrate and maintain information over much longer timescales than perceptual processes (Murray et al., 2014). These processes are interrupted whenever meaning-level information is nonsensical or scrambled, such as when scenes in a movie are presented in an incorrect sequence (Aly, Chen, Turk-Browne, & Hasson, 2018; Baldassano et al., 2017). The amount of processing resources that cognitive operations require can be thought of as cognitive load. Cognitive load increases in relation to two primary factors: 1) an increase in the amount of information that must be held in working memory; 2) an increase in the unfamiliarity, ambiguity, uncertainty, or error-proneness of this information. Cognitive load has primarily been manipulated using simple working memory tasks, such as requiring a participant to hold a string of numbers or letters in working memory or remember items previously seen in a task, but it can also be manipulated by increasing the conceptual complexity of a message or a task (e.g., introducing unfamiliar concepts or more ambiguous rules; Lavie, 2010).

Cognitive load is perceived as intrinsically effortful (Westbrook & Braver, 2015) and individuals (usually) seek to minimize it (Inzlicht, Shenhav, & Olivola, 2018; Kool, McGuire, Rosen, & Botvinick, 2010), although increased motivation seems to lead to increased willingness to expend cognitive effort (Botvinick & Braver, 2015; Huskey, Craighead, Miller, & Weber, 2018; Locke & Braver, 2008). Recall that higher perceptual load tends to lead to reduced processing of task-irrelevant stimuli. In contrast, higher cognitive load is often associated with increases in behavioral and neural indicators of task-irrelevant stimulus processing (Fitousi & Wenger, 2011; Kelley & Lavie, 2011; Lavie, 2005). As cognitive load increases, it becomes more likely that a task-irrelevant stimulus will interfere with performance on a primary task and that it will be encoded into memory (Lavie, 2005). This effect is especially pronounced in individuals with cognitive processing difficulties such as ADHD (Forster & Lavie, 2008, 2016; Forster, Robertson, Jennings, Asherson, & Lavie, 2014). Within a media task, cognitive load could correspond to things like learning the rules of a complex game (Bowman et al., 2018), reconciling conflicting information in a narrative (Yarkoni, Speer, & Zacks, 2008; Zacks & Magliano, 2011), or learning new items that must be remembered (Mayer, 2014; Moreno & Mayer, 1999).

Perceptual processing-related activity within sensory regions and pathways is highly correlated during stimulus processing both within and between subjects, but this activity is largely uncorrelated with activity in other brain regions in the same subjects (such as those used to process sensory information from other modalities; Godwin, Barry, & Marois, 2015). As cognitive processing increases, these modality-specific networks become integrated with one another and with other large-scale neuronal networks in a "global workspace" network distributed across the whole brain (Hearne, Cocchi, Zalesky, & Mattingley, 2017; Kitzbichler, Henson, Smith, Nathan, & Bullmore, 2011; Shine & Poldrack, 2018). The extent to which these networks become integrated during cognitive processing is a predictor of performance (Finc et al., 2017). Thus, increases in cognitive processing requirements (cognitive load) should lead to modality-general effects on resource availability and indicators of processing performance (such as memory and learning). Behavioral and neuroscientific findings provide support for this idea, reporting that (provided cognitive load is kept constant) the effects of perceptual load are largely modality-specific whereas effects of cognitive load seem to not depend on the modality in which complexity is introduced or performance is measured (Duncan et al., 1997; Keitel, Maess, Schröger, & Müller, 2013; Sandhu & Dyson, 2016; Wahn & König, 2017).

To date, these findings are largely constrained to non-naturalistic working memory tasks and highly controlled stimuli, but emerging evidence suggests that they may be generalizable to a multimedia context (Wang & Duff, 2016). A recent study using inter-subject correlations of brain imaging data reported that perceptual processing of auditory and visual narratives recruited modality-specific processing networks, but that cognitive processing (conscious attending and sense-making) was associated with activation patterns that spread across modalities and into higher-order processing networks (Regev et al., 2018). Thus, it could be expected that the extent to which complexity in one modality interferes with resource availability in the other is contingent upon the extent to which the complexity is cognitive (as opposed to merely perceptual) in nature. With these things in mind, we predict that perceptual load should reduce resource availability in a modality-specific fashion whereas cognitive load should reduce resource availability in both modalities (these hypotheses, along with an initial experimental design and analysis plan, are pre-registered. Preregistration, as well as all code and data, can be accessed at https://osf.io/as2u5).

5. Methods

5.1. General Overview

An experiment was conducted in which participants played 30 minutes of a specially designed experimental video game stimulus (see below). Participants played the game under conditions of cognitive and (visual) perceptual load, and resource availability was measured in both the visual and the auditory modality. All frequentist data analysis was conducted using linear mixed-effects models in R (R Core Team, 2013), and all non-frequentist, Bayes factor analysis was conducted using the *BayesFactor* package in R (https://CRAN.R-project.org/package=BayesFactor).

5.2. Subjects

101 participants were recruited from the undergraduate research pool at a large western university ($N_{\text{male}} = 44$, $N_{\text{female}} = 57$, $M_{\text{age}} = 20.06$). Before data collection, a power analysis was conducted using the *simr* package in R (Green & MacLeod, 2016) in order to determine sufficient sample size. This analysis revealed that 60 subjects

was sufficient for 80% power given the size of previous effects using a similar manipulation. Thirteen participants were excluded due to equipment failure, or due to their non-compliance with experimental protocol, leaving a final *N* of 88 for the analyses reported herein.

5.3. Stimulus

The stimulus for this experiment was Asteroid Impact (https://github.com/medianeuroscience/asteroid_impact), an open-source video game developed in Python. Asteroid Impact allows for fine-grained experimental control over gameplay variables as well as high-resolution data logging. The object of the game is to pilot a spaceship around the screen to collect valuable crystals while avoiding asteroids. Asteroid Impact adapts to the skill level of the subject, gradually increasing in difficulty as the subject successfully collects crystals and decreasing in difficulty as the subject fails to avoid asteroids. The base size, frequency, and speed of all in-game sprites were held constant across all conditions.

5.4. Procedure

Participants were invited one at a time into a computer lab containing ten cubicles, each with one Dell computer with a 1600 × 900 monitor (60 Hz refresh rate). A researcher guided the participants to a computer and gave them a consent form containing relevant information regarding the study design. After signing the consent form, participants viewed the instruction screen for the experiment (see Figure 1a, 1b). Roughly half of the participants were assigned to the visual STRT condition and half of the participants were assigned to the auditory STRT condition, but all participants underwent the same cognitive and perceptual load conditions (for a visual depiction of the experimental design see Figure 2). Before beginning gameplay, participants listened to a brief script read by the researcher reminding them that their primary task would be to collect as many crystals as they could while avoiding asteroids and that their secondary task would be to press the space bar when they either saw the star or heard the tone. Participants were then instructed to put on their headphones and begin the experiment. Audio was presented through Bose QuietComfort 15 headphones with computer volume set to 15/50.

Participants played a one-minute practice round of Asteroid Impact followed by six five-minute rounds of gameplay. Two rounds contained no load manipulation, two rounds contained the perceptual load manipulation, and two rounds contained the cognitive load manipulation. Following the practice round, each subsequent round was presented in random order. Instruction screens before each round alerted participants of the different gameplay conditions without revealing core hypotheses of the study (see Figure 1d, 1e). Upon completing gameplay, participants filled out a brief survey to assess individual cognitive differences and media use habits. These data were not analyzed in this study (as a part of this survey, participants were asked to rate their own video game skill on a scale from 1 to 7. In this sample, mean video game skill was 3.87 [*SD* = 1.76]. This and other participant-level data are available in the OSF repository for this project).

Move your ship around with your mouse, picking up crystals
Pick up all the crystals
Avoid the bouncing asteroids. Hit one and it's game over.
Pick up a shield to pass through asteroids for a few seconds
Pick up a clock to slow asteroids for a few seconds
Press spacebar when you see a star

Move your ship around with your mouse, picking up crystals
Pick up all the crystals
Avoid the bouncing asteroids. Hit one and it's game over.
Pick up a shield to pass through asteroids for a few seconds
Pick up a clock to slow asteroids for a few seconds
Press spacebar when you hear a tone

Your ship's display has been damaged by an asteroid!
It may be more difficult to see in this round

In this round, some of the crystals are dangerous!
If you collect two of the same crystal in a row
you will lose 1000 points!

Figure 1. Depiction of the main screens in the game environment. **a)** Instruction screen for the visual modality condition; **b)** instruction screen for the auditory modality condition, **c)** depiction of the cognitive load manipulation, **d)** depiction of the instruction screen preceding the cognitive load manipulation, **e)** depiction of the instruction screen preceding the perceptual load manipulation, **f)** depiction of the perceptual load manipulation. Under perceptual load, randomly generated Mondrian-type squares were overlaid onto the screen at 80% opacity, rendering game elements much more difficult to see. In the cognitive load condition, collection of two of the same-colored crystal in a row would cause a loss of 1000 points (equivalent to ten crystals).

5.5. Manipulating Perceptual Load

Although measures have been proposed for overall message complexity (such as ii; Lang et al., 2006), a specific measure of perceptual load in a multimedia environment does not currently exist. As such, recent work in the field employs direct manipulations of perceptual load. This has been done in several ways: by introducing a sensory-rich stimulus as opposed to a relatively sparse one (Stróżak & Francuz, 2017), by increasing the number of items in the visual field (Wang & Duff, 2016) and by reducing contrast between foreground and background items (Fisher, Hopp, & Weber, 2018, 2019). In this experiment, we manipulated perceptual load in the visual channel using a well-validated manipulation from visual perception research involving randomly regenerating shapes and colors (Bahrami, Carmel, Walsh, Rees, & Lavie, 2008; Hesselmann, Hebart, & Malach, 2011; Lavie, Lin, Zokaei, & Thoma, 2009). To induce perceptual load, we added semi-transparent visual overlay consisting of Mondrian-like rectangles of varying colors and sizes that changed locations and colors at a random time point within each ten-second period of gameplay (see Figure 1). This manipulation was chosen in that it was: a) as tightly controlled as possible, not introducing potential confounds with cognitive load, and b) easily integrated into the narrative of the game. An instruction screen presented before perceptual load levels alerted participants that their “spaceship display is damaged” and that the following level may be more difficult to see.

5.6. Manipulating Cognitive Load

As with perceptual load, a direct measure of cognitive load does not currently exist for selecting multimedia stimuli, so it must be directly introduced through “modding” the video game or message stimulus (Elson & Quandt, 2016). Previous work has manipulated cognitive load in video games by increasing the number of items in a matching task (Wang & Duff, 2016) and by introducing a 1-back memory maintenance component into the game (Fisher, Hopp, & Weber, 2018; Fisher et al., 2019). In this experiment, we manipulated cognitive load using the 1-back maintenance task outlined in Fisher, Hopp, and Weber (2018). This manipulation has been shown to be perceived as cognitively difficult, and to elicit activation in working memory-related brain regions (Eriksson, Vogel, Lansner, Bergström, & Nyberg, 2015; Veltman, Rombouts, & Dolan, 2003). This manipulation is similar in many ways to the “n-back” (Owen, McMillan, Laird, & Bullmore, 2005), a very widely used working memory manipulation in cognitive neuroscience research. An instruction screen presented before the cognitive load levels alerted participants that “in this level, some of the crystals are dangerous” and that they are no longer allowed to collect two subsequent crystals of the same color. If two crystals of the same color were collected in sequence, a short, negative “buzzer” sound played, and the participant’s in-game score dropped by 1000 points. This task required participants to maintain the identity of the most recently collected crystal in their working memory, and to continually update this information as new crystals were collected.

5.7. Measuring Resource Availability

The primary dependent variable of interest in this experiment is resource availability. Previous work has demonstrated that the STRT is a reliable indicator of resources available at encoding provided that the participant does not enter cognitive overload (see e.g., Lang, 2006; Lang & Basil, 1998). In a typical STRT paradigm, participants are told that they will be responding to a secondary task while completing the primary task (in this case, video game play). Most commonly, participants are asked to press a button upon seeing a flash or hearing a tone. Participants are instructed to concentrate on the primary task, but to respond to the secondary task probe as quickly as they can. Previous work demonstrates that reward can modulate STRTs (Fisher et al., 2019). As such, responding to the secondary task was worth the same amount of points across all conditions in the game. The modality of the STRT probe was manipulated between participants. In the visual STRT condition, the secondary task prompt was a white star that appeared in a random location on the screen. In the auditory STRT condition, the secondary task prompt was a 400Hz tone. Following the good-practice recommendations in Whelan (2008), we conducted three preprocessing steps on the reaction time data. First, any reaction times less than 100 msec were discarded, along with reaction prompts that were missed entirely. After this, reaction times were filtered to remove any values that were more than three standard deviations away from the mean within participants and conditions. These filtering steps removed an average of 13.1 reaction times per participant (out of a total of 180). Finally, the remaining reaction times were log transformed.

6. Results

Based on our theoretical model regarding the modality-specific effects of perceptual load, we expected that the visual perceptual load induction would influence STRTs in the visual modality but not in the auditory modality. Under high perceptual load, visual STRTs should be slower but auditory STRTs should be similar under both high and low load. In contrast, we expected that cognitive load would lead to slower STRTs regardless of the modality in which the STRT was measured.

6.1. Main Effects of Load and Modality

Previous work has shown that cognitive load robustly influences resource availability such that resource availability drops (STRTs lengthen) as cognitive load increases

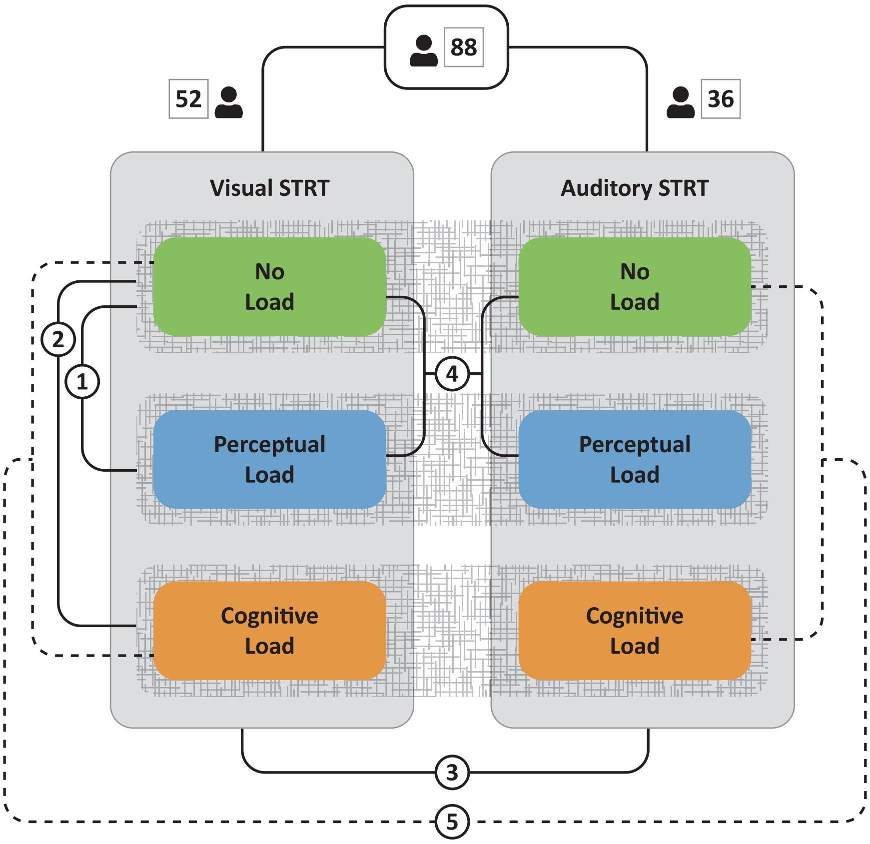

Figure 2. Depiction of the experimental design and contrasts employed in our analyses. After data cleaning, 52 participants were in the visual STRT condition and 36 participants were in the auditory STRT condition. No load, cognitive load, perceptual load conditions were presented two times each in random order. Contrasts are as follows: 1) main effect of perceptual load irrespective of condition; 2) main effect of cognitive load irrespective of condition; 3) main effect of condition, irrespective of cognitive load or perceptual load; 4) interaction effect between perceptual load and condition; 5) interaction effect between cognitive load and condition. Except for the interaction between cognitive load and condition, all effects were significant ($p < .001$).

(pending that participants remain focused on the primary task, see e.g., Fisher et al., 2019; Fox, Park, & Lang, 2007). All predictions were tested using linear mixed-effects model fit using the lme4 package in R (Bates, Mächler, Bolker, & Walker, 2015). Cognitive load, perceptual load, and modality were treated as fixed effects, and were coded using effects coding. The dependent variable (log STRTs) was z-transformed before data analysis. Random intercepts and slopes were included for participants and for cognitive load and perceptual load nested within modality condition. All reported betas are standardized. For a visual depiction of the contrasts employed in this experiment please see Figure 2.

There was a large[1] effect of cognitive load on STRT—$\beta(87) = .288$, 95% CI [.253,.323], $\omega^2 = .222$, Cohen's $d = .903$, $p < .001$—such that reaction times were slower under high cognitive load ($M = 1535.54$) as compared to low cognitive load ($M = 982.67$, see Figure 3). Likewise, there was a small effect of perceptual load—$\beta(87) = .091$, 95% CI [.064, .117], $\omega^2 = .029$, Cohen's $d = .21$, $p < .001$—such that reaction times under high perceptual load ($M = 1152.49$) were slower than those observed in the low perceptual load condition ($M = 982.67$). In addition, there was a medium-sized effect of modality—$\beta(87) = -.137$, 95% CI [−.225,-. 049], $\omega^2 = .077$, Cohen's $d = -.49$, $p < .001$—such that participants responded faster overall to the auditory prompt ($M = 1093.05$) than to the visual prompt ($M = 1309.94$).

6.2. Interactions Between Modality and Load

Based on our model, it was expected that perceptual load and modality would interact such that under high (visual) perceptual load, STRTs in response to the visual probe would become slower whereas STRTs in response to the auditory probe would remain about the same.

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[1] The importance of an effect is contingent both on the research domain in which the effect size is observed and on the nature of the hypothesis. The traditional "small" ($d = .2$), "medium" ($d = .5$), and "large" ($d = .8$) labels ascribed to effect sizes are essentially arbitrary but can be helpful in understanding how the effect compares to other effects observed in the literature. For more thorough overviews see Funder and Ozer (2019), Schäfer and Schwarz (2019).

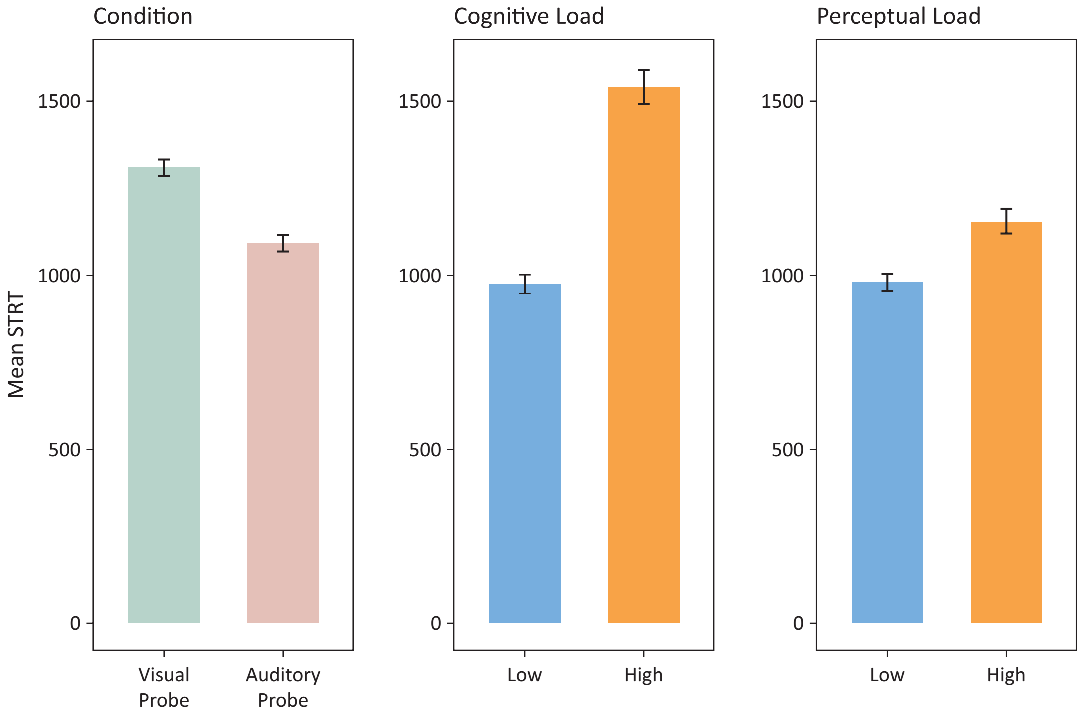

Figure 3. Main effects for condition, cognitive load, and perceptual load. Cognitive load and perceptual load are each compared to a control condition containing neither the cognitive load nor the perceptual load manipulation. Error bars represent 95% confidence intervals.

As cognitive load is predicted to influence resource availability in a modality-independent fashion, no interaction effect was predicted for cognitive load and modality.

Cognitive load, perceptual load, modality, and the interaction between cognitive/perceptual load and modality were treated as fixed effects and were coded using effects coding. Random intercepts and slopes were included for participants and for cognitive/perceptual load nested within modality condition. This analysis revealed an interaction between perceptual load and modality—$\beta(87) = -.08$, 95% CI $[-.099, -.056]$, $\omega^2 = 0.028$, $p < .001$—such that the difference in STRT times between high and low perceptual load was greater in the visual STRT condition ($\Delta M = 281.77$) than in the auditory STRT condition ($\Delta M = 9.26$, see Figure 4). There was a significant difference in STRTs between high and

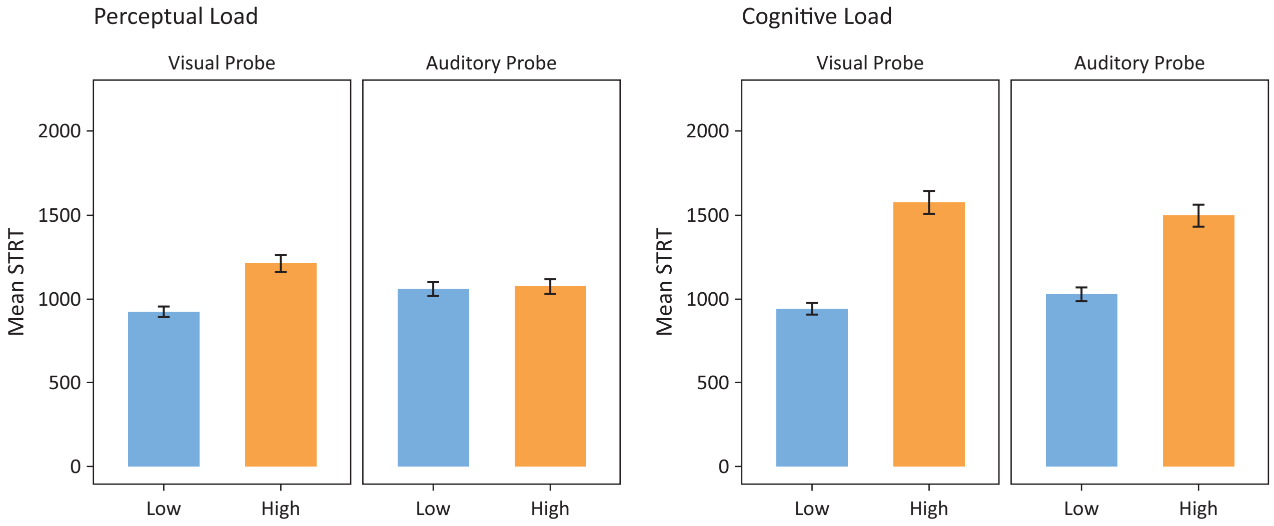

Figure 4. Interaction effects between perceptual load and modality (top) and between cognitive load and modality (bottom). There was an interaction between perceptual load and modality. The difference in STRTs between high and low perceptual load was 281.77 msec in the visual STRT condition and was 9.26 msec in the auditory STRT condition. There was not a significant interaction between cognitive load and modality. Error bars represent 95% confidence intervals.

low perceptual load in the visual condition—$t(51) = 9.95$, $p < .001$—but not in the auditory condition ($p = .401$). As predicted, there was no interaction effect between cognitive load and modality ($p = .316$).

6.3. Non-Frequentist Analysis

A follow-up Bayes factor analysis was conducted in order to further ascertain the evidence in favor of the interaction we observed between perceptual load and modality in this experiment (Rouder, Morey, Verhagen, Swagman, & Wagenmakers, 2017) and against the presence of an interaction between cognitive load and modality. Using the model described above, we obtain a BF_{10} of 2.06×10^4 (± 5.30%) compared to a model containing the main effects and random effects only. Regarding an interaction between cognitive load and modality, an observation of no significant difference between experimental conditions is not necessarily evidence that there is no difference between the two conditions (Weber & Popova, 2012). As such, we subjected the model containing an interaction between cognitive load and modality to a Bayesian analysis as well. When comparing the model containing the cognitive load × modality interaction to a model containing only main effects and random effects, we obtain a BF_{10} of $= .12$ to 1 (± 5.44%), indicating that the interaction model is about eight times less likely given the data than is the main effects model alone.

7. Discussion

In this experiment, we manipulated visual perceptual load while measuring STRTs (an indicator of resource availability) in both the visual and auditory channel. Our data suggest that perceptual load influences resource availability only within the modality in which it was introduced whereas cognitive load influences resource availability irrespective of modality. Framing these findings in the language of Holbert and Park (2019), perceptual load's influence on resource availability is contingent upon modality whereas cognitive load's influence is not. When resource availability was measured in the visual channel, increased visual perceptual load lengthened reaction times, but when resource availability was measured in the auditory channel, increased perceptual load did not lead to a significant increase in reaction times. Bayesian analyses revealed that the relative likelihood of the perceptual load × modality model compared to a main effects model is about 20,000 to one (given the data observed herein). This provides strong evidence for the modality-specificity of perceptual resources during multimedia processing.

Our data also reveal substantial main effects of both cognitive load and modality on resource availability, as well as a smaller main effect of perceptual load. These results replicate a spate of findings in cognitive and media psychology showing that cognitive load robustly influences resource availability during media processing (Fisher et al., 2019; Huskey et al., 2018; Lang et al., 2006). It is worth noting that the main effect of modality observed in this study is in contrast with the findings of Basil (1994a), who showed that reaction times to auditory probes were slower overall than reactions to visual probes (although see Thorson et al., 1985). We hesitate to interpret this finding as supporting the idea that auditory responses are faster in general than are visual responses, as it is possible that the main effect of load could simply be reflective of the baseline visual perceptual load in the task or due to the active nature of our task (playing a video game versus passively viewing a message). Future work should investigate how the main effect of modality varies as a function of baseline perceptual load or the interactivity of the media stimulus.

These findings support the predictions of the revised version of the LC4MP put forth by Fisher, Huskey, et al. (2018) and extend beyond the predictions of the original LC4MP. In the original LC4MP (Lang, 2000, 2006), resource capacity limitations were treated as purely conceptual, having no particular basis in the structure or function of the brain. In this model, it was simply proposed that increased complexity within a media environment should be associated with reduced resource availability (pending that resource allocation is held constant). This conceptualization, although allowing for remarkable advancements in our understanding of message processing, did not provide a framework for more specific predictions regarding how resource availability may vary based on modality or process type. In the updated model (Fisher, Huskey, et al., 2018), capacity limitations on information processing are given a biological basis. It is proposed that these capacity limitations are related to spatial, chemical, or temporal constraints on neural firing present within large-scale semi-specialized brain networks. As such, the architecture of these networks places bounds on the sorts of processes that can happen concurrently. This updated assumption leads to the prediction that increased complexity within a message will influence resource availability in different ways depending on whether the complexity is perceptual or cognitive, and upon the modality in which the information is introduced. Increased perceptual load in a media environment should reduce resource availability primarily within the modality in which the load was introduced (visual or auditory), having minimal influence on resource availability in another modality. In contrast, cognitive load should influence resource availability in visual and auditory channels in a roughly equivalent fashion.

In addition, these results suggest a general note of caution for researchers who use STRTs as an indicator of resource availability during media processing—especially when a message is high in perceptual load. If perceptual load is high in a given modality, but STRTs are measured in another modality, it is likely that the effects of load on resource availability will not be captured by the STRT task. Likewise, these data suggest that slow STRTs observed in one modality alone are not necessarily an indicator that cognitive load in the media stimulus is high, given that perceptual load can reduce resource availability within one modality even in the absence of increased cognitive load. With this in mind, future research using rich audiovisual stimuli should ensure that the STRT probe is either: a) within the primary modality in which load is introduced; b) alternatingly presented in each modality and treated as a combined index across modalities; or c) if modality-specific questions are not of interest, present in both modalities (e.g., a flash accompanied by a tone).

In directly manipulating perceptual and cognitive load in line with validated procedures developed in neuroscience research, this work pushes beyond what has previously been tested within this context, allowing for more precise investigation of the roles of modality, cognitive load, and perceptual load in media processing. This does not mean that this approach is not without limitations that may circumscribe the generalizability of the observed findings. One primary limitation of the approach outlined herein is that Asteroid Impact is predominantly visual in nature (i.e., auditory cues are mostly irrelevant for successful gameplay). As such, effective manipulation of auditory perceptual load in the game environment is not currently feasible. It is possible that an induction of auditory perceptual load may have different modality-specific effects than did the visual perceptual load manipulation employed here. Future work should investigate the modality-specific effects of load for tasks that are primarily auditory, such as listening to narratives or radio shows, to ascertain how an induction of auditory perceptual load influences resource availability and processing performance within and between modalities.

Second, this experiment only contained two levels of cognitive and perceptual load (low versus high), limiting the utility of this work for understanding the parametric relationship between cognitive/perceptual load and resource availability. Extant research suggests that the parametric relationship between cognitive load and attentional resource allocation is curvilinear rather than linear (Weber, Alicea, Huskey, & Mathiak, 2018). Future work should manipulate cognitive/perceptual load along a continuum to paint a fuller picture of how load influences processing in naturalistic tasks.

Finally, although a “modding” approach (Elson & Quandt, 2016) allows researchers to circumvent many of the shortcomings inherent in single message designs, it is still the case that Asteroid Impact is only one video game, and that it is rather rudimentary compared to “state of the art” video games widely available today. As such, Asteroid Impact, just like any other media stimulus, contains myriad uncontrollable idiosyncrasies that may limit the generalizability of the effects observed here. Future work should seek to manipulate cognitive and perceptual load in novel ways and in novel contexts (such as a different genre of game or a non-interactive form of media) in order to ascertain the robustness of the model proposed herein.

8. Modality and Interactive Media

The role of modality in multimedia processing and other naturalistic tasks, although a long-neglected question, is perhaps of greater importance now than it has ever been. Three recent developments in the multimedia landscape have highlighted the importance of understanding when and why information loads modality-independent cognitive resources and when it loads modality-specific ones.

First, video games and other interactive media are becoming increasingly multisensory, employing rich cross- and inter-modal stimuli in order to build more engaging and immersive worlds. This is especially true in emerging virtual reality and augmented reality systems. We know that enjoyment and performance in video games is contingent on the demands that the game places on the human processing system (Sherry, 2004). These demands can be cognitive, emotional, physical, or social (Bowman et al., 2018). Despite the clear diversity in the sorts of demands that video games and other interactive media can place on individuals, the bulk of research in this domain has considered these demands in a non-specific sense, using terms such as “cognitive load” as a catch-all for the myriad ways in which these media may generate demand (Bowman et al., 2018). The data presented in this article suggest that perceptual demands may have their own role to play in influencing experiences with interactive media. Indeed, perceptual persuasiveness—the extent to which the sensory experience of a video game is rich and immersive—has been shown to be a robust predictor of game enjoyment (Weber, Behr, & DeMartino, 2014). Video games that more effectively manage modality-specific and modality-general resources are likely to be more immersive, and therefore enjoyable. Further research in this area is critical for the development of more effective games aimed at cognitive rehabilitation and optimization, as it has been shown that perceptually immersive and enjoyable games more effectively elicit neuroplastic changes in key neural substrates (Bavelier, Levi, Li, Dan, & Hensch, 2010; Kamke et al., 2012) and are more likely to lead to treatment compliance (Kofler et al., 2018).

Second, driven by technological advancements and changes in media use habits, individuals increasingly multitask within and between perceptual modalities using digital technology (Rideout, Foehr, & Roberts, 2010). Individuals multitask upwards of 92% of the time when using certain forms of media (Deloitte, 2015), and switch between streams up to 2.5 times per minute (Brasel & Gips, 2017). If it is the case that cognitive load and perceptual load differentially influence the salience of stimulus cues that are external to the task at hand, then it could be expected that individuals’ within- and between-device multitasking behaviors would likely be predicted by the relative cognitive and perceptual load within each concurrently attended information stream. In fact, a large body of literature from the cognitive neuroscience of perception shows that the salience of peripheral sensory cues is contingent upon the perceptual load present in the primary task (Lavie, 2010; Lavie et al., 2004). With this in mind, it could be suggested that an understanding of the modality-dependence of perceptual load may lead to increased predictive accuracy regarding media multitasking behavior, and a better understanding of when and why individuals choose to switch within and between mediated tasks.

Finally, multisensory digital interfaces are increasingly being incorporated into complex activities like driving a car (Spence & Ho, 2008), controlling robots (Martinez-Hernandez, Boorman, & Prescott, 2017), conducting surgery (Chen et al., 2015), and many other domains. These tasks are often time-critical, requiring quick and accurate reactions to multiple stimuli in quick succession. Overload or inappropriate attentional patterns in one or multiple modalities during these tasks is likely to increase risk of injury or fatality. As such, optimal presentation of multisensory cues in these tasks in view of modality-specific resource limitations is necessary for ensuring safety and efficiency of these interfaces.

9. Closing Remarks

In this article, we have provided a re-introduction and refinement of the concept of perceptual load into message processes and effects research. Drawing on extant work in the neuroscience of sensation and perception, we further explicated and showed support for the clarifications and extensions to the model outlined in Fisher, Huskey, et al. (2018). Results from the experiment reported herein provide clear support for these predictions and suggest that progress toward resolving current ambiguities and inconsistencies regarding message complexity and modality can be found when considering the independent contributions of perceptual and cognitive load.

Results from this experiment also suggest that recently-developed frameworks conceptualizing the demand landscape within video games (see e.g., Bowman et al., 2018) would perhaps benefit from a specific consideration of perceptual load as separable from cognitive load—at least whenever the modality in which information is provided is an area of interest. It is likely that a more granular consideration of which components of a game are merely perceptual (orienting, filtering, dedistortion, etc.) and which components involve higher-order cognitive processes like working memory and cognitive control will increase the utility of these frameworks for understanding the various demands that video game play places on the human processing system.

In summary, this study highlights the importance of perceptual load for understanding how information presented in the visual or auditory modality may lead to modality-specific or modality-general effects on resource availability. In a rapidly changing multimedia environment, characterized by increasingly multimodal stimuli, it has become even more critical that media psychology researchers develop an understanding of how these processes work in order to contribute to the design of digital messages and tools that are immersive and engaging, but also that reduce unnecessary load on the cognitive and perceptual systems, facilitating safer and more effective media and media use behaviors.

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Conflict of Interests

The authors declare no conflict of interests.

References

Alais, D., Morrone, C., & Burr, D. (2006). Separate attentional resources for vision and audition. *Proceedings of the Royal Society B: Biological Sciences*, *273*(1592), 1339–1345.

Alais, D., Newell, F., & Mamassian, P. (2010). Multisensory processing in review: From physiology to behaviour. *Seeing and Perceiving*, *23*(1), 3–38.

Aly, M., Chen, J., Turk-Browne, N. B., & Hasson, U. (2018). Learning naturalistic temporal structure in the posterior medial network. *Journal of Cognitive Neuroscience*, *30*(9), 1345–1365.

Arrighi, R., Lunardi, R., & Burr, D. (2011). Vision and audition do not share attentional resources in sustained tasks. *Frontiers in Psychology*, *2*(56), 1–4.

Bahrami, B., Carmel, D., Walsh, V., Rees, G., & Lavie, N. (2008). Unconscious orientation processing depends on perceptual load. *Journal of Vision*, *8*(3), 12.

Baldassano, C., Chen, J., Zadbood, A., Pillow, J. W., Hasson, U., & Norman, K. A. (2017). Discovering event structure in continuous narrative perception and memory. *Neuron*, *95*(3), 709–721.

Basil, M. D. (1994a). Multiple resource theory I: Application to television viewing. *Communication Research*, *21*(2), 177–207.

Basil, M. D. (1994b). Multiple resource theory II: Empirical examination of modality-specific attention to television scenes. *Communication Research*, *21*(2), 208–231.

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48.

Bavelier, D., Levi, D. M., Li, R. W., Dan, Y., & Hensch, T. K. (2010). Removing brakes on adult brain plasticity: From molecular to behavioral interventions. *Journal of Neuroscience*, *30*(45), 14964–14971.

Bear, M. F., Connors, B., & Paradiso, M. (2015). *Neuroscience: Exploring the brain* (4th ed.). Philadelphia, PA: Wolters-Kluwer.

Bolls, P. D. (2002). I can hear you, but can I see you? The use of visual cognition during exposure to high-imagery radio advertisements. *Communication Research*, *29*(5), 537–563.

Bolls, P. D., & Muehling, D. D. (2007). The effects of dual-task processing on consumers' responses to high- and low-imagery radio advertisements. *Journal of Advertising*, *36*(4), 35–47.

Botvinick, M., & Braver, T. (2015). Motivation and cognitive control: From behavior to neural mechanism. *Annual Review of Psychology*, *66*(1), 83–113.

Bowman, N. D., Banks, J., & Wasserman, J. (2018). Development of a video game demand scale. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 204–233). New York, NY: Routledge.

Brasel, S. A., & Gips, J. (2017). Media multitasking: How visual cues affect switching behavior. *Computers in Human Behavior*, *77*, 258–265.

Broadbent, D. E. (1958). *Perception and communication*. London: Pergamon Press.

Brosius, H.-B. (1989). Influence of presentation features and news content on learning from television news. *Journal of Broadcasting & Electronic Media*, *33*(1), 1–14.

Brosius, H.-B. (1993). The effects of emotional pictures in television news. *Communication Research*, *20*(1), 105–124.

Buschman, T. J., Siegel, M., Roy, J. E., & Miller, E. K. (2011). Neural substrates of cognitive capacity limitations. *Proceedings of the National Academy of Sciences*, *108*(27), 11252–11255.

Chen, D., & Hutchinson, J. B. (2018). What is memory-guided attention? How past experiences shape selective visuospatial attention in the present. In M. Geyer, B. Ellenbroek, & C. Marsden (Eds.), *Current topics in behavioral neurosciences* (pp. 1–28). Berlin: Springer Nature.

Chen, X., Xu, L., Wang, Y., Wang, H., Wang, F., Zeng, X., . . . Egger, J. (2015). Development of a surgical navigation system based on augmented reality using an optical see-through head-mounted display. *Journal of Biomedical Informatics*, *55*, 124–131.

Cosman, J. D., & Vecera, S. P. (2009). Perceptual load modulates attentional capture by abrupt onsets. *Psychonomic Bulletin & Review*, *16*(2), 404–410.

Cosman, J. D., & Vecera, S. P. (2010a). Attentional capture by motion onsets is modulated by perceptual load. *Attention, Perception, & Psychophysics*, *72*(8), 2096–2105.

Cosman, J. D., & Vecera, S. P. (2010b). Attentional capture under high perceptual load. *Psychonomic Bulletin & Review*, *17*(6), 815–820.

Deloitte. (2015). *Digital democracy survey: A multi-generational view of consumer technology, media and telecom trends* (9th Edition). New York, NY: Deloitte.

Drew, D. G., & Grimes, T. (1987). Audio-visual redundancy and TV news recall. *Communication Research*, *14*(4), 452–461.

Duncan, J., Martens, S., & Ward, R. (1997). Restricted attentional capacity within but not between sensory modalities. *Nature*, *387*, 808–810.

Elliott, J. C., & Giesbrecht, B. (2010). Perceptual load modulates the processing of distractors presented at task-irrelevant locations during the attentional blink. *Attention, Perception, & Psychophysics*, *72*(8), 2106–2114.

Elson, M., & Quandt, T. (2016). Digital games in laboratory experiments: Controlling a complex stimulus through modding. *Psychology of Popular Media Culture*, *5*(1), 52–65.

Eriksson, J., Vogel, E. K., Lansner, A., Bergström, F., & Nyberg, L. (2015). Neurocognitive architecture of working memory. *Neuron*, *88*(1), 33–46.

Finc, K., Bonna, K., Lewandowska, M., Wolak, T., Nikadon, J., Dreszer, J., . . . Kühn, S. (2017). Transition of the functional brain network related to increasing cognitive demands. *Human Brain Mapping*, *38*(7), 3659–3674.

Fisher, J. T., Hopp, F. R., & Weber, R. (2018). *"Look harder!" ADHD, media multitasking, and the effects of cognitive and perceptual load on resource availability and processing performance*. Paper presented at the 68th Annual Conference of the International Communication Association, Prague, Czech Republic.

Fisher, J. T., Hopp, F. R., & Weber, R. (2019). *Disentangling the roles of reward and process type on resource allocation in an interactive task*. Paper presented at the 69th Annual Conference of the International Communication Association, Washington, DC, USA.

Fisher, J. T., Huskey, R., Keene, J. R., & Weber, R. (2018). The limited capacity model of motivated mediated message processing: Looking to the future. *Annals of the International Communication Association*, *42*(4), 291–315.

Fisher, J. T., Keene, J. R., Huskey, R., & Weber, R. (2018). The limited capacity model of motivated mediated message processing: Taking stock of the past. *Annals of the International Communication Association*, *42*(4), 270–290.

Fitousi, D., & Wenger, M. J. (2011). Processing capacity under perceptual and cognitive load: A closer look at load theory. *Journal of Experimental Psychology: Human Perception and Performance*, *37*(3), 781–798.

Forster, S., & Lavie, N. (2008). Failures to ignore entirely irrelevant distractors: The role of load. *Journal of Experimental Psychology: Applied*, *14*(1), 73–83.

Forster, S., & Lavie, N. (2016). Establishing the attention-distractibility trait. *Psychological Science*, *27*(2), 203–212.

Forster, S., Robertson, D. J., Jennings, A., Asherson, P., & Lavie, N. (2014). Plugging the attention deficit: Perceptual load counters increased distraction in ADHD. *Neuropsychology*, *28*(1), 91–97.

Fox, J. R. (2004). A signal detection analysis of audio/video redundancy effects in television news video. *Communication Research*, *31*(5), 524–536.

Fox, J. R., Park, B., & Lang, A. (2007). When available resources become negative resources: The effects of cognitive overload on memory sensitivity and criterion bias. *Communication Research*, *34*(3), 277–296.

Franconeri, S. L., Alvarez, G. A., & Cavanagh, P. (2013). Flexible cognitive resources: Competitive content maps for attention and memory. *Trends in Cognitive Sciences*, *17*(3), 134–141.

Fu, S., Huang, Y., Luo, Y., Wang, Y., Fedota, J., Greenwood, P. M., & Parasuraman, R. (2009). Perceptual load interacts with involuntary attention at early processing stages: Event-related potential studies. *NeuroImage*, *48*(1), 191–199.

Funder, D. C., & Ozer, D. J. (2019). Evaluating effect size in psychological research: Sense and nonsense. *Advances in Methods and Practices in Psychological Science*, *2*(2), 156–168.

Geiger, S., & Newhagen, J. (1993). Revealing the black box: Information processing and media effects. *Journal of Communication*, *43*(4), 42–50.

Godwin, D., Barry, R. L., & Marois, R. (2015). Breakdown of the brain's functional network modularity with awareness. *Proceedings of the National Academy of Sciences*, *112*(12), 3799–3804.

Grabe, M. E., Bas, O., & van Driel, I. I. (2015). Defecting from the Gutenberg legacy: Employing images to test knowledge gaps. *Journal of Communication*, *65*(2), 300–319.

Grabe, M. E., Lang, A., & Zhao, X. (2003). News content and form: Implications for memory and audience evaluations. *Communication Research*, *30*(4), 387–413.

Green, P., & MacLeod, C. J. (2016). SIMR: An R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution*, *7*(4), 493–498.

Grimes, T. (1990). Audio-video correspondence and its role in attention and memory. *Educational Technology Research and Development*, *38*(3), 15–25.

Grimes, T. (1991). Mild auditory-visual dissonance in television news may exceed viewer attentional capacity. *Human Communication Research*, *18*(2), 268–298.

Hasson, U., Chen, J., & Honey, C. J. (2015). Hierarchical process memory: Memory as an integral component of information processing. *Trends in Cognitive Sciences*, *19*(6), 304–313.

Hearne, L. J., Cocchi, L., Zalesky, A., & Mattingley, J. B. (2017). Reconfiguration of brain network architectures between resting-state and complexity-dependent cognitive reasoning. *Journal of Neuroscience*, *37*(35), 8399–8411.

Hesselmann, G., Hebart, M., & Malach, R. (2011). Differential BOLD activity associated with subjective and objective reports during "blindsight" in normal observers. *Journal of Neuroscience*, *31*(36), 12936–12944.

Holbert, R. L., & Park, E. (2019). Conceptualizing, organizing, and positing moderation in communication research. *Communication Theory*. Advance online publication. https://doi.org/10.1093/ct/qtz006

Hsia, H. J. (1968). Output, error, equivocation, and recalled information in auditory, visual, and audiovisual information processing with constraint and noise. *Journal of Communication*, *18*(4), 325–345.

Huskey, R., Craighead, B., Miller, M. B., & Weber, R. (2018). Does intrinsic reward motivate cognitive control? A naturalistic-fMRI study based on the synchronization theory of flow. *Cognitive, Affective, & Behavioral Neuroscience*, *18*(5), 902–924.

Huskey, R., Wilcox, S., Clayton, R., & Keene, J. R. (2019). *The limited capacity model of motivated mediated message processing: A meta-analytic summary of two decades of research*. Manuscript submitted for publication.

Inzlicht, M., Shenhav, A., & Olivola, C. Y. (2018). The effort paradox: Effort is both costly and valued. *Trends in Cognitive Sciences*, *22*(4), 337–349.

Kahneman, D. (1973). *Attention and effort*. Englewood Cliffs, NJ: Prentice-Hall.

Kamke, M. R., Hall, M. G., Lye, H. F., Sale, M. V., Fenlon, L. R., Carroll, T. J., . . . Mattingley, J. B. (2012). Visual attentional load influences plasticity in the human motor cortex. *Journal of Neuroscience*, *32*(20), 7001–7008.

Keene, J. R., & Lang, A. (2016). Dynamic motivated processing of emotional trajectories in public service announcements. *Communication Monographs*, *83*(4), 468–485.

Keitel, C., Maess, B., Schröger, E., & Müller, M. M. (2013). Early visual and auditory processing rely on modality-specific attentional resources. *NeuroImage*, *70*, 240–249.

Kelley, T. A., & Lavie, N. (2011). Working memory load modulates distractor competition in primary visual cortex. *Cerebral Cortex*, *21*(3), 659–665.

Kitzbichler, M. G., Henson, R. N. A., Smith, M. L., Nathan, P. J., & Bullmore, E. T. (2011). Cognitive effort drives workspace configuration of human brain functional networks. *Journal of Neuroscience*, *31*(22), 8259–8270.

Kofler, M. J., Sarver, D. E., Austin, K. E., Schaefer, H. S., Holland, E., Aduen, P. A., . . . Lonigan, C. J. (2018). Can working memory training work for ADHD? Development of central executive training and comparison with behavioral parent training. *Journal of Consulting and Clinical Psychology*, *86*(12), 964–979.

Kool, W., McGuire, J. T., Rosen, Z. B., & Botvinick, M. M. (2010). Decision making and the avoidance of cognitive demand. *Journal of Experimental Psychology: General*, *139*(4), 665–682.

Lang, A. (1995). Defining audio/video redundancy from a limited-capacity information processing perspective. *Communication Research*, *22*(1), 86–115.

Lang, A. (2000). The limited capacity model of mediated message processing. *Journal of Communication*, *50*(1), 46–70.

Lang, A. (2006). Using the limited capacity model of motivated mediated message processing to design effective cancer communication messages. *Journal of Communication*, *56*, S57–S80.

Lang, A. (2009). The limited capacity model of motivated mediated message processing. In R. Nabi & M. B. Oliver (Eds.), *The Sage handbook of media processes and effects* (pp. 193–204). Thousand Oaks, CA: Sage.

Lang, A., & Basil, M. D. (1998). Attention, resource allocation, and communication research: What do secondary task reaction times measure, anyway? *Annals of the International Communication Association*, *21*(1), 443–458.

Lang, A., Bradley, S. D., Park, B., Shin, M., & Chung, Y. (2006). Parsing the resource pie: Using STRTs to measure attention to mediated messages. *Media Psychology*, *8*(4), 369–394.

Lang, A., Gao, Y., Potter, R. F., Lee, S., Park, B., & Bailey, R. L. (2015). Conceptualizing audio message complexity as available processing resources. *Communication Research*, *42*(6), 759–778.

Lang, A., Newhagen, J., & Reeves, B. (1996). Negative video as structure: Emotion, attention, capacity, and memory. *Journal of Broadcasting & Electronic Media*, *40*(4), 460–477.

Lang, A., Potter, D., & Grabe, M. E. (2003). Making news memorable: Applying theory to the production of local television news. *Journal of Broadcasting & Electronic Media*, *47*(1), 113–123.

Lang, A., Potter, R. F., & Bolls, P. D. (1999). Something for nothing: Is visual encoding automatic? *Media Psychology*, *1*(2), 145–163.

Lang, A., Sanders-Jackson, A., Wang, Z., & Rubenking, B. (2013). Motivated message processing: How motivational activation influences resource allocation, encoding, and storage of TV messages. *Motivation and Emotion*, *37*(3), 508–517.

Lang, P. J., Bradley, M. M., Cuthbert, B. N., & Simons, R. F. (1997). Motivated attention: Affect, activation, and action. In P. J. Lang, R. F. Simons, & M. Balaban (Eds.), *Attention and orienting: Sensory and motivational processes* (pp. 97–135). Mahwah, NJ: Lawrence Erlbaum Associates.

Lavie, N. (1995). Perceptual load as a necessary condition for selective attention. *Journal of Experimental Psychology: Human Perception and Performance*, *21*(3), 451–468.

Lavie, N. (2005). Distracted and confused? Selective attention under load. *Trends in Cognitive Sciences*, *9*(2), 75–82.

Lavie, N. (2010). Attention, distraction, and cognitive control under load. *Current Directions in Psychological Science*, *19*(3), 143–148.

Lavie, N., Hirst, A., de Fockert, J. W., & Viding, E. (2004). Load theory of selective attention and cognitive control. *Journal of Experimental Psychology: General*, *133*(3), 339–354.

Lavie, N., Lin, Z., Zokaei, N., & Thoma, V. (2009). The role of perceptual load in object recognition. *Journal of Experimental Psychology: Human Perception and Performance*, *35*(5), 1346–1358.

Lee, S., & Lang, A. (2015). Redefining media content and structure in terms of available resources: Toward a dynamic human-centric theory of communication. *Communication Research*, *42*, 599–625.

Locke, H. S., & Braver, T. S. (2008). Motivational influences on cognitive control: Behavior, brain activation, and individual differences. *Cognitive, Affective, & Behavioral Neuroscience*, *8*(1), 99–112.

Marois, R., & Ivanoff, J. (2005). Capacity limits of information processing in the brain. *Trends in Cognitive Sciences*, *9*(6), 296–305.

Martinez-Hernandez, U., Boorman, L. W., & Prescott, T. J. (2017). Multisensory wearable interface for immersion and telepresence in robotics. *IEEE Sensors Journal*, *17*(8), 2534–2541.

Mayer, R. E. (2014). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 31–48). Cambridge: Cambridge University Press.

Moreno, R. (2006). Does the modality principle hold for different media? A test of the method-affects-learning hypothesis. *Journal of Computer Assisted Learning*, *22*(3), 149–158.

Moreno, R., & Mayer, R. E. (1999). Cognitive principles of multimedia learning: The role of modality and contiguity. *Journal of Educational Psychology*, *91*(2), 358–368.

Murphy, G., Groeger, J. A., & Greene, C. M. (2016). Twenty years of load theory—Where are we now, and where should we go next? *Psychonomic Bulletin & Review*, *23*(5), 1316–1340.

Murray, J. D., Bernacchia, A., Freedman, D. J., Romo, R., Wallis, J. D., Cai, X., . . . Wang, X.-J. (2014). A hierarchy of intrinsic timescales across primate cortex. *Nature Neuroscience*, *17*(12), 1661–1663.

Nelken, I., & Bar-Yosef, O. (2008). Neurons and objects: The case of auditory cortex. *Frontiers in Neuroscience*, *2*.

Newhagen, J. E., & Reeves, B. (1992). The evening's bad news: Effects of compelling negative television news images on memory. *Journal of Communication*, *42*(2), 25–41.

Owen, A. M., McMillan, K. M., Laird, A. R., & Bullmore, E. (2005). N-back working memory paradigm: A meta-analysis of normative functional neuroimaging studies. *Human Brain Mapping*, *25*(1), 46–59.

R Core Team. (2013). *R: A language and environment for statistical computing*. Vienna: R Foundation for Statistical Computing.

Regev, M., Simony, E., Lee, K., Tan, K. M., Chen, J., & Hasson, U. (2018). Propagation of information along the cortical hierarchy as a function of attention while reading and listening to stories. *Cerebral Cortex*, *29*(10), 4017–4034.

Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). *Generation M2: Media in the lives of 8-to 18-year-olds*. Menlo Park, CA: Henry J. Kaiser Family Foundation. Retrieved from https://www.kff.org/wp-content/uploads/2013/04/8010.pdf

Rouder, J. N., Morey, R. D., Verhagen, J., Swagman, A. R., & Wagenmakers, E.-J. (2017). Bayesian analysis of factorial designs. *Psychological Methods*, *22*(2), 304.

Sandhu, R., & Dyson, B. J. (2016). Cross-modal perceptual load: The impact of modality and individual differences. *Experimental Brain Research*, *234*(5), 1279–1291.

Santangelo, V., & Spence, C. (2008). Is the exogenous orienting of spatial attention truly automatic? Evidence from unimodal and multisensory studies. *Consciousness and Cognition*, *17*(3), 989–1015.

Schäfer, T., & Schwarz, M. A. (2019). The meaningfulness of effect sizes in psychological research: Differences between sub-disciplines and the impact of potential biases. *Frontiers in Psychology*, *10*.

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review*, *84*(1), 1–66.

Severin, W. J. (1967). Pictures as relevant cues in multichannel communication. *Journalism Quarterly*, *44*(1), 17–52.

Sherry, J. L. (2004). Flow and media enjoyment. *Communication Theory*, *14*(4), 328–347.

Shine, J. M., & Poldrack, R. A. (2018). Principles of dynamic network reconfiguration across diverse brain states. *NeuroImage*, *180*, 396–405.

Spence, C., & Ho, C. (2008). Multisensory interface design for drivers: Past, present and future. *Ergonomics*, *51*(1), 65–70.

Stróżak, P., & Francuz, P. (2017). Event-related potential correlates of attention to mediated message processing. *Media Psychology*, *20*(2), 291–316.

Thorson, E., & Lang, A. (1992). The effects of television videographics and lecture familiarity on adult cardiac orienting responses and memory. *Communication Research*, *19*(3), 346–369.

Thorson, E., Reeves, B., & Schleuder, J. (1985). Message complexity and attention to television. *Communication Research*, *12*(4), 427–454.

Thorson, E., Reeves, B., & Schleuder, J. (1987). Attention to local and global complexity in television messages. *Communication Yearbook*, *10*(1), 366–383.

Treisman, A. M. (1969). Strategies and models of selective attention. *Psychological Review*, *76*(3), 282–299.

Veltman, D. J., Rombouts, S. A. R. B., & Dolan, R. J. (2003). Maintenance versus manipulation in verbal working memory revisited: An fMRI study. *NeuroImage*, *18*(2), 247–256.

Wahn, B., & König, P. (2017). Is attentional resource allocation across sensory modalities task-dependent? *Advances in Cognitive Psychology*, *13*(1), 83–96.

Wang, Z., & Duff, B. R. L. (2016). All loads are not equal: Distinct influences of perceptual load and cognitive load on peripheral ad processing. *Media Psychology*, *19*(4), 589–613.

Weber, R., Alicea, B., Huskey, R., & Mathiak, K. (2018). Network dynamics of attention during a naturalistic behavioral paradigm. *Frontiers in Human Neuroscience*, *12*.

Weber, R., Behr, K.-M., & DeMartino, C. (2014). Measuring interactivity in video games. *Communication Methods and Measures*, *8*(2), 79–115.

Weber, R., & Popova, L. (2012). Testing equivalence in communication research: Theory and application. *Communication Methods and Measures*, *6*(3), 190–213.

Wember, B. (1983). *Wie informiert das fernsehen?* [How does television inform?]. Munich: Paul List.

Westbrook, A., & Braver, T. S. (2015). Cognitive effort: A neuroeconomic approach. *Cognitive, Affective, & Behavioral Neuroscience*, *15*(2), 395–415.

Whelan, R. (2008). Effective analysis of reaction time data. *The Psychological Record*, *58*(3), 475–482.

Winkler, I., Czigler, I., Sussman, E., Horváth, J., & Balázs, L. (2005). Preattentive binding of auditory and visual stimulus features. *Journal of Cognitive Neuroscience*, *17*(2), 320–339.

Woolsey, T. A., Hanaway, J., & Mokhtar, G. H. (2017). *The brain atlas: A visual guide to the human central nervous system* (4th ed.). Oxford: Wiley-Blackwell.

Yarkoni, T., Speer, N. K., & Zacks, J. M. (2008). Neural substrates of narrative comprehension and memory. *NeuroImage*, *41*(4), 1408–1425.

Yegiyan, N. S. (2015). Gun focus effect revisited II: How sex modulates emotional information processing strategy. *Communication Research*, *42*(7), 903–921.

Zacks, J. M., & Magliano, J. P. (2011). Film, narrative, and cognitive neuroscience. In D. Melcher & F. Bacci (Eds.), *Art and the senses* (pp. 435–454). Oxford: Oxford University Press.

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Article

Harder, Better, Faster, Stronger? The Relationship between Cognitive Task Demands in Video Games and Recovery Experiences

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Abstract
Research has repeatedly demonstrated that the use of interactive media is associated with recovery experiences, suggesting that engaging with media can help people to alleviate stress and restore mental and physical resources. Video games, in particular, have been shown to fulfil various aspects of recovery, not least due to their ability to elicit feelings of mastery and control. However, little is known about the role of cognitive task demand (i.e., the amount of cognitive effort a task requires) in that process. Toward this end, our study aimed to investigate how cognitive task demand during gameplay affects users' recovery experiences. Results of a laboratory experiment suggest that different dimensions of the recovery experiences seem to respond to different levels of cognitive task demand. While control experiences were highest under low cognitive task demand, there was no difference between groups regarding experiences of mastery and psychological detachment. Nevertheless, both gaming conditions outperformed the control condition regarding experiences of mastery and psychological detachment. Controlling for personal gaming experiences, relaxation was higher in the low cognitive task demand condition compared to the control condition. Findings are discussed in terms of their implications for research on the multilayered recovery effects of interactive media.

Keywords
cognitive task demand; gaming; interactive media; recovery experiences; video games

Issue
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1. Introduction

People adopt various strategies to recover from stress; some engage in sports, others enjoy a special meal, or just relax while watching their favorite series. Indeed, previous research has identified the use of entertainment media as an effective strategy to alleviate negative affective states (e.g., Zillmann, 1988) and to recover from stressful situations (e.g., Rieger, Reinecke, Frischlich, & Bente, 2014). Video games in particular have been in the focus of media research given their interactive nature that challenges players to master quests, win out over other players or the game itself and, in doing so, fulfill psychological needs for recovery and well-being (e.g., Reinecke, 2009a; Reinecke, Klatt, & Krämer, 2011). While such research suggests that video games may be a significant recovery resource, the gaming environment also places continual demands on the player: Players engage in continuous "input–output loops" (Klimmt & Hartmann, 2006, p. 137) with the gaming environment and need to react to new challenges. The cognitive task demand of video games can be conceptualized as a function of the cognitive skills required to play as well as the cognitive resources needed to direct attention towards the actions in the game (Bowman, 2018). The role of the fit between a game's cognitive task demand and players' abilities to recover through gaming has been largely neglected by media psychological research thus far. However, as suggested by previous gaming research, experiences that fit media users' (cognitive) capacities may be particularly enjoyable, motivating users to push further, thus helping them to address their recovery needs (Schmierbach, Chung, Wu, & Kim, 2014).

Given that video games—not least due to their interactive nature—demand that players allocate a certain amount of their cognitive ability toward the game, the current article aims to close the gap in current research by testing the assumption that video games that demand just the right level of cognitive capacity are best suited to provide recovery experiences for their players. To this end, we instructed participants to play a high demand, low demand, or no video game and measured their cognitive task demand as well as recovery experiences in an experimental setting.

2. Media Use and Recovery Experiences

A plethora of daily activities—both in and out of work—drain people's mental and physical resources, which can result in negative affect or physiological and psychological fatigue (Fuller et al., 2003; Sluiter, de Croon, Meijman, & Frings-Dresen, 2003). To restore these resources and to avoid long-term stress or health ramifications, people need to recover. In general, recovery refers to the "process of replenishing depleted resources or rebalancing suboptimal systems" (Sonnentag & Zijlstra, 2006, p. 331), which is a vital factor for people's performance and psychological well-being. While the everyday use of the word recover(ing) usually refers to relatively passive activities and a state of low activation (e.g., relaxing or resting), recovery experiences go beyond winding down. In an attempt to integrate the different facets of recovery, Sonnentag and Fritz (2007) discuss four distinct recovery experiences that address different ways to replenish depleted resources: psychological detachment (i.e., mentally/physically distancing oneself from stress-inducing tasks); relaxation (i.e., reducing activation/increasing positive affect); mastery (i.e., experiencing competence and proficiency); and control (i.e., being able to choose activities at one's discretion). While the first two recovery experiences—psychological detachment and relaxation—imply that no new demands are imposed on the person, the latter two—mastery and control—suggest that recovery can also result from engaging in (new) activities that help to build up internal resources such as knowledge or self-efficacy (see also Reinecke & Eden, 2017).

Considering that recovery is a crucial self-regulatory process and essential for health and well-being, it comes as no surprise that determinants and antecedents of successful recovery have attracted considerable scholarly attention, particularly in industrial and organizational psychology (for an overview see Sonnentag, Venz, & Casper, 2017). While this line of recovery research has often marginalized the role of media use, research in media psychology and communication studies has demonstrated that (entertainment) media use is a frequently used and highly successful strategy to recover from stress and strain (e.g., Janicke, Rieger, Reinecke, & Connor, 2018; Reinecke et al., 2011; Rieger & Bente, 2018; Rieger, Reinecke, et al., 2014). Some studies explain these findings by the cognitive challenges posed by the content (e.g., Bartsch & Hartmann, 2017). These studies provide evidence that both interactive (e.g., video games) and non-interactive (e.g., movies) entertainment media can promote the four recovery experiences proposed by Sonnentag and Fritz (2007), although to different extents. Specifically, it was shown that non-interactive and interactive media elicit comparable levels of psychological detachment and relaxation but differ in their effect on experiencing mastery and control (Reinecke et al., 2011). Being interactive in nature, video games demand active participation from users and allow them to be in control of their actions, thus making games particularly suitable for fulfilling recovery needs (see also Reinecke, 2009a, 2009b).

3. Video Games, Cognitive Task Demand, and Recovery Experiences

Video games are interactive entertainment media which require players to use cognitive abilities to solve problems and tasks. Notably, such cognitive task demands are referred to differently in the literature. While some authors speak of "task load" (e.g., Moroney, Reising, Biers, & Eggemeier, 1993; Rieger, Frischlich, Wulf, Bente, & Kneer, 2015), some call it "task demand" (e.g., Bowman & Tamborini, 2012) or "cognitive load" (Read, Lynch, & Matthews, 2018). Considering that there are various demands necessary when playing video games (see Bowman, 2018), we have decided to stick to the term cognitive task demand(s) in the current article to refer broadly to the concept of "cognitive skills required to play games as well as the cognitive resources that the game pulls from the player in order to arrest attention toward the myriad messages in a game's environment" (Bowman, 2018, p. 7).

Solving tasks while playing an interactive video game may result in experiences of self-efficacy (Bandura, 1977), as players will directly experience how their actions affect the game. Early on, it was shown that such experiences are related to game enjoyment (Klimmt, Hartmann, & Frey, 2007; Trepte & Reinecke, 2011). In terms of mood management theory (Zillmann, 1988), being forced to act comes with intervention potential that helps players to be distracted from aversive states (Bowman & Tamborini, 2012; Bryant & Davies, 2006). Rieger and colleagues (2015) instructed participants to either play a game of the arcade classic game Pac-Man or let them watch a video of someone else playing it. They found that playing participants regulated their negative mood more efficiently than the other groups and that cognitive task demand fostered mood regulation. Recently, similar results were found for quiz games' ability to foster competence repair (Koban et al., 2018). Yet, this picture appears simplistic. Bowman and Tamborini (2012) confronted bored and stressed participants with more nuanced cognitive task demand conditions. They found that with increasing cognitive task demand participants' mood regulation increased as long as players were able to control the interactive environment. However, once the game became too demanding, their mood repair decreased. Altogether, the right match between cognitive task demand and players' cognitive capabilities thus appears relevant for the impact of interactive media on mood repair.

Previous research on the recovery potential of video games suggests that the benefit of playing cognitively demanding video games goes beyond mere mood repair. Data from a survey study by Reinecke (2009b) demonstrate that video games can contribute to all four recovery dimensions within Sonnentag and Fritz's (2007) conceptualization. We suggest that cognitive task demand resonates with Reinecke's (2009a) reasoning. First, Reinecke (2009a) argues that video games contribute to psychological detachment by forcing users "to focus their full attention on the game" as they "do not leave much room for thoughts that are not directed toward the gaming environment" (Reinecke, 2009a, p. 128). This argument is supported by authors describing video games as coming with varying task difficulties which players have to adapt to (e.g., Klimmt & Hartmann, 2006) as well as research showing that players immerse into the game and forget about the reality outside of the gaming narrative (e.g., Sherry, Lucas, Greenberg, & Lachlan, 2006). Accordingly, we expect that with increasing cognitive task demand players will experience higher levels of psychological detachment, as they are better able to distract themselves from the sources of their stress:

> H1a: Players in a high cognitive task demand condition will experience more psychological detachment compared to players in a low cognitive task demand condition and participants in a control group not playing a game;
>
> H1b: Players in a low cognitive task demand condition will experience more psychological detachment compared to participants in a control group not playing a game.

Reinecke (2009a) further argues that video games can help people to relax—although studies often attest that playing games comes with a rise in physiological arousal (e.g., Rieger et al., 2015). The relaxing effects of gaming may function based on similar mechanisms as physical activities, which are followed up by a decrease in anxiety and tension after the actual experience (e.g., Taylor, Sallis, & Needle, 1985). As high cognitive task demand may come with high levels of arousal, it appears counterintuitive that it could be experienced as particularly relaxing. Thus, we pose the following research question with regard to relaxation:

> RQ1: Does the experience of relaxation differ between players in high, low, and no cognitive task demand conditions?

More intuitively, players experience control when solving in-game tasks. First, the experience of self-efficacy (Bandura, 1977; Klimmt et al., 2007; Trepte & Reinecke, 2011) may help people to experience control over certain gaming tasks. Second, video games provide players with a plethora of decisions, ranging from customization of avatars (Trepte & Reinecke, 2010) to freely exploring the in-game world. For the experience of control, cognitive task demand should play a crucial role. Under low cognitive task demand, players may easily keep all problems in check and experience high levels of control, whereas a game with high cognitive task demand may overstrain players and inhibit control experiences. However, even under conditions of high cognitive task demand, games are likely to provide more opportunities to experience control than the complete absence of current tasks. Thus, we pose the following set of hypotheses:

> H2a: Players in a low cognitive task demand condition will experience more control compared to players in a high cognitive task demand condition and participants in a control group not playing a game;
>
> H2b: Players in a high cognitive task demand condition will experience more control compared to participants in a control group not playing a game.

Finally, video games help players to experience mastery by allowing them to solve challenges, achieve success, and feel generally competent when playing the game (Klimmt et al., 2007; Rieger, Wulf, Kneer, Frischlich, & Bente, 2014; Ryan, Rigby, & Przybylski, 2006; Sherry et al., 2006). For the experience of mastery, cognitive task demand may play an important part. The more challenging the game, the more triumphant is the experience of having solved it. Hence, we expect:

> H3a: Players in a high cognitive task demand condition will experience more mastery compared to players in a low cognitive task demand condition and participants in a control group not playing a game;
>
> H3b: Players in a low cognitive task demand condition will experience more mastery compared to participants in a control group not playing a game.

Furthermore, researchers have argued that individual experiences playing video games differ between players as a function of their skills. A game which overexerts the player may lead to frustration (Bowman & Tamborini, 2012) and a game high in cognitive task demand may be too challenging for some players, thus impeding mastery or control experiences. If players are too inexperienced, such games might induce stress rather than helping them to recover from it. On the other hand, if the task is too easy, the experience of recovery may also be impeded, given that the task could have been solved by anyone without special effort. Thus, we pose as our final research question:

> RQ2: Does controlling for previous experience with video games impact recovery experiences between conditions of different cognitive task demand?

4. Method

4.1. Participants and Procedure

Participants were 148 German adults (77% female; age: $M = 24.82$, $SD = 5.49$; 95% students) recruited via student mailing lists and ad hoc on-campus recruitment at a large German University. All students received course credit for participation. After obtaining informed consent and introducing participants to the procedure of the experiment, participants worked on the KLT-R (Düker, Lienert, Lukesch, & Mayrhofer, 2001), a fatiguing concentration test, for about 5 to 10 minutes. The KLT-R consists of a large number of relatively easy arithmetic problems that need to be solved under time pressure. Similar tasks have been successfully used in previous media psychological studies to induce fatigue (e.g., Reinecke et al., 2011; Rieger, Hefner, & Vorderer, 2017).

Following this task, we randomly assigned participants to one of three conditions. Participants in the two gaming conditions played either a low (easy mode) or high (hard mode) cognitive task demand version of Tetris on a computer. During gameplay, participants had to react to a secondary reaction time task as an implicit measure for cognitive task demand (see Section 4.2). The control group did not play a video game, but its members were instructed to relax and react to the audio signals. After finishing the game, participants in the two treatment conditions reported their subjective cognitive effort and recovery experiences. Finally, we assessed demographic variables and debriefed participants. Originally, we also employed a second manipulation. Participants in both gaming conditions were given false feedback on their performance (i.e., they were told that they performed either better or worse than most other players). However, this manipulation failed, as 68.2% rated the authenticity of the feedback poorly. We tested whether feedback manipulation had an impact on any of the target variables when also accounting for task demand. These analyses yielded additional information that this second manipulation failed. Thus, we decided to exclude this variation from our final analyses. This second manipulation is included in the data set provided in our Open Science Framework (OSF) repository and may be used for further analyses (the respective variable is labelled as “feedback”).

4.2. Measures

4.2.1. Cognitive Task Demand

We used a secondary reaction time task programmed with OpenSesame (Mathôt, Schreij, & Theeuwes, 2012) as an implicit measure for cognitive task demand. We instructed participants in all three conditions to press a button with their free hand (as Tetris kept only one of their hands busy) whenever they heard an audio signal (altogether, 20 trials). This procedure is an established measure for cognitive task demand and has been used, for example, within research on message processing (Hefner, Rothmund, Klimmt, & Gollwitzer, 2011; Lang & Basil, 1998; Lang, Bradley, Park, Shin, & Chung, 2006). For the evaluation of reaction times, we identified missing values and outliers. From all trials ($N = 2{,}960$ possible data points), 542 data points were missing values. These missing values are either due to: a) technical issues; or b) participants not reacting at all during a trial. Among the remaining 2418 data points, we identified 79 trials within two standard deviations of the respective trial mean as outliers (Baayen & Milin, 2010), which corresponds to roughly 3.3% of the measured and non-missing data points. Notably, all of these outliers were located two standard deviations above (not below) the respective trial mean. This can be problematic if the right tail is responsible for the effects found in the data (Baayen & Milin, 2010; Luce, 1986). However, given that we excluded less than 5% of cases, this should not pose a problem (Baayen & Milin, 2010; Ratcliff, 1993). From the valid 2,339 trials, we calculated the mean reaction time (in seconds) for each participant ($M = .76$, $SD = .33$).

Additionally, we measured subjective cognitive task demand (cognitive effort) with four items of the NASA Task Load Index (NASA-TLX), assessed by default on a 20-point Likert scale ranging from “Low” to “High” (Moroney et al., 1993). Reliability analyses suggested excluding one item (asking participants how satisfied they were with the overall performance) to reach adequate reliability of the remaining three items ($M = 9.93$, $SD = 5.01$, $\alpha = .83$). This scale has been used in previous gaming studies focusing on cognitive task demand (e.g., Bowman & Tamborini, 2015). Both indices for cognitive task demand (reaction times and cognitive effort) correlated significantly ($r = .27$, $p = .01$).

4.2.2. Recovery Experiences

We measured recovery experiences with the scale developed by Sonnentag and Fritz (2007). This scale measures recovery experiences on four subscales, psychological detachment, relaxation, mastery, and control (each on a 5-point scale). Both the scale overall (recovery) and the previously mentioned subscales showed good internal consistency (recovery, $M = 2.87$, $SD = .78$, $\alpha = .89$; psychological detachment, $M = 3.22$, $SD = 1.03$, $\alpha = .81$; relaxation, $M = 2.89$, $SD = 1.11$, $\alpha = .88$; mastery, $M = 2.49$, $SD = .99$, $\alpha = .83$; control, $M = 2.88$, $SD = 1.02$, $\alpha = .79$).

4.2.3. Previous Gaming Experiences

As a covariate of interest, we asked participants to indicate how often they play video games in their everyday life. This scale ranged from 1 (never) to 5 (often; $M = 2.00$, $SD = 1.23$).

5. Results

Data, as well as analysis scripts of the current project, can be accessed in an OSF repository at https://osf.io/jgp58. Zero-order correlations between all variables of interest are presented in Table S1 in the supplementary material. All items used in the questionnaire can be accessed in Table S2 within the same file.

5.1. Manipulation Check(s)

To check whether the gaming conditions successfully induced different levels of cognitive task demand, we conducted a MANOVA with condition (low demand game vs. high demand game vs. control condition) as the independent variable and both measures of cognitive task demand (NASA-TLX for subjective cognitive task demand and reaction times as an implicit measure of cognitive task demand) as dependent variables. There was a significant effect of condition on subjective and implicit cognitive task demand, Wilk's $\Lambda = .46$, $F(4, 256) = 30.07$, $p < .001$, $\eta_p^2 = .32$. Separate follow-up univariate ANOVAs revealed that condition had a significant impact on both the NASA-TLX, $F(2, 129) = 54.58$, $p < .001$, $\eta_p^2 = .46$, and on reaction times, $F(2, 129) = 14.95$, $p < .001$, $\eta_p^2 = .19$. Sidak post hoc tests for both cognitive task demand measures showed that while subjective cognitive task demand (NASA-TLX) differed between all conditions following a linear trend in the expected direction (high, $M = 13.36$, $SD = 3.37$; low, $M = 9.65$, $SD = 3.97$; no game, $M = 4.32$, $SD = 3.45$), the high-demand ($M = .80$, $SD = .29$) and low-demand ($M = .86$, $SD = .32$) condition did not significantly differ in reaction times. However, participants in both gaming conditions showed slower reaction times compared to the control condition ($M = .47$, $SD = .28$). Altogether, the manipulation can be regarded as successful.

5.2. Cognitive Task Demand and Recovery Experiences

To test the impact of cognitive task demand on recovery experiences (H1–H3 and RQ1), we conducted a second MANOVA with condition as the independent variable and the four recovery dimensions (Sonnentag & Fritz, 2007) as dependent variables. There was a significant effect of condition on recovery experiences, Wilk's $\Lambda = .74$, $F(8, 284) = 5.67$, $p < .001$, $\eta_p^2 = .14$. Separate follow-up univariate ANOVAs revealed that condition had a significant impact on each dimension of recovery. For ease of interpretation, details and Sidak post hoc tests are presented in Table 1. Post hoc tests revealed that for psychological detachment and mastery experiences, both gaming conditions achieved higher recovery scores than the control condition, but there was no difference between the low cognitive demand and high cognitive demand gaming condition. Thus, H1a and H3a had to be rejected, whereas the findings supported H1b and H3b. There was no significant difference between the three conditions for relaxation (RQ1). For control experiences, all groups differed significantly from each other, with the low cogni-

Table 1. Univariate analyses and simple comparisons between conditions for all recovery experiences.

	Conditions					
	No Game Control *M* (*SE*)	**Low Cognitive Demand Game** *M* (*SE*)	**High Cognitive Demand Game** *M* (*SE*)	***F*-Test** *F* (*df*)	***p***	η_p^2
Psychological Detachment	2.60^a	3.49^b	3.30^b	**8.51**	< .001	.11
	(.18)	(.13)	(.13)	(2,145)		
Relaxation	2.65^a	3.15^a	2.78^a	**2.57**	.080	.03
	(.20)	(.15)	(.14)	(2,145)		
Mastery Experiences	1.95^a	2.63^b	2.64^b	**6.25**		
	(.17)	(.13)	(.12)	(2,145)	.002	.08
Control Experiences	2.15^a	3.30^c	2.88^b	**15.26**	< .001	.17
	(.17)	(.13)	(.12)	(2,145)		

Note: Within rows, means (*M*) with no superscript in common differ significantly.

tive demand gaming condition scoring highest, the control condition lowest, and the high cognitive demand gaming condition in between, supporting H2a and H2b.

5.3. The Influence of Previous Gaming Experiences

To account for individual differences in the use of video games (RQ2), we repeated the MANOVA above and introduced the measure for previous gaming experiences as a covariate to the model. When accounting for participants' gaming frequency, the MANCOVA yielded both condition ($\Lambda = .68$, $F(8, 282) = 7.50$, $p < .001$, $\eta_p^2 = .18$) and gaming frequency ($\Lambda = .84$, $F(4, 141) = 6.82$, $p < .001$, $\eta_p^2 = .16$) as significant predictors of recovery. Follow-up univariate ANOVAs for all recovery dimensions by both condition and gaming frequency were significant. For condition: psychological detachment, $F(2{,}144) = 12.79$, $p < .001$; relaxation, $F(2{,}144) = 3.73$, $p = .026$; mastery, $F(2{,}144) = 7.59$, $p = .001$; control, $F(2{,}144) = 20.26$, $p < .001$. For casual game play: psychological detachment, $F(1{,}144) = 19.62$, $p < .001$; relaxation, $F(1{,}144) = 3.73$, $p = .006$; mastery, $F(1{,}144) = 5.43$, $p = .021$; control, $F(1{,}144) = 15.15$, $p < .001$. Keeping gaming frequency constant, the observed effects of cognitive task demand remained. In addition, there now was a significant effect of condition on relaxation. That is, the low cognitive demand gaming condition was more relaxing than the no-game control condition (see Table 2).

6. Discussion

The current study was guided by one overarching question: How does cognitive task demand in a gaming situation impact users' recovery experiences? First, we expected that with increasing cognitive task demand, psychological detachment would increase, as more cognitive capacities would be required. As anticipated, the results indicate that playing a game (low and high cognitive demand gaming conditions) leads to significantly higher psychological detachment than not playing a game. However, there was no difference between both gaming conditions, even when controlling for previous gaming experiences. The simplest explanation for this finding would be that the amount of cognitive task demand does not affect psychological detachment as previous work has suggested (e.g., Bowman, 2018; Klimmt & Hartmann, 2006; Reinecke, 2009a; Sherry et al., 2006). Another explanation for this unexpected finding could be that while subjective cognitive task demand actually differed between all conditions in the expected direction, objective measures (reaction times) only indicated a difference between playing (either high or low cognitive demand) and not playing (control condition). In other words, while players differed in their subjective experience between the two gaming conditions, the objective cognitive task demand was comparable and response speed to the audio signal was similar across gaming conditions. These findings may indicate that psychological detachment could depend on the actual allocation of cognitive resources rather than the subjective experience of doing a cognitively demanding task. Furthermore, we might assume that psychological detachment does not directly connect to cognitive task demand or task difficulty but rather to other characteristics of the game, such as the complexity of the game world, story narration, or control elements that encourage people to immerse deeper into the game (e.g., Sherry et al., 2006). In the current study, participants in both gaming conditions used the same controls to play the same game which had the same visual features.

Second, we found no difference between any of the conditions regarding relaxation outcomes. It could be that video games—due to their interactive nature—are

Table 2. Univariate analyses and simple comparisons between conditions for all recovery experiences with previous gaming experiences held constant at a value of 2.

	Conditions					
	No Game Control *M* (*SE*)	**Low Cognitive Demand Game** *M* (*SE*)	**High Cognitive Demand Game** *M* (*SE*)	***F*-Test** *F* (*df*)	***p***	η_p^2
Psychological Detachment	2.50^{a}	3.55^{b}	3.29^{b}	**12.79**	< .001	.16
	(.17)	(.12)	(.12)	(2,144)		
Relaxation	2.57^{a}	3.19^{b}	2.78^{a,b}	**3.73**	.026	.06
	(.20)	(.15)	(.14)	(2,144)		
Mastery Experiences	1.90^{a}	2.66^{b}	2.64^{b}	**7.59**	.001	.10
	(.17)	(.13)	(.12)	(2,144)		
Control Experiences	2.06^{a}	3.35^{c}	2.87^{b}	**20.26**	< .001	.22
	(.16)	(.12)	(.11)	(2,144)		

Notes: Within rows, means with no superscripts in common differ significantly. 1 = never play games; 5 = often play games.

not able to reduce arousal levels below a certain point. For relaxation, non-interactive media such as movies might be the better choice (Rieger & Bente, 2018). However, controlling for previous gaming experiences, there was a difference in relaxation between the low cognitive demand gaming and the no-game control condition (with the high cognitive demand gaming condition scoring in between the two, but without being significantly different from any of them). For participants who play games at least seldomly, the low cognitive demand gaming condition achieved more relaxation than the no-game condition. These findings imply that relaxation as a recovery experience from playing video games depends on the fit between pre-experiences/skill and the cognitive task demand of a given game. To investigate this further, future research might consider targeting several player samples with different skill levels and assign them to conditions with different cognitive task demands.

For the experience of control, our findings showed that participants in the low cognitive demand gaming condition experienced most control, participants not playing a game reported the lowest control, and players in the high cognitive demand condition scored in between these conditions. These results are in line with research connecting experiences of self-efficacy with playing video games (e.g., Klimmt et al., 2007; Trepte & Reinecke, 2011). Participants in the low cognitive demand condition experienced the highest levels of control given that they were able to successfully respond to all in-game challenges, whereas participants in the high cognitive demand condition struggled to keep the gaming environment under control. Surprisingly, controlling for previous gaming experiences did not change these findings. It appears plausible that experienced players might find it easier to master a high cognitive demand version of the game, resulting in more control experiences compared to the same game being played by an inexperienced player. However, this finding may also imply that the experience of control is not connected to skill but to the perceived freedom of being able to choose how much subjective effort is invested in a given task. Again, subjective cognitive task demand (and not implicit measures) significantly differed between the high and low cognitive demand gaming condition. All players—independent of their gaming experiences—realized that in the hard condition more demands were placed on their cognition in order for them to control the situation.

Finally, we found a significant difference in mastery experiences between the two gaming conditions and the control condition, but not between the low and high cognitive demand gaming conditions. While it appears plausible that playing a game comes with more mastery experiences than just reacting to an audio signal, we had expected that cognitive task demand in the gaming situation would affect the experience of mastery. Although previous research suggests that cognitive task demand—as a proxy for challenge and difficulty—affects feelings of mastery and competence (Klimmt et al., 2007; Rieger, Wulf, et al., 2014; Ryan et al., 2006; Sherry et al., 2006), our findings imply that such experiences may occur independent of a game's cognitive demands or might depend more heavily on related outcomes such as success. If players are able to successfully cope with in-game challenges in both gaming conditions, those in the high cognitive demand condition should experience more mastery because they solved the more difficult task. Whereas, if the high cognitive demand condition was too difficult, players in the low cognitive demand condition should experience more mastery than the high cognitive demand condition. Given that controlling for gaming experiences did not change the results, both of these explanations do not seem to apply to our findings. Indeed, video game researchers found that success plays a crucial role in the experience and appraisal of gaming episodes (e.g., Rieger et al., 2015; Schmierbach et al., 2014; Trepte & Reinecke, 2011). Future research, therefore, might be interested to use the game score as an indicator for success and further explore its relationship with recovery outcomes (given that the current article focusses on task demand and recovery, we decided to refrain from analyzing the success/score variable; however, we encourage researchers to use the data in our OSF repository for further exploratory analyses). Noteworthy in this regard, Tetris offers only limited feedback and cues about actual performance beyond the game score (which is difficult to evaluate if players do not have the scores of other players for comparison). Thus, players have to rely on their own gut feeling of how successful they were at playing which may influence experiences of mastery (to account for the possibility that the dropped false-feedback factor may have impacted this analysis, we conducted an additional t-test with feedback condition—positive vs. negative performance feedback—on mastery experiences; there was no significant difference for mastery experiences between participants in the positive [$M = 2.55$, $SD = .97$] and negative [$M = 2.72$, $SD = .98$] feedback condition, t[114] = -.95, $p = .34$). Another explanation why the gaming groups did not differ might be that both conditions are not optimal for the experience of mastery: The low cognitive demand condition might have been too easy while the high cognitive demand condition may have been too difficult. Bowman and Tamborini (2012) found similar levels of affect in their low and high cognitive demand conditions with the medium cognitive demand condition between those two showing highest affect ratings (see Bowman & Tamborini, 2012). Future research might apply such a design instead of using a non-gaming condition to identify the optimal cognitive task demand for mastery experiences.

Taken together, these findings suggest that it is necessary for future research to differentiate between the subjective levels of cognitive task demand (as measured with the NASA-TLX in the current study) and the actual cognitive capacity objectively demanded (as measured with an implicit reaction time task). Our findings imply that these dimensions of cognitive task demand and its appraisal hold different implications for psychological constructs, in our case recovery experiences. While the distraction from a fatiguing task in terms of psychological detachment seems connected to the actual cognitive workload, experiences of control within the gaming experience appear to depend on subjective levels of cognitive task demand. Thus, future research should account for these nuances in the experience of cognitive task demand.

Beyond the open questions already raised above, some further methodological limitations of the present study have to be considered. First, there may be some questions regarding how our findings can be applied to real gaming situations. We instructed participants to play a certain game in a predefined mode. While we chose Tetris because cognitive task demand could easily be modified, participants were not able to not choose a game or a difficulty level to suit their needs on their own, threatening external validity. Another limitation in this regard is the assessment of cognitive task demand with a secondary reaction time task. Usually, players do not have to react on an audio signal while playing games. This task might have impacted the actual recovery experience of players in our study. Finally, for ecological reasons, we used a single-item measure as a proxy to account for variance in participants' previous gaming experiences. However, a single item cannot broadly map participants' complex history, skills, and encounters with video games. Thus, the covariate analysis conducted herein should be interpreted carefully and extended by future research.

7. Conclusion

The current study replicated and extended previous work on the intersection of video games, cognitive task demand, and recovery experiences. Findings showed that playing interactive video games could have beneficial effects on recovery. However, one has to account for different dimensions of recovery to see the whole picture. In the current study, playing a game contributed to psychological detachment and mastery experiences (independent of its difficulty). For the control dimension of recovery, findings indicate that difficulty plays a crucial role in the way that low cognitive task demand contributes particularly to control recovery experiences. Finally, accounting for previous gaming experiences, the low cognitive task demand condition also showed higher levels of relaxation than no gameplay. These findings show that research on entertainment media and recovery experiences should account for the different dimensions of recovery and their interaction with different levels of cognitive task demand. This might help to further uncover the underlying processes of recreation from everyday stress and strain.

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Conflict of Interests

The authors declare no conflict of interests.

References

Baayen, R. H., & Milin, P. (2010). Analyzing reaction times. *International Journal of Psychological Research*, *3*(2), 12–28. https://doi.org/10.21500/20112084.807

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bartsch, A., & Hartmann, T. (2017). The role of cognitive and affective challenge in entertainment experience. *Communication Research*, *44*(1), 29–53. https://doi.org/10.1177/0093650214565921

Bowman, N. D. (2018). The demanding nature of video game play. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 1–24). New York, NY: Routledge.

Bowman, N. D., & Tamborini, R. (2012). Task demand and mood repair: The intervention potential of computer games. *New Media & Society*, *14*(8), 1339–1357. https://doi.org/10.1177/1461444812450426

Bowman, N. D., & Tamborini, R. (2015). "In the mood to game": Selective exposure and mood management processes in computer game play. *New Media & Society*, *17*(3), 375–393. https://doi.org/10.1177/1461444813504274

Bryant, J., & Davies, J. (2006). Selective exposure to video games. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences* (pp. 181–194). Mahwah, NJ: Erlbaum.

Düker, H., Lienert, G. A., Lukesch, H., & Mayrhofer, S. (2001). *KLT-R*: *Konzentrations-leistungs-testrevidierte Fassung* [KLT-R: Concentration achievement test—Revised version]. Göttingen: Hogrefe.

Fuller, J. A., Stanton, J. M., Fisher, G. G., Spitzmüller, C., Russell, S. S., & Smith, P. C. (2003). A lengthy look at the daily grind: Time series analysis of events, mood, stress, and satisfaction. *Journal of Applied Psychology*, *88*(6), 1019–1033. https://doi.org/10.1037/0021-9010.88.6.1019

Hefner, D., Rothmund, T., Klimmt, C., & Gollwitzer, M. (2011). Implicit measures and media effects research: Challenges and opportunities. *Communication Methods and Measures*, *5*(3), 181–202, https://doi.org/10.1080/19312458.2011.597006

Janicke, S. H., Rieger, D., Reinecke, L., & Connor, W. (2018). Watching online videos at work: The role of positive and meaningful affect for recovery experiences and well-being at the workplace. *Mass Communication and Society*, *21*(3), 345–367. https://doi.org/10.1080/15205436.2017.1381264

Klimmt, C., & Hartmann, T. (2006). Effectance, self-efficacy, and the motivation to play video games. In P. Vorderer & J. Bryant (Eds.), *Playing video games:*

Motives, responses, and consequences (pp. 132–145). Mahwah, NJ: Lawrence Erlbaum Associates.

Klimmt, C., Hartmann, T., & Frey, A. (2007). Effectance and control as determinants of video game enjoyment. *Cyberpsychology Behavior*, *10*(6), 845–847. https://doi.org/10.1089/cpb.2007.9942

Koban, K., Breuer, J., Rieger, D., Mohseni, M. R., Noack, S., & Ohler, P. (2018). Playing for the thrill and skill: Quiz games as means for mood and competence repair. *Media Psychology*. Advance online publication. https://doi:10.1080/15213269.2018.1515637

Lang, A., & Basil, M. (1998). Attention, resource allocation, and communication research: What do secondary task reaction times measure anyway? In M. E. Rollof (Ed.), *Communication yearbook* (Vol. 21, pp. 443–474). Thousand Oaks, CA: Sage.

Lang, A., Bradley, S. D., Park, B., Shin, M., & Chung, Y. (2006). Parsing the resource pie: Using STRTs to measure attention to mediated messages. *Media Psychology*, *8*(4), 369–394. https://doi.org/10.1207/s1532785xmep0804_3

Luce, R. (1986). *Response times*. New York, NY: Oxford University Press.

Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. *Behavior Research Methods*, *44*(2), 314–324. https://doi.org/10.3758/s13428-011-0168-7

Moroney, W. F., Reising, J., Biers, D. W., & Eggemeier, F. T. (1993). The effect of previous levels of workload on the NAA task load index (NASA-TLX) in a simulated flight task. In *Proceedings of the 7th International Symposium on Aviation Psychology*. Columbus, OH: Ohio State University.

Ratcliff, R. (1993). Methods for dealing with reaction time outliers. *Psychological Bulletin*, *114*(3), 510–532. https://doi.org/10.1037/0033-2909.114.3.510

Read, G. L., Lynch, T., & Matthews, N. L. (2018). Increased cognitive load during video game play reduces rape myth acceptance and hostile sexism after exposure to sexualized female avatars. *Sex Roles*, *79*(11/12), 683–698. https://doi.org/10.1007/s11199-018-0905-9

Reinecke, L. (2009a). Games and recovery: The use of video and computer games to recuperate from stress and strain. *Journal of Media Psychology*, *21*(3), 126–142. https://doi.org/10.1027/1864-1105.21.3.126

Reinecke, L. (2009b). Games at work: The recreational use of computer games during working hours. *CyberPsychology & Behavior*, *12*(4), 461–465. https://doi.org/10.1089/cpb.2009.0010

Reinecke, L., & Eden, A. (2017). Media use and well-being: An introduction to the special issue. *Journal of Media Psychology*, *29*(3), 111–114. https://doi.org/10.1027/1864-1105/a000227

Reinecke, L., Klatt, J., & Krämer, N. C. (2011). Entertaining media use and the satisfaction of recovery needs: Recovery outcomes associated with the use of interactive and noninteractive entertaining media. *Media Psychology*, *14*(2), 192–215. https://doi.org/10.1080/15213269.2011.573466

Rieger, D., & Bente, G. (2018). Watching down cortisol levels? Effects of movie entertainment on psychophysiological recovery. *Studies in Communication and Media*, *7*(2), 231–255. https://doi.org/10.5771/2192-4007-2018-2-231

Rieger, D., Frischlich, L., Wulf, T., Bente, G., & Kneer, J. (2015). Eating ghosts: The underlying mechanisms of mood repair via interactive and noninteractive media. *Psychology of Popular Media Culture*, *4*(2), 138–154. https://doi.org/10.1037/ppm0000018

Rieger, D., Hefner, D., & Vorderer, P. (2017). Mobile recovery? The impact of smartphone use on recovery experiences in waiting situations. *Mobile Media & Communication*, *5*(2), 161–177. https://doi.org/10.1177/2050157917691556

Rieger, D., Reinecke, L., Frischlich, L., & Bente, G. (2014). Media entertainment and well-being-linking hedonic and eudaimonic entertainment experience to media-induced recovery and vitality. *Journal of Communication*, *64*(3), 456–478. https://doi.org/10.1111/jcom.12097

Rieger, D., Wulf, T., Kneer, J., Frischlich, L., & Bente, G. (2014). The winner takes it all: The effect of in-game success and need satisfaction on mood repair and enjoyment. *Computers in Human Behavior*, *39*, 281–286. https://doi.org/10.1016/j.chb.2014.07.037

Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion*, *30*(4), 347–363. https://doi.org/10.1007/s11031-006-9051-8

Schmierbach, M., Chung, M.-Y., Wu, M., & Kim, K. (2014). No one likes to lose: The effect of game difficulty on competency, flow, and enjoyment. *Journal of Media Psychology*, *26*(3), 105–110. https://doi.org/10.1027/1864-1105/a000120

Sherry, J. L., Lucas, K., Greenberg, B., & Lachlan, K. (2006). Video game uses and gratifications as predictors of use and game preference. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences* (pp. 213–224). Mahwah, NJ: Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203873700

Sluiter, J. K., de Croon, E. M., Meijman, T. F., & Frings-Dresen, M. H. W. (2003). Need for recovery from work related fatigue and its role in the development and prediction of subjective health complaints. *Occupational and Environmental Medicine*, *60*, 62–70. https://doi.org/10.1136/oem.60.suppl_1.i62

Sonnentag, S., & Fritz, C. (2007). The recovery experience questionnaire: Development and validation of a measure for assessing recuperation and unwinding from work. *Journal of Occupational Health Psychol-*

ogy, *12*(3), 204–221. https://doi.org/10.1037/1076-8998.12.3.204

Sonnentag, S., Venz, L., & Casper, A. (2017). Advances in recovery research: What have we learned? What should be done next? *Journal of Occupational Health Psychology*, *22*(3), 365–380. https://doi.org/10.1037/ocp0000079

Sonnentag, S., & Zijlstra, F. R. H. (2006). Job characteristics and off-job activities as predictors of need for recovery, well-being, and fatigue. *Journal of Applied Psychology*, *91*(2), 330–350. https://doi.org/10.1037/0021-9010.91.2.330

Taylor, C. B., Sallis, J. F., & Needle, R. (1985). The relationship of physical activity and exercise to mental health. *Public Health Reports*, *100*, 195–202.

Trepte, S., & Reinecke, L. (2010). Avatar creation and video game enjoyment: Effects of life-satisfaction, game competitiveness, and identification with the avatar. *Journal of Media Psychology*, *22*(4), 171–184. https://doi.org/10.1027/1864-1105/a000022

Trepte, S., & Reinecke, L. (2011). The pleasures of success: Game-related efficacy experiences as a mediator between player performance and game enjoyment. *Cyberpsychology, Behavior, and Social Networking*, *14*(9), 555–557. https://doi.org/10.1089/cyber.2010.0358

Zillmann, D. (1988). Mood management through communication choices. *American Behavioral Scientist*, *31*(3), 327–340.

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Article

Between a Troll and a Hard Place: The Demand Framework's Answer to One of Gaming's Biggest Problems

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Abstract
The demand framework is commonly used by game scholars to develop new and innovative ways to improve the gaming experience. However, the present article aims to expand this framework and apply it to problematic gaming, also known as trolling. Although still a relatively new field, research into trolling has exploded within the past ten years. However, the vast majority of these studies are descriptive in nature. The present article marries theory and trolling research by closely examining interdisciplinary empirical evidence from a single platform—video games—and applying the various forms of demands to propose a testable, dual-route model of trolling behaviour. Within the video game context, I argue the presence of two primary causal mechanisms that can lead to trolling: 1) Demand imbalance between players and the game; and 2) demand imbalance between players. The article discusses how these two types of imbalance can lead to trolling, which kinds of demands can be imbalanced, and how future researchers can use the demand framework to expand our understanding of trolling.

Keywords
demand imbalance; flow theory; motivations; multiplayer online games; trolling

Issue
This article is part of the issue "Video Games as Demanding Technologies" edited by Nicholas David Bowman (Texas Tech University, USA).

1. Introduction

The demand framework presented in Bowman's (2018) overview has been a useful tool for games scholars in recent years, explaining gamers and their behaviours by relating them to four key demands: cognitive, emotional, social, and physical. However, the majority of studies examining the impact demands have on gamers' choices both in-game and out deal with optimization. Games' cognitive demands, for example, are studied for their potential benefits for cognitive training and interventions (Boot, Kramer, Simons, Fabiani, & Gratton, 2008; Bowman & Tamborini, 2012; Green, 2018). Although this research is beneficial for many gamers, in reality, not all gamers are striving for an optimal experience. In fact, there has been a recent explosion of literature concerning gamers who seem to seek the opposite for both themselves and other players in the game: trolls (Cook, Schaafsma, & Antheunis, 2018; Thacker & Griffiths, 2012).

Though trolling as a whole is still a widely misunderstood phenomenon rife with contradicting definitions and conflicting accounts of motivations and reactions (for complete discussions see Cook et al., 2018; Dynel, 2016), trolling specific to gaming platforms is a much clearer concept. Comprising behaviours traditionally associated with griefing culture (Chesney, Coyne, Logan, & Madden, 2009; Coyne, Chesney, Logan, & Madden, 2009) as well as more lighthearted jabs and jokes (Cook et al., 2018; Thacker & Griffiths, 2012), trolling is an umbrella term that refers to the instrumental use of game, website, or chat mechanics at another person's expense, though it finds its roots in both practical jokes and boundary maintenance practices in niche communities (see Graham, 2019). The mechanics that trolls use are the very same mechanics that create a game's demands.

The same vocal channel that a Counter Strike: Global Offensive player uses to strategize with his team—a social demand of the game—a troll uses to spam his teammates with an off-key rendition of Jingle Bells. While a skilled player might practice their aim for hours to land a kill in League of Legends, thus meeting the game's cognitive and physical demands, a troll might fling their avatar in front of a poorly-aimed shot in order to die, thus disadvantaging their team (for additional examples, see Table 1). Trolls can even operate outside of the game via online streaming websites like Twitch.tv to emotionally victimize a vulnerable streamer (Johnson, 2019) or even another audience member (Seering, Kraut, & Dabbish, 2017). Although there are accounts of trolling being an enjoyable activity, usually between friends (for examples see Cook et al., 2018), it is generally considered an issue that has been plaguing online gaming since its inception. The present piece proposes demand imbalance as a major cause of this choice of playstyle, and aims to explain how the very same demands in the very same game can cause one player to flourish, and another to rebel.

2. Conceptualizing Demands and Trolling in Games

As previously stated, games produce four key demand types: cognitive, social, emotional, and physical (Bowman, 2018). Exact theoretical definitions for these demand types are presented in Table 1, as well as examples of how these demands could be a part of trolling practices. These demands are typically treated as continuous dimensions, as evidenced by the Video Game Demand Scale (Bowman, Wasserman, & Banks, 2018).

According to Bowman et al. (2018), interactivity is the key to their operationalization. It is the constant, two-way interaction between the player and the game mechanics that creates demand, explaining at least in part how different demand levels can be produced in different players by the same game mechanics. However, it is much easier to operationalize a game mechanic than an interaction, and so most demand scholars refer more heavily to mechanics over demands (for examples see Eden, Ewoldsen, Lee, & Beyea, 2018; Green, 2018; Possler, Klimmt, & Raney, 2018). Despite the mechanics being the simpler aspect to understand and describe, and thus more frequently referenced in demand literature, demands themselves are actually the bi-directional relationship between the player and the mechanics, as visualized in Figure 1.

The top half of Figure 1 illustrates the basic relationships that make up the demand framework, but we cannot explain trolling without implicating the result of these interactions: in-game behaviour. Behaviour here is conceptually defined as any action taken by a player within a game's user interface. This definition not only neatly encompasses all actions that could be taken in a game, such as killing an enemy or solving a puzzle, but also covers any action that could be defined as trolling within a gaming context, such as harassing another player via chat or purposely killing a teammate (see Cook et al., 2018). Physical demands present perhaps the most obvious case of behaviour resulting from in-game demands: Your avatar needs to get to the other side of the screen to save a captured princess, so you press the appropriate buttons on your controller to make that happen. However, there is a hidden premise underlying the previous statement: Your goals match the predetermined goals given by the game developer. This is an important assumption that goes largely unmentioned in most demand-based literature, but scaffolds most of the optimization findings presented in extant literature. You meet or exceed the demands the game presents only if you want to win the game; there is no need to train our multitasking capabilities (Green, 2018) or feel guilty about murdering innocents (see No Russian mission in Call of Duty: Modern Warfare 2) if we do not care about reaching the end of the game. Thus, in order to understand how demand theory can explain trolls and trolling, we first have to understand trolls' goals.

2.1. Goal Alignment and Co-Creation in Relation to Trolling Practices

According to existing trolling research, trolls' goals only sometimes align with that of developers (Buckels,

Table 1. Definitions of demands as presented by Bowman (2018).

Demand	Definition	Trolling Example
Cognitive	"The extent to which the user is required to implicitly or explicitly rationalize or understand the game" (p. 5).	Increasing cognitive demand by thwarting one's team's strategy to win by purposely killing one's own character.
Emotional	"The extent to which a video game causes the user to have an implicit or explicit affective response to the game" (p. 8).	Increasing emotional demand by hurling personal insults at a teammate or enemy.
Social	"The extent to which a system (or actor) triggers an implicit or explicit response in the user to the presence of other social actors" (p. 13).	Increasing social demand by spamming in the chat window.
Physical	"The extent to which a system requires the user to exert discrete or holistic physical effort" (p. 11).	Reducing physical demand by abusing a glitch to become invulnerable in-game.

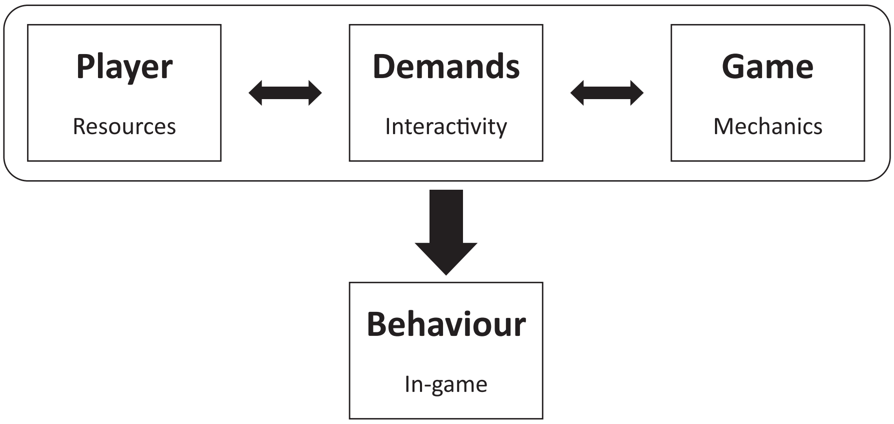

Figure 1. The author's interpretation of the demand framework as it is conceptualized in Bowman (2018). Note: Demands function as an interaction between a player's resources and the game's mechanics, producing the player's in-game behaviours.

Trapnell, & Paulhus, 2014; Cook et al., 2018; Herring, Job-Sluder, Scheckler, & Barab, 2002; Shachaf & Hara, 2010; Thacker & Griffiths, 2012). Trolling behaviours that are motivated by revenge or interaction seeking (Cook et al., 2018; Thacker & Griffiths, 2012), for example, can simply ignore the demands presented by the game, using the mechanics to achieve goals independent to the game's (i.e., making a friend or giving a troll a taste of their own medicine). In this case, trolling is a breakdown of the co-creation that typifies normal game play (Bowman, 2018). Instead of the aligned goals implicit to traditional demand theory work—Situation A in Figure 2—trolling motivated by personal goals that do not involve winning the game looks more like Situation C (Figure 2). In essence, goal alignment determines just how demanding a game's demands are to a player; with complete alignment, players work to meet the game's demands and co-create the gaming experience, while with no alignment, the co-creation process breaks down completely.

Even so, Situation B, in which the developer and player's goals align only partially, remains unexplained. How common is this situation? Trolling literature would suggest that, with deviant players, this is actually the most common option from those listed in Figure 2 (Cook et al., 2018). According to Cook et al. (2018), the number one motivation for trolling is personal enjoyment, and the most popular catalyst for trolling is feeling bored or 'tilted,' which is to say in a negative mood or headspace. Given that games are usually considered a leisure activity designed to alleviate boredom and promote enjoyment (Daneels, Vandebosch, & Walrave, 2019), it would seem that the trolls' goal to have fun is at least partially aligned with developers' goal to create a game that fills that need. Of course, this is not the case for all games and all developers, but with the exception of rage games—

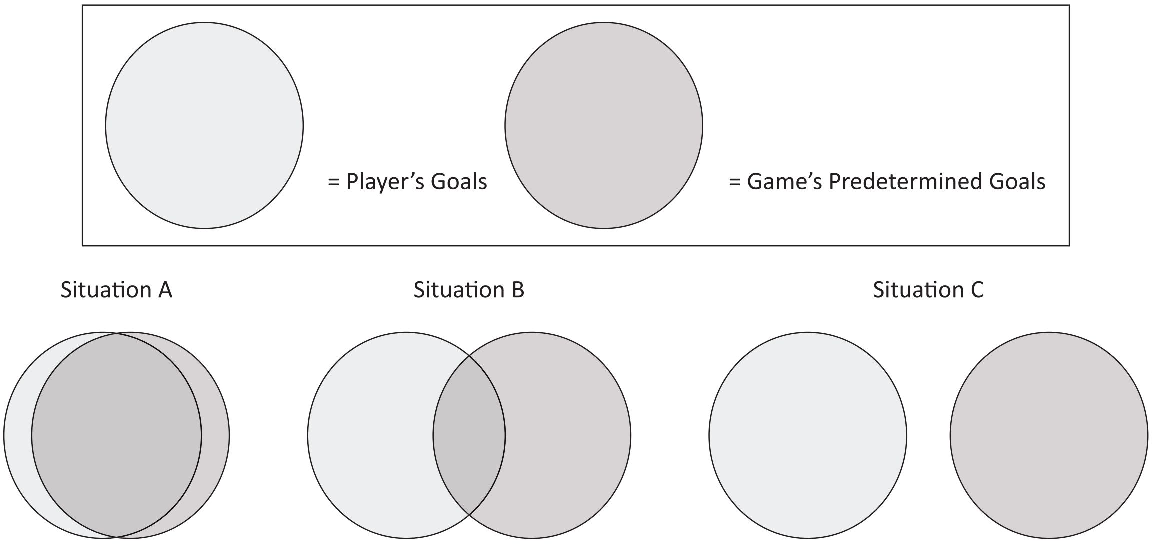

Figure 2. A visualization of players' goals and game developers' goals, and the various configurations of alignment or misalignment these can take.

e.g., I Wanna Be the Guy and Trap Adventure 2—rare is the game players are expected to hate the whole way through (for a more complete discussion of these exceptions see Newman, 2018; Wilson & Sicart, 2010), hence the at least partial alignment on the point of enjoyment. This would suggest that, if trolls go into the game experience expecting the game to provide some entertainment, they should start by attempting to meet or exceed the game's demands in order to experience the promised pleasure. The question then becomes: How do demands cause trolling when the player's and developer's goals are mostly aligned?

3. Game Demands and Flow Theory Applied to Precursors Trolling Behaviour

To answer the previous question, we have to turn to another important theory for game scholarship: flow theory (Nakamura & Csikszentmihalyi, 2001). According to this theory, people can achieve a state of flow in which they feel focused, calm, and able to succeed when a person's skill at a task is perfectly balanced with the level of challenge that task presents (Chen, 2007; Stoll, 2019). It is essentially a dynamic state of optimal human functioning, and the theory has been applied to both traditional sports (Stoll, 2019) and video games (Chen, 2007). It is also the antithesis of the "tilt," described by gamers as a frequent precursor to negative trolling activity (Cook et al., 2018). Just as flow is a balancing act between challenge and skill, straying too far in one direction—either excessive skill or excessive challenge—can lead a person into the tilted headspace that often precedes trolling. If a level in a game is beyond the player's current skill level, for example, the player either has to develop their skills or try another level closer to their capabilities in order to achieve an optimal state. If the player does not make these changes, they risk becoming tilted once they pass their personal threshold of tolerance. It is important to note here that, just as one can be more or less tilted, this "optimal state" is ever-changing as the game enters into more or less challenging areas and as the player develops their skills throughout the experience; there is no one optimal state, but rather what Chen (2006) calls a "fuzzy zone" in which players can experience this feeling of flow, allowing them to "work harder or work safer" to have fun. This concept of flow as a zone at the intersection of player skill and challenge is remarkably similar to that of cognitive and physical game demands. These, too, are an interaction between player and game (Bowman, 2018), and can produce the same kinds of behavioural outcomes (i.e., increased practice or changing levels in a game). Although arguably less researched than cognitive and physical demands, the same could be said of social and emotional demands in games, although instead of skill or proficiency interacting with challenge, it is more of a personal tolerance level and current state of being. People have differing preferences in terms of how they want to feel and how they want to interact with others (North, 1949), and games can push these boundaries in different directions. As a person's mood changes and interacts with a particularly poignant storyline segment in a game, this could theoretically push a person over the edge into unwanted tears. If the player is craving interaction with other people, a single-player run of a single-player game like Skyrim is unlikely to present enough social demand to give the player the kind of experience they desire. This could, however, change over time depending on the person's ever-shifting moods and desires at a given moment, as well as the game's different segments and challenges. Theoretically, we conceptualize flow and demand in much the same way.

Just as flow theory describes an optimal zone of functioning, I propose that demand theory is currently being used in much the same way: to describe the optimal range of demand in a game. The full extent of the demand dimension is presented in Figure 3. Demand levels within the middle range are what most game scholars interested in demand theory have studied. In this region, where demands are balanced with players' capacities, normal gameplay is expected. For cognitive and physical demands, which are arguably the most commonly researched in relation to media enjoyment (see

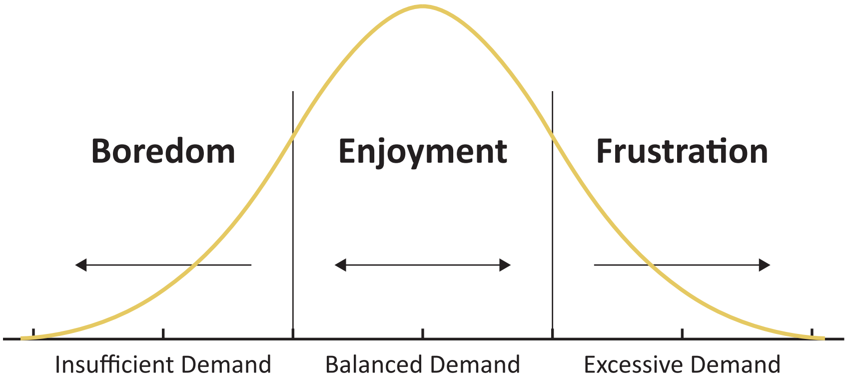

Figure 3. The full spectrum of demands as dimensions. Notes: The majority of gamers will fall into the middle section during the majority of their gameplay experience, which is what most demand research covers. The two extremes represent demand configurations that, if held for a significant period of time, could cause problematic behaviour (i.e., trolling).

Sherry's, 2004, seminal article on the subject for more details), this is when the player is capable of using the game's mechanics effectively to attain theirs and the developers' goals, and this would produce normal gameplay. When it comes to social or emotional demands, I propose that this is when the level of demand produces the amount of interaction or emotive content (usually narrative) that allow the player to experience their desired emotions or desired amount of social interaction, while keeping their state of mind/being in a positive space. At the centermost range of the parabola would be the game experience of flow that game scholars often seek—Chen's (2006) "flow zone," in which players are able to meet the cognitive and physical challenges of the game and have a positive social and emotional experience playing the game. However, when these four demand types are either excessive or too limited when interacting with the player's skills and state—imbalanced—I hypothesize that players will be prone to exhibit trolling behaviour.

At either end of the curve presented in Figure 3 lie two of the primary motivations for trolling: boredom and frustration (Cook et al., 2018; Thacker & Griffiths, 2012). At the left end of the curve, where the game demands are insufficient to meet the capacities of the player at the time, is boredom. Logically, if a game is too easy, it is unlikely to keep a player's attention (Patsis, Sahli, Verhelst, & de Troyer, 2013). However, there is also evidence for this being a trolling trigger (Cook et al., 2018; Coyne et al., 2009; Thacker & Griffiths, 2012). Cook et al. (2018) affirm that, in their sample, boredom was the second most popular catalyst to trolling behaviour. Trolls reported that, at a certain point, they became so proficient at the game that the game by itself was no longer exciting enough to keep their attention. From a flow perspective, the player capacities had likely increased to the point that the game was unable to create the challenge necessary for an optimal experience. Several other studies focusing on trolling also report that the number one global motivation for trolling is personal enjoyment, or as the trolls in Thacker and Griffiths' (2012) sample put it, "for the lulz." A particularly boring round of a game can, according to trolling literature, be the catalyst for a later round of trolling, highlighting the dynamic interaction between player and game over time.

On the other side of the parabola, however, is frustration. This is, of course, the opposite of boredom: when the game demands too much of the player, exceeding their capacities at the time, or pushing them too far emotionally or socially. Once again, we face the primary motivator for trolling behaviour: personal pleasure (Buckels et al., 2014; Cook et al., 2018; Shachaf & Hara, 2010; Thacker & Griffiths, 2012). Just as boredom can rob someone of a positive game experience, being too frustrated can cause the same outcome (see McGloin, Farrar, Krcmar, Park, & Fishlock, 2016, for a full discussion of frustration and aggression in gameplay). This is also supported by evidence from trolling literature. In Cook et al. (2018) taxonomy of trolling triggers, being "on tilt," gamer-speak for being in a negative headspace (Urban Dictionary, 2012), is listed alongside boredom as one of the top catalysts to trolling behaviour. It is worth noting that this frustration is often caused by losing a game, which is fundamentally a case of the game's cognitive and/or physical demands overwhelming the player's capacities. In other words, when the game's demands are excessive, the player can experience an emotional state that has been listed as a common precursor to trolling behaviour. That said, there is always room for individual differences, for just as flow is an interaction between skill and challenge, gameplay is an interaction between player and game, and no two players are exactly alike. Most games, even the most successful, have at least some moments of downtime (Pavlovich, 2014), while other games, such as the Dark Souls series, are beloved for their extreme degree of challenge (Rad, 2016). Regardless of players' differing tilting points, however, it would appear that excessive demands in a game can lead to frustration, which in turn can lead to trolling behaviour in-game.

3.1. Demand Imbalance: Players vs. Games

However, this all begs the question: Which particular game demands need to be excessive or lacking to cause trolling behaviour? Although this has yet to be formally researched, trolling literature does provide us with some clues. For example, one common thread running through most articles exploring trolling in games is the fact that trolls are often veteran players who prey on the inexperienced (Chesney et al., 2009; Cook et al., 2018; Thacker & Griffiths, 2012). They claim to use their superior knowledge of the game to either misdirect newer players or to trick others into pointless arguments, wasting their time. This would suggest that trolls often have a high degree of mastery, which is to say that they have exceeded the cognitive and physical demands of the game and are adept users of the game's mechanics. Cook et al.'s (2018) trolls often claimed that the game itself no longer presented a challenge, and thus they applied their skills elsewhere in the game environment to assuage their desire for fun. This would suggest that the major demands that are out of whack are cognitive and physical—skill-based as opposed to state-based. However, trolls also talk about a generational gap in trolling, that trolls can be divided into two types: veterans and kids (Cook et al., 2018). The veterans say that they have exceeded the game's demands, while the kids, often called "squeakers" due to their high-pitched voices over voice chat (Rooster Teeth, 2011), appear to be consistently frustrated by the same demands. Their trolling is also said to differ, using more abrupt flaming and spamming, compared to veterans' more subtle tactics of misdirection (Cook et al., 2018). It remains unclear whether age or the result of differing demand imbalances (frustration vs. boredom) is the cause of these different trolling strategies, but the pattern does appear to both exist in extant literature and be explainable at least in part by cognitive and physical demand imbalance.

In the case of multiplayer games, the game itself often exerts a social demand as well. Although non-player characters can also exert social demands (Kryston, Novotny, Schmälzle, & Tamborini, 2018; Peña, 2018), in competitive games like League of Legends or Counter Strike: Global Offensive which are known for their troll-filled communities (Cook et al., 2018; Cook, Conijn, Antheunis, & Schaafsma, 2019), communication between players is an essential prerequisite to victory. As soon as teamwork becomes critical to winning, social interaction between players becomes a part of the game's demands. Incidentally, it is in these games that existing studies find the most heightened, and often aggressive, trolling behaviour (Blackburn & Kwak, 2014; Cook et al., 2018; Kwak & Blackburn, 2014; Kwak, Blackburn, & Han, 2015). This often consists of flaming (Cook et al., 2018, 2019; O'Sullivan & Flanagin, 2003), although it can also take a behavioural form, such as feeding, which is purposely getting one's avatar killed in-game to advantage the other team. Although a formal causal relationship between the two has yet to be established, based on trolling accounts in literature examining multiplayer games, as the social demand of the game increases, the associated trolling appears to intensify accordingly (Cook et al., 2018; Kwak & Blackburn, 2014). Given the fact that trolling takes place between human players in a virtual world (Cook et al., 2018), a situation in which trolling is caused by insufficient social demands is unlikely, as they are ever-present; however, there are games in which the social demands are variable. In massively-multiplayer online role playing games (MMORPGs), players can choose to play the game alone or with others in guilds, parties, or partnerships (Chen, Sun, & Hsieh, 2008; Snodgrass et al., 2016), thus having the option to choose the amount of social interaction they desire instead of having a demand placed upon them. Reports of trolling behaviour in these games is also more varied in literature, from playfully pushing someone's avatar into water (Cook et al., 2018) to revealing real-life information about a player in-game (Chesney et al., 2009), also called "doxing" (Merriam-Webster, n.d.). It remains to be tested whether this also varies as a function of whether the motivation is boredom or frustration, but again, the pattern itself does appear in trolling literature (Cook et al., 2018, 2019).

3.2. Demand Imbalance: Players vs. Players

All of that said, it is critical to understand that, in the case of trolling, the game itself is not the only source of demands. Though trolling work agrees on little, there is one element that all extant literature shares: Sociality (Buckels et al., 2014; Cook et al., 2018; Herring et al., 2002; Thacker & Griffiths, 2012). Trolling cannot take place in a social vacuum; it requires a minimum of one troll and one victim, and due to its online nature, almost always includes several bystanders. As integral agents within the game environment, other players too exact demands on the player in question. These other players can be teammates, enemies, or be of no particular relation to the player in question, but they exist in the game world and have the same degree of agency as anyone else. Another player in a MMORPG, for example, could increase social demand by advertising an item to trade or a party looking for new members, while a skilled opponent in a multiplayer online battle arena (MOBA) could demand you sharpen your focus on the game, engaging more cognitive resources than a less-skilled opponent would require of you in order to achieve victory. On a bad day, a particularly vicious flame could be too emotionally demanding for a victim, who could theoretically respond with reciprocated aggression in chat or silent tears on the other side of the screen. In-game demands are always an interaction (Bowman, 2018), but interactions occur between players as well as players and the game itself. Thus, demand imbalance can come from two sources in a trolling situation—the game and the other players—and I hypothesize that both imbalances function according to the graph presented in Figure 3.

The mere presence of an "other" is enough to trigger a social demand (Peña, 2018), be it an artificial intelligence or otherwise, but social interaction between players in multiplayer games is usually quite intense (Smyth, 2007). Researchers have found that such interactions contain both socioemotional and task elements, meaning that players are concerned about how they and the other players are feeling, as well as completing the in-game goal (Peña & Hancock, 2006). Existing research would thus suggest that players could exert social and/or emotional demands on their fellow players, usually by increasing the amount of the given demand. In the case of trolling, this would theoretically consist of the emotional demands of the troll pushing the victim's emotional state over the edge into negativity. However, there is also the possibility that other players can also exert physical or cognitive demands in a game as well. In a MOBA or first-person shooter (FPS) game, for example, the other players on the opposing team essentially take the role of computerized enemies in a single-player game; the opponent's skill level becomes the demand, or in flow theory language, the challenge. By meeting or exceeding the physical and cognitive demands presented by the game, an opponent theoretically becomes the physical and cognitive demands players must meet or exceed themselves. The same could be hypothesized of player versus player modes in MMORPGs, although more often than not, studies show that gameplay in these types of games is cooperative (Martončik & Lokša, 2015), which would mean that their skills would contribute to all players meeting the game's cognitive and physical demands collectively. In short, a player can exert social and emotional demands verbally via chat functions in a game, while they can either exert or relieve cognitive and physical demands through their gameplay.

All that said, trolling itself is a form of social interaction, and thus also qualifies as a social demand to which players can respond. Trolling interactions have been shown in extant literature to use both excessive profanity and a high degree of game-specific jargon, suggesting that players are constantly being directed by or directing other players (Cook et al., 2019). It is also worth noting that these features are not exclusive to the troll; the same studies find that victims and bystanders seem to use as much profanity and jargon as trolls themselves (Cook et al., 2018, 2019). Existing research has also shown that trolling likely follows a cycle (Cook et al., 2018, 2019); victims are likely to become perpetrators, who in turn will likely create more victims, and so on and so forth. From the perspective of the demand framework, if players are excessively socially demanding, this would theoretically trigger trolling, which would in turn create further demand for other players, perpetuating the aforementioned cycle. When a person feels compelled to respond to perceived aggression, either verbally or behaviourally (Cook et al., 2018, 2019), theoretically, they have fewer resources to deal with the social, cognitive, and physical demands of the game, diminishing their capacities and thus likely tipping the demand balance in favour of frustration. Although a causal link has yet to be established, this pattern is reflected in trolling literature, as according to Cook et al. (2018) interviews with self-confessed trolls, being trolled first is the number one most popular catalyst to trolling behaviour. In short, victims appear to often feel compelled to respond to trolling behaviour, theoretically creating excessive social demand, which is likely to lead to frustration for victims, who may in turn go on to release that frustration via further trolling.

In fact, being a victim of trolling could not only be socially demanding, but also emotionally demanding, depending on the type of trolling and the victim's personality, personal vulnerabilities, and state of mind on the given day. For example, if a person takes the game at hand very seriously and personally, and a troll starts to purposely throw the game by feeding or broadcasting the team's positions to the enemy, this could feasibly take an emotional toll on the victim. That said, someone who was more relaxed about the experience, or who was in a particularly good mood, may not fall into the trolling cycle. Individual differences have been a major part of trolling research in recent years (Buckels et al., 2014; Craker & March, 2016; March, Grieve, Marrington, & Jonason, 2017; Sest & March, 2017), and are an implicit part of demand theory in games as well, given demands' status as an interaction between unique players and unique games (Bowman, 2018). Personality scholars have yet to link individual differences to trolls in a gaming medium, but the labels they give to other online trolls—sadist and narcissist, to name a few (Buckels et al., 2014; Craker & March, 2016)—suggest an emotional element. Sadism in particular paints an emotionally vampiric image of trolls, as if they feed off the emotional turmoil in their victims. The individual differences of trolling victims have also yet to be formally researched, but extant literature would suggest that they likely have lower capacities to deal with emotional demands, as trolls in most media forms have been shown to seek and obtain outrageous reactions from their victims (Buckels et al., 2014; Cook et al., 2018; Herring et al., 2002; Shachaf & Hara, 2010). In any case, extant literature suggests that trolling does appear to have emotional impact in both victims and perpetrators, and has the potential to create emotional demand in a gaming setting.

4. Conclusions and Future Directions

In sum, although demand theory has typically been used to describe average and optimal gameplay, there is sufficient overlap with trolling literature to indicate that demand theory could also be used to explain deviant play. By extending demand theory to players as a source of demands and exploring the extremes of demands as dimensions, we can expand demand theory's applications beyond typical gameplay. When game demands fall out of the ideal range, the effects—boredom and frustration—have been shown in extant literature to be causally linked to trolling behaviour (Buckels et al., 2014; Cook et al., 2018, 2019; Thacker & Griffiths, 2012). In addition, when trolling is interpreted as an emotional or social demand, it also theoretically leads to further trolling, supporting the idea of the trolling cycle that is also present in trolling literature (Cook et al., 2018, 2019). For a field of research that is often derided for its atheoretical nature (see Cook et al., 2018), this application of demand theory is a promising step forward in marrying theory and empirical work in trolling literature.

Naturally, this is not the only framework that could 'solve' trolling, nor have demands been validated as a casual explanation for trolling as of yet. However, through the careful integration of existing theories like personality and flow with the demand framework, our understanding can continue to grow. Experiments can be designed to manipulate the level of various demands, for example, and see which manipulations cause which types of trolling. By manipulating the intensity of a flame in different gaming genres, for example, we could tease apart the emotional demands of a game from the emotional demands of other players and see which are more predictive of trolling outcomes in victims. Different personality characteristics can be evaluated in combination with different levels of different demands to determine which if any interactions are in play and how these produce different trolling types in trolls, and responses in victims and bystanders. There also remains the question of enjoyable vs. unenjoyable trolling, something that Paul, Bowman, and Banks (2015) have explored, but merits further testing in the light of this new connection with the demand framework. By testing these variables, we can better comprehend the exact precursors of trolling, and consequently learn how to prevent the kinds of trolling that insufficient or excessive demands could be creating.

There are also other perspectives to integrate, such as the ethnographic works of both Whitney Phillips (2015) and Kishonna Gray (2014), who explore how the unwritten rules inherent in Western society often dictate trolling practices in and beyond games. The cultural experience of trolling, whether it be in game you are playing or watching (Taylor, 2018), is a space that still needs exploring, as there are almost certainly variables in the humanities and beyond that can be added to strengthen our admittedly psychological explanations presented thus far. Even within the psychological perspective I have presented here, the concepts of frustration and boredom are still open for exploration, particularly in the context of emotional and social demands. Flow theory has been applied successfully in relation to cognitive and physical demands in the past (see Sherry, 2004), but its application to emotional and social demands in games is still new territory for games scholars and psychologists alike. In short, there is still more work to be done, but there is promise and there is a trajectory for researchers to explore. Armed with new variables to test, we are poised to begin to explain a problem that has plagued gamers and netizens for years.

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Conflict of Interests

The author declares no conflict of interests.

References

Blackburn, J., & Kwak, H. (2014). *STFU NOOB! Predicting crowdsourced decisions on toxic behavior in online games*. Paper presented at the 23rd International World Wide Web Conference, Seoul, South Korea.

Boot, W. R., Kramer, A. F., Simons, D. J., Fabiani, M., & Gratton, G. (2008). The effects of video game playing on attention, memory, and executive control. *Acta Psychologica*, *129*(3), 387–398. https://doi.org/10.1016/j.actpsy.2008.09.005

Bowman, N. D. (2018). The demanding nature of video game play. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 1–24). New York, NY: Taylor & Francis.

Bowman, N. D., & Tamborini, R. (2012). Task demand and mood repair: The intervention potential of computer games. *New Media & Society*, *14*(8), 1339–1357. https://doi.org/10.1177/1461444812450426

Bowman, N. D., Wasserman, J., & Banks, J. (2018). Development of the video game demand scale. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 208–233). New York, NY: Taylor & Francis.

Buckels, E. E., Trapnell, P. D., & Paulhus, D. L. (2014). Trolls just want to have fun. *Personality and Individual Differences*, *67*, 97–102. https://doi.org/10.1016/j.paid.2014.01.016

Chen, C.-H., Sun, C.-T., & Hsieh, J. (2008). Player guild dynamics and evolution in massively multiplayer online games. *CyberPsychology & Behavior*, *11*(3), 293–301. https://doi.org/10.1089/cpb.2007.0066

Chen, J. (2006). *Flow in games: A Jenova Chen MFA thesis* (Master's thesis). University of Southern California, Los Angeles, USA.

Chen, J. (2007). Flow in games (and everything else). *Communications of the ACM*, *50*(4), 31–34. https://doi.org/10.1145/1232743.1232769

Chesney, T., Coyne, I., Logan, B., & Madden, N. (2009). Griefing in virtual worlds: Causes, casualties and coping strategies. *Info Systems Journal*, *19*(6), 525–548. https://doi.org/10.1111/j.1365-2575.2009.00330.x

Cook, C. L., Conijn, R., Antheunis, M. L., & Schaafsma, J. (2019). For whom the gamer trolls: A study of trolling interactions in the online gaming context. *Journal of Computer-Mediated Communication*, *2019*. https://doi.org/10.1093/jcmc/zmz014

Cook, C. L., Schaafsma, J., & Antheunis, M. L. (2018). Under the bridge: An in-depth examination of online trolling in the gaming context. *New Media & Society*, *20*(9), 3323–3340. https://doi.org/10.1177/1461444817748578

Coyne, I., Chesney, T., Logan, B., & Madden, N. (2009). Griefing in a virtual community: An exploratory survey of second life residents. *Zeitschrift für Psychologie/Journal of Psychology*, *217*(4), 214–221. https://doi.org/10.1027/0044-3409.217.4.214

Craker, N., & March, E. (2016). The dark side of Facebook®: The dark tetrad, negative social potency, and trolling behaviours. *Personality and Individual Differences*, *102*, 79–84. https://doi.org/10.1016/j.paid.2016.06.043

Daneels, R., Vandebosch, H., & Walrave, M. (2019). *Just for fun? Digital games' potential for meaningful media experiences among adolescents*. Paper presented at the 69th Annual International Communication Association Conference, Washington, DC, USA.

Dynel, M. (2016). "Trolling is not stupid": Internet trolling as the art of deception serving entertainment. *Intercultural Pragmatics*, *13*(3), 353–381. https://doi.org/10.1515/ipp.2016--0015

Eden, A., Ewoldsen, D. R., Lee, J., & Beyea, D. (2018). Behavioral demands as behavioral affordances in video games. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 92–107). New York, NY: Taylor & Francis.

Graham, E. (2019). Boundary maintenance and the origins of trolling. *New Media & Society*, *21*(9), 2029–2047. https://doi.org/10.1177/1461444819837561

Gray, K. L. (2014). *Race, gender, and deviance in Xbox live: Theoretical perspectives from the virtual margins*. New York, NY: Routledge.

Green, C. S. (2018). Video games and cognitive skills. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 25–43). New York, NY: Taylor & Francis.

Herring, S., Job-Sluder, K., Scheckler, R., & Barab, S. (2002). Searching for safety online: Managing "trolling" in a feminist forum. *The Information Society*, *18*(5), 371–384. https://doi.org/10.1080/01972240290108186

Johnson, M. R. (2019). Inclusion and exclusion in the digital economy: Disability and mental health as a live streamer on Twitch.tv. *Information, Communication & Society*, *22*(4), 506–520. https://doi.org/10.1080/1369118X.2018.1476575

Kryston, K., Novotny, E., Schmälzle, R., & Tamborini, R. (2018). Social demand in video games and the synchronization theory of flow. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 161–177). New York, NY: Taylor & Francis.

Kwak, H., & Blackburn, J. (2014). *Linguistic analysis of toxic behavior in an online video game*. Paper presented at the 1st "Exploration on Games and Gamers" workshop, Barcelona, Spain.

Kwak, H., Blackburn, J., & Han, S. (2015). *Exploring cyberbullying and other toxic behavior in team competition online games*. Paper presented at "CHI: Crossings", Seoul, South Korea.

March, E., Grieve, R., Marrington, J., & Jonason, P. K. (2017). Trolling on Tinder® (and other dating apps): Examining the role of the dark tetrad and impulsivity. *Personality and Individual Differences*, *110*, 139–143. https://doi.org/10.1016/j.paid.2017.01.025

Martončik, M., & Lokša, J. (2015). Do World of Warcraft (MMORPG) players experience less loneliness and social anxiety in online world (virtual environment) than in real world (offline)? *Computers in Human Behavior*, *56*, 127–134. https://doi.org/10.1016/j.chb.2015.11.035

McGloin, R., Farrar, K. M., Krcmar, M., Park, S., & Fishlock, J. (2016). Modeling outcomes of violent video game play: Applying mental models and model matching to explain the relationship between user differences, game characteristics, enjoyment, and aggressive intentions. *Computers in Human Behavior*, *62*, 442–451. https://doi.org/10.1016/j.chb.2016.04.018

Merriam-Webster. (n.d.). Dox. *Merriam-Webster*. Retrieved from https://www.merriam-webster.com/dictionary/dox

Nakamura, J., & Csikszentmihalyi, M. (2001). The concept of flow. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 89–105). Oxford: Oxford University Press.

Newman, J. (2018). Kaizo Mario Maker: ROM hacking, abusive game design and Nintendo's Super Mario Maker. *Convergence*, *24*(4), 339–356. https://doi.org/10.1177/1354856516677540

North, R. D. (1949). An analysis of the personality dimensions of introversion-extroversion. *Journal of Personality*, *17*, 352–368. https://doi.org/10.1111/j.1467-6494.1949.tb01219.x

O'Sullivan, P. B., & Flanagin, A. J. (2003). Reconceptualizing 'flaming' and other problematic messages. *New Media & Society*, *5*(1), 67–93. https://doi.org/10.1177/1461444803005001908

Patsis, G., Sahli, H., Verhelst, W., & de Troyer, O. (2013). Evaluation of attention levels in a tetris game using a brain computer interface. In S. Carberry, S. Weibelzahl, A. Micarelli, & G. Semeraro (Eds.), *21st International UMAP conference: User modeling, adaptation, and personalization*, (pp. 127–138). Rome: Springer. Retrieved from https://link.springer.com/content/pdf/10.1007%2F978-3-642-38844-6.pdf

Paul, H., Bowman, N. D., & Banks, J. (2015). The enjoyment of griefing in online games. *Journal of Gaming and Virtual Worlds*, *7*(3), 243–258. https://doi.org/10.1386/jgvw.7.3.243_1

Pavlovich, M. (2014). Dimensions of games: Downtime. *Games Precipice*. Retrieved from http://www.gamesprecipice.com/downtime

Peña, J. (2018). A communication model of social demands in video games. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 126–145). New York, NY: Taylor & Francis.

Peña, J., & Hancock, J. T. (2006). An analysis of socioemotional and task communication in online multiplayer video games. *Communication Research*, *33*(1), 92–109. https://doi.org/10.1177/0093650205283103

Phillips, W. (2015). *This is why we can't have nice things: Mapping the relationship between online trolling and mainstream culture*. Cambridge, MA: MIT Press.

Possler, D., Klimmt, C., & Raney, A. A. (2018). Gaming is awesome! A theoretical model on cognitive demands and the elicitation of aw during video game play. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 74–91). New York, NY: Taylor & Francis.

Rad, C. (2016, March 23). Dark Souls 3 is the hardest Dark Souls yet. *IGN*. Retrieved from https://www.ign.com/articles/2016/03/23/dark-souls-3-is-the-hardest-dark-souls-yet

Rooster Teeth. (2011). Stop the squeakers in gaming!!! [Online discussion group]. Retrieved from https://roosterteeth.com/forum/general-gaming/topic/2211106

Seering, J., Kraut, R., & Dabbish, L. (2017). Shaping pro and anti-social behavior on Twitch through moderation and example-setting. In *Proceedings of the 2017*

ACM conference on computer-supported cooperative work and social computing (pp. 111–125). New York, NY: ACM. Retrieved from http://delivery.acm.org/10.1145/3000000/2998277/p111-seering.pdf?ip=85.244.253.133&id=2998277&acc=CHORUS&key=4D4702B0C3E38B35%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35%2E6D218144511F3437&__acm__=1574261078_0723e8341e83379b17af1f5e22f8f092

Sest, N., & March, E. (2017). Constructing the cyber-troll: Psychopathy, sadism, and empathy. *Personality and Individual Differences*, *119*, 69–72. https://doi.org/10.1016/j.paid.2017.06.038

Shachaf, P., & Hara, N. (2010). Beyond vandalism: Wikipedia trolls. *Journal of Information Science*, *36*(3), 357–370. https://doi.org/10.1177/0165551510365390

Sherry, J. L. (2004). Flow and media enjoyment. *Communication Theory*, *14*(4), 328–347. https://doi.org/10.1111/j.1468-2885.2004.tb00318.x

Smyth, J. M. (2007). Beyond self-selection in video game play: An experimental examination of the consequences of massively multiplayer online role-playing game play. *CyberPsychology & Behavior*, *10*(5), 717–721. https://doi.org/10.1089/cpb.2007.9963

Snodgrass, J. G., Lacy, M. G., Dengah, H. F., Batchelder, G., Eisenhower, S., & Thompson, R. S. (2016). Culture and the jitters: Guild affiliation and online gaming eustress/distress. *Ethos*, *44*(1), 192. https://doi.org/10.1111/etho.12108

Stoll, O. (2019). Peak performance, the runner's high, and flow. In M. H. Ansel, S. J. Petruzello, & E. E. Labbé (Eds.), *APA handbook of sport and exercise psychology, volume 2: Exercise psychology* (pp. 447–465). Washington, DC: American Psychological Association.

Taylor, T. L. (2018). *Watch me play: Twitch and the rise of live game streaming*. Princeton, NJ: Princeton University Press.

Thacker, S., & Griffiths, M. D. (2012). An exploratory study of trolling in online video gaming. *International Journal of Cyber Behavior*, *2*(4), 17–33. https://doi.org/10.4018/ijcbpl.2012100102

Urban Dictionary. (2012). Tilting. *Urban Dictionary*. Retrieved from https://www.urbandictionary.com/define.php?term=Tilting

Wilson, D., & Sicart, M. (2010). *Now it's personal: On abusive game design*. Paper presented at FuturePlay, Vancouver, Canada.

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Article

Audible Efforts: Gender and Battle Cries in Classic Arcade Fighting Games

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Abstract

Video games are demanding work indeed. So demanding that our screen heroes and heroines are constantly making sounds of strife, struggle, or victory while conducting surrogate labor for us running, fighting, saving worlds. These sounds also represent the very real demanding labor of voice actors, whose burnout and vocal strain have recently come to the fore in terms of the games industries' labor standards (Cazden, 2017). But do heroes and she-roes sound the same? What are the demands—virtual, physical, and emotional—of maintaining sexist sonic tropes in popular media; demands that are required of the industry, the game program, and the player alike? Based on participatory observations of gameplay (i.e., the research team engaging with the material by playing the games we study), close reading of gendered sonic presence, and a historical content analysis of three iconic arcade fighting games, this article reports on a notable trend: As games self-purportedly and in the eyes of the wider community improve the visual representation of female playable leads important aspects of the vocal representation of women has not only lagged behind but become more exaggeratedly gendered with higher-fidelity bigger-budget game productions. In essence, femininity continues to be a disempowering design pattern in ways far more nuanced than sexualization alone. This media ecology implicates not only the history of best practices for the games industry itself, but also the culture of professional voice acting, and the role of games as trendsetters for industry conventions of media representation. Listening to battle cries is discussed here as a politics of embodiment and a form of emotionally demanding game labor that simultaneously affects the flow and immersion of playing, and carries over toxic attitudes about femininity outside the game context.

Keywords

battle cry; games; gender; media; representation; sound; voice

Issue

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1. Introduction

Video games are demanding work indeed. So demanding that our screen heroes and heroines are constantly making sounds of strife, struggle, or victory while conducting surrogate labor for us running, fighting, saving worlds. These sounds also represent the very real demanding labor of voice actors, whose burnout and vocal strain have recently come to the fore in terms of the games industries' labor standards (Cazden, 2017). Battle cries as media artefacts involve technological demand, interactional demand, physical demand, and emotional demand: concepts defined by Bowman (2018) in articulating games as demanding technologies. One question that we can then ask is do male and female action leads sound the same? What are the demands—virtual, physical, and emotional—to maintaining sexist sonic tropes in popular media; demands that are required of the industry, the game program and the player alike? To say that mediated voice performance has always been gendered is well-documented, particularly in the area of film studies. Media writers such as Mary Ann Doane (1985), Kaja Silverman (1988), and Clarice Butkus (2010) have long brought attention to the gendered sonic positioning of the female voice in popular media in terms of vocal tone, accent, and role in the screen's diegesis. Historians of radio similarly offer accounts of the subordination of female sound (e.g., representing hysteria, nurturing, or seduction) in relation to the male voice (invoking authority, confidence, authenticity), which has come to symbolize the technology of radio itself (Loviglio, 2007; Zakharine, 2013). Ann Carson (1985) and Mary Beard (2014) provide historical interpretations of the symbolic standing of women's voice in antiquity, as unbalanced, uncontrollable, and unpleasant—all qualities that justified the silencing of women in public communication, political life, and early media participation (Zakharine, 2013). In her study of the history of the operatic voice, Constance Clément (2000) further articulates stereotypical relationships between voice typology and narrative standing (e.g., tenor voice as hero, soprano as tragic love interest). However, attention to voice and sound is still sparse in cultural game studies: a significant gap considering the importance of sound in game design and its experiential presence during gameplay (Droumeva, 2018). In this project, I take up the battle cry as the core indexicality of voice in games, akin to vocal presence in cinema, and apply a critical media studies lens to the sonic representation of women. As Sterne (2003) argues, mediated voice is situated between authenticity and the politics of technology, and manifests through sets of audile techniques: standards and conventions, which become discursive grammar for media production and consumption. The historicity of vocal presence in games—the battle cry—then constitutes a unique perspective from which to examine the politics of embodiment.

The battle cry, it can be argued, is the quintessential vocal presence of a playable character; a temporally persistent audio-visual aspect of the demanding labor of gameplay and a chief aspect of a synchronous flow state (Weber, Tamborini, Westcott-Baker, & Kantor, 2009). It is also a sound effect that embodies gendered, racialized, and class connotations by virtue of sonifying a constructed body (the avatar). It is important to note that discussions around gender representation and design in games have historically focused on differences between cis-gendered male and female avatars. While exciting work focusing on non-binary and queer characters, monsters, and hybrids is now emerging (Ruberg, 2019), this article limits its analysis to binary gender representation. There are two reasons for this: 1) Sound is underexplored in game studies and our mixed methods study has a limited scope that aims to address a still-entrenched gender dichotomy; and 2) what we demonstrate with this work is that there is yet further exploration to be done in understanding the nuanced and multi-faceted ways in which game characters are gendered, which itself is foundational to representation of non-binary, queer, and/or non-human avatars. By focusing on this specific vocalization this project offers a model for doing media analysis of sonic representation akin to studies done in visual representation of gender, race, and sexuality in screen-based media. Specifically, analyzing the battle cry as a demanding artifact of technology at the same time as exploring its implications for the player means that we can refresh the conversation about gendered media tropes and their role in facilitating or burdening the "player–program dialogue" (Bowman, 2018). To that end, this article reports on a notable trend: As games self-purportedly and in the eyes of the wider community improve the visual representation of female playable leads, important aspects of the vocal representation of women has not only lagged behind but become more exaggeratedly gendered with higher-fidelity bigger-budget game productions. In essence, femininity continues to be a disempowering design strategy in ways far more nuanced than visual representation alone. Thinking about gendered vocal tropes in games as a form of emotional and social labor brings into focus the reality that resisting and shifting entrenched (but harmful) mediatized conventions requires equally demanding cultural labor. Since video game design, including audio-visual synchresis, produces virtual as well as actual affective states (Banks & Bowman, 2016), this work is also a feminist take on voice and gender as aspects of gaming necessarily tied to (but often lacking) in research on emotion, affect, and flow states in gameplay.

2. The Battle Cry Study

This project traces both qualitatively and quantitatively iterations of the battle cry across three iconic series in the genre of fighting arcade games: Mortal Kombat (MK), Street Fighter (SF) and Soul Calibur (SC). The intention is to map how the demands for greater and better gender representation in games have unfolded over time in terms of industry conventions, technological advances, and purposeful design of gender differences. If we consider battle cries as 'audible efforts' emitted by avatars that make interactional and emotional demands on the player, how might this experience be gendered? This battle cry study cuts across three layers of analysis: 1) Historical content analysis of female vs. male avatar vocalizations in terms of percentage of battle cries in fight sequences; 2) close reading of the gendered staging of battle cries using spectrograms and participatory play-observations; and 3) an interpretive analysis of battle cries as demanding technological artefacts within a player–avatar sociality matrix (Banks & Bowman, 2016). Mobilizing the concept of 'demand' literally, figuratively, and virtually towards the production and experience of battle cries opens space for a novel critique of persistent sexist tropes in games. By locating battle cries within the player–avatar matrix of sociality we can better understand the "mechanisms underlying affective and cognitive states during gameplay" (Banks & Bowman, 2016, p. 211). Ultimately, this project hopes to challenge the games industry to introduce new cultural demands of the player—ones that are compatible with a complex and equitable view of gender and identity in popular media.

Classic arcade fighting games were selected for this analysis in their capacity as influential trendsetters for subsequent game genre design with regard to not only representation, but also aesthetics and mechanics. The impetus for this work came in part through personal experiences with arcade fighting games, and in part through conversations in the wider gaming community about ‘playing as a female character’: an activity that is still ‘other’ enough to the normativity of playing-as-male to warrant continued discussion. The first central observation in this study, and one that aligns with Carson (1985) and Beard’s (2014) accounts of women’s historic silencing is that women are just *so quiet* in early versions of arcade fighting games. That is, they emit battle cries far less frequently than their male counterparts. Curious to test out whether that was indeed the case as a historical and genre trend we designed a mixed-methodology study focusing on battle cries that included gameplay, observations and field notes, content analysis (tallying distribution of male to female battle cries in a given fighting sequence), and close reading of narrative-sonic elements. The first stage of the study involved distilling several sonic tropes in terms of tonal character, vocal parameters and presence, using film media theory as a guide to formulating voice typologies.

2.1. Gender Coding and Sonic Tropes

In order to distill female battle cry typologies we looked across 286 fighting sequences with 30 unique female arcade fighting characters across the three abovementioned franchises, with footage ranging from 1993 to 2015. Naturally, in earlier titles audible differentiation between gendered opponents involves simple spectrum shaping to synthesize lower or higher frequency tonal bursts, and vocalizations are generally sparse. The emphasis in those early soundtracks is on upbeat music, noise burst ‘punches’ and intermittent voice-off combat phrases. As console technology improved over time in terms of fidelity and compression (as well as hard drive space allocated to sound), game design began importing pre-existing vocal stereotypes from cinema and advertising, which unfortunately further entrenches cultural constructs of femininity (Clément, 2000; Doane, 1985; Silverman, 1988). Common theatrical, broadcasting, and cinematic tropes such as creaking, sultriness, hysteria, naiveté, and ‘female masculinity’ voice (Loviglio, 2007) persist in game soundscapes through the craft of vocal acting. Based on participatory play-observations which involved the research team playing games (separately and together), research memo writing based on gameplay, and group discussion of gameplay captures, our team developed three consistent female vocal typologies in the arcade and early role-playing games genres. While these are discussed elsewhere in more detail (Droumeva, Evans, Fertado, & Bangert, 2017), briefly, they include the ‘warrior woman’ voice, the seductress, and the ‘butt-kicking doll’ voice. The warrior woman (e.g., Sonya Blade) is a confident female voice of medium-high register with clear timbre, coded as middle-class and white, often featuring British or (non-regional) American accent. The warrior uses low tones, and is only breathy to accentuate the importance in what she is trying to communicate. In the same way as lowering the vocal register afforded female radio personalities airtime and respect in more ‘serious’ news domains (Loviglio, 2007), the warrior woman’s voice in popular media marks the emergence of the ‘strong female lead’ (Kennedy, 2003) alongside traditionally male superheroes. Her clear accent and enunciation marks her higher status compared to other often regionally-accented characters (Ensslin, 2011). The butt-kicking doll (e.g., Sakura) embodies a notion of sexualized innocence; vocally she is overly apologetic, playful and giggly, and her voice is often artificially pitched up, light, breathy, and squealy. This vocal trope, particularly in Japanese-originating game titles, is part of a wider cultural context of female infantilization in anime and the deployment of squeal and brethiness as vestiges of pornography (Butkus, 2010). Yet, in western pop media we see similar trends in the teenage pop voice (James, 2016), and the ideal of the virginal woman as innocent, childish, or angelic (Silverman, 1988). The seductress (e.g., Mileena) is a witch trope: Her vocal traits of low drawl, creaking, and growling possess elements of overt inviting sexuality intrinsically linked to a kind of otherworldly quality about the witch—deep-seated evil, connections to magic and the arcane, and/or physical hybridity or deformities. The witch is possibly the oldest formulation of agential female character, dating back to antiquity (Carson, 1985), and the more modern history of Western opera. In her work on gender representation, operatic training and early popular entertainment, Constance Clément (2000) positions the mezzo-soprano—a lower register typically raspy female singing voice—as consistently narratively aligned with evil, sexuality, spirituality, and being outcast from ‘normal’ society. Sultry breathiness was also established as a film standard in early expressive cinema with Marylin Munroe’s boudoir vocal performances marking her as always already sexually charged. Finally, the witch in games is powerful and taunting, much as the witch in opera is one of the only women with agency over their life, openly flaunting their power and freedom (Clément, 2000). For the content analysis portion of this research, one example of each vocal typology was selected for analysis, per title, and followed over time.

2.2. Battle Cry Content Analysis

The battle cry content analysis spans historically over several iterations of each game from 1993 to 2015, including: MK II, IV, 9, and X; SF II, IV and V; SC II, IV and V. We traced major franchise characters Mileena, Kitana, and Sonya Blade (+ Jury) from MK; Chun Li, Cammy, and Sakura from SF; and Taki/Hilde, Ivy, and Xianghua/Leixia from SC. A total of 166 fighting sequences have been played and captured representing 15–20 fights for each character of interest. This includes 10 games and 69 characters (12 female playing against a total of 57 male opponents). To be clear, this small-scale case study lacks the scope of data collection to adequately address the politics of technology as part of the apparatus of representation, nor the historical granularity to excavate indexical changes in mediated embodiment through sound (Sterne, 2003). Instead, this is a theory-informed model for doing interpretive content analysis that takes up Doane's (1985) notion of the 'fantasmic' female voice in order to attempt to decode the technological, discursive, and political aspects (Sterne, 2003) of game characters' vocal embodiment. To that end, any claims made regarding technological evolution of battle cries as sound technology artifacts are interpretive and illustrative, intended to engage the ethos of game platform advancement as part of the hegemony of gender representation. A note on game iterations selection: Since we wanted to focus on 1) direct title iterations rather than special editions, and 2) the contract between older and newer games, the selected titles are not equally spaced chronologically (e.g., MK IV was released in 1997, while MK 9 in 2008). With these limitations in mind, this proof-of-concept case study of battle cries aims to shed light on a certain evolution of female representation in games manifest in sonic terms. For consistency's sake we focused on the console version of the games; older titles had to be played on emulators while newer titles were played in-house on a PlayStation 3 and 4 respectively. In some cases, however, if was difficult to obtain and play certain titles and so we turned to and captured YouTube videos of corresponding fights. It is important to note that many published YouTube videos of arcade fighting gameplay feature extra-hard modes or 'best of' fatalities, showcasing the gaming prowess of the author. We wanted to instead develop—both in our own gameplay, and in YouTube capturing conditions—a constructed 'average play' scenario for each fight. An average fight would involve the classic version of each character and a fighting choreography where both characters deal similar amounts of damage at a medium difficulty setting. Further to that, in order to avoid deriving conclusions from single fights, each character's battle cry count is an average of 5 random fights with different male opponents (to account for character specificity) where some fights were won and some lost. The battle cry coding schema included counting the number of combat verbalizations such as grunts, pants, sighs, straining noises, and any reaction sounds when getting hit, excluding the sounds of feet stomping on the ground or the impact of punches and kicks landing on the bodies of opponents. We looked at cut-scene phrases (e.g., at the beginning or end of a fight) separately but counted voice-off remarks during fights as gendered vocalizations and part of the coding schema. Battle cries were coded for both female and male characters, by two separate coders who cross-checked work to ensure consistent application of the coding rules. Coding was performed using Screenflow for video playback and a simple log sheet.

As a global finding our quantitative analysis shows that female battle cries have increased over 300% across all three titles between the mid-1990s and the mid-2000s (see the MK chart in Figure 1 for average numbers of battle cry instances in a fight sequence). This can be attributed to the industry's evolving standards for more authenticity through higher quality graphics and sound, and the shift to voice acting instead of sound synthesis coupled with higher memory allowance for audio on console games. A 300% increase of average in-fight vocalizations are representative of both an increased demand on the game system and an increased demand for the laboring avatars (not to mention the labor of vocal actors sonifying these game events). So how is this demanding sonic presence gendered?

A look at the quantitative distribution of female-to-male battle cries historically reveals some interesting patterns that converge and diverge across titles (see Figure 1). Overall, the female warrior character is most vocally restrained producing 42–48% of battle cries on average. Yet while Hilde's (SC) count remains steady over time at 48–49%, Chun Li's vocalization feature a massive increase from earlier iterations of SF at 37%, going up to 53% of battle cries in the last iteration of SF. Sonya Blade displays a more modest but similar trend growing from 42% to 53% of in-fight vocalizations between MK IV and MK X. In SF, the butt-kicking doll Sakura actually sees a decrease in her vocalizations over time going from an average of 52% down to 47%, while SC's corresponding characters Xiangua and Leixia see a modest increase from 52% to 54% on average. Interestingly, in our gameplay experience the butt-kicking doll seemed like the most vocal trope, yet that is not necessarily reflected in the numbers. Instead it is the seductress that produces the most vocalizations historically, and sees a gradual increase over time in all three franchises, with Mileena (MK) being the most vocal of this sonic typology at an average of 56% of in-fight vocalizations in MK X. As made clear by the confidence intervals presented for each character's battle cry count in Figure 1, there were significant fluctuations depending on the fight situation, and these fluctuations are not historical (i.e., more recent titles fluctuate as well). At this stage of research they are likely due to the small sample of five to six fights for each character, however, it is important to note large fluctuations can naturally occur owing to randomized sound sampling in the game sound engine, player skill, difficulty setting, etc. During our participatory play-observations it was not uncommon to hear anywhere from 25% to 75% of female battle cry vocalizations in individual fights and, observationally speaking, the most vocally demanding trope was the butt-kicking doll with elongated, breathy phrases and cries, resulting in a more dominant sound profile overall compared with her various male opponents. Save for the largest outliers in Figure 1, this finding is supported by the confidence intervals presented; still, the range sizes call for further study in terms of content analysis using a larger sample of fight sequences and character pairs. Readers are invited to visit and interact with the study at http://osf.io/e4qrp. The open-source project folder con-

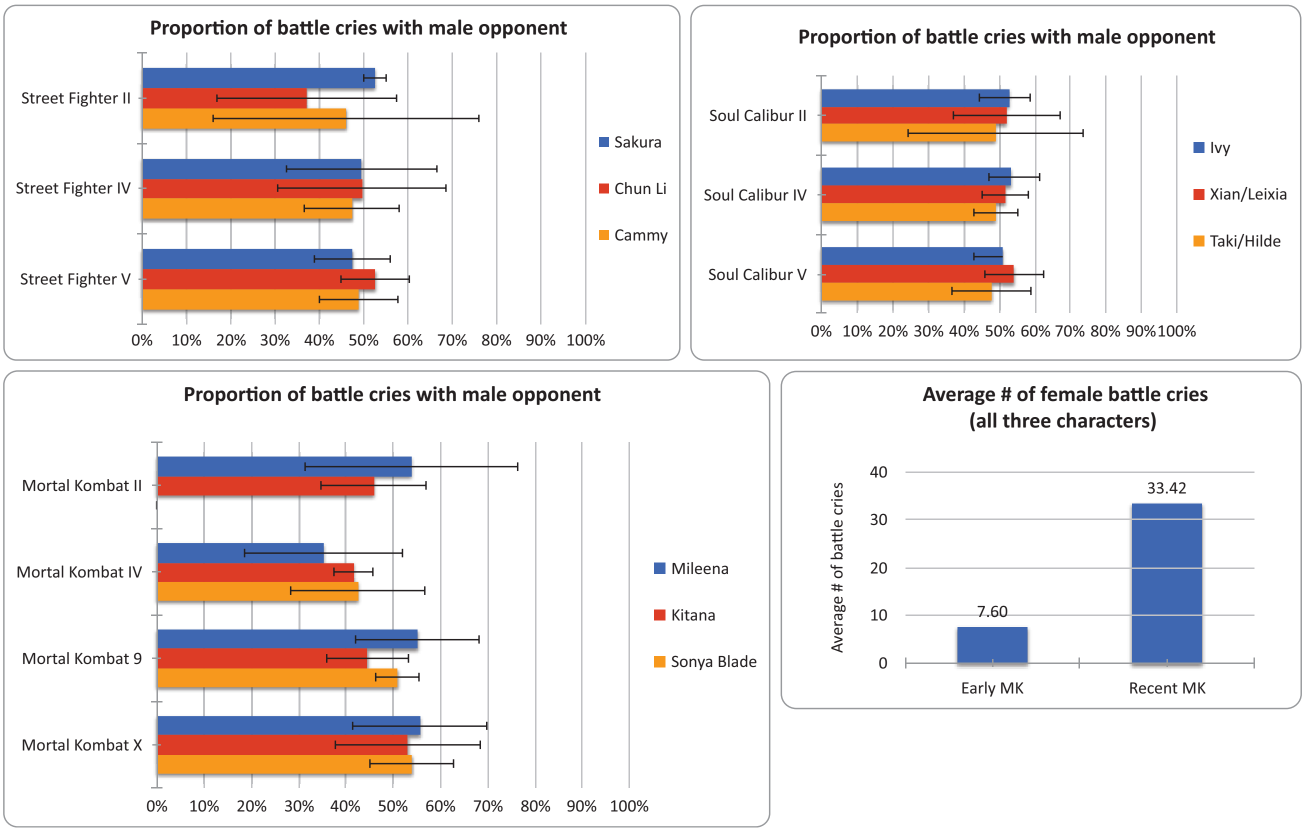

Figure 1. Charts comparing major franchise characters in terms of their average percentage of battle cries in fights with a male opponent. Notes: From top, clockwise—SF, SC, MK, and MK comparison of late 1990s vs. late 2000s actual instances of female battle cries.

tains the dataset in the form of spreadsheets with content analysis counts per title, along with a references document to YouTube videos used for the content analysis, and a video selection of our own gameplay captures.

2.3. Sonic Presence and Audible Effort

In our participatory observations, or close readings (Bizzocchi & Tanenbaum, 2011) of arcade fighting gameplay, we note a clear shift between early (1990s) and later (mid-2000s and up) game titles in terms of gendered sonic differentiation for game characters. Sounds made by female characters are very similar if not identical to the male characters in early versions of MK. By MK IV (1997) the sounds emitted by characters in 'kombat' are different for men and women. One notable difference is that women grunt, sigh, and moan while male characters often speak threatening words: e.g., Scorpion will growl "Get over here!" throughout the fight. MK vs DC Universe (2008) features, like MK IV, more explicit sexualization of the characters visually and even further gendering vocally. The defensive noises from women are over-the-top wails; in contrast, even when male characters emit a vocalization when hit, they are soft, short grunts. Female characters make less noise in general in this title, with Kitana making up 46% of total fight vocalizations and Sonya Blade 39% respectively. With MK X (2015) we see a turn to a more 'authentic' realism of the voice performances where battle cries are less exaggerated, and the timbral qualities of each voice matches more realistically the body type, age, and appearance of the female character. In SF we observe the same trend, in that both men and women are making defensive and offensive sounds; however, when a female character is injured the sound is generally weak and anguished, whereas males tend to make a big "Ooof!" type noise that indicates injury but not necessarily weakness.

On the surface, historical progression disproves the original observation that female avatars are 'silenced' in any political way. If anything, with time they take up more space in the sonic ecology of an average fight. However, a closer read of their sonic presence reveals an interesting trend: Women appear more vocal because they emit more vocal reactions to being hit; most male characters simply absorb the hit and do not vocalize at all; we just see their life stats go down. Female avatars yelp, cry, and shout in pain far more than their male counterparts, even when the point damage is minimal. In other words, even though there isn't (or shouldn't be) any algorithmic disparity between male and female avatar stats, women overwhelmingly vocalize pain and suffering more than their male counterparts, *as if* they are physically weaker, *as if* they struggle and feel more pain, and the fight is more demanding for them as the player's proxy. Looking beyond the surface, female characters do often have different/lesser life, attack, and defense stats even if that information is not very clear in the game or is complicated in console versions by character evolution and gear. As fans and gamers have long observed, female characters are gendered in terms of their very design and mechanics: posture that embodies their narrative typology (e.g., Juri contorting as a witch, or Leixia buckling at the knees as a teen girl warrior); these characters often feature suggestive, sexualized, or otherwise feminized combo actions—e.g., Sonya Blade's 'kiss' fatality, Ivy's dominatrix whip combo, or Sindel's 'migraine' scream. In developer circles the strength of characters has been discussed as a matter of authenticity: One of the designers of SF's iconic Chun Li for instance wanted to make her life bar shorter to reflect women's weaker nature, but was convinced otherwise (Lee, 2014). Similarly, official fan rankings of MK characters (Duran, 2018) in terms of strength place Sonya Blade—the classic female warrior—in 27th place out of 30; Mileena at 21/30; and only one woman places in the top 10—Cassie Cage—a new character in MK X (2015), arguably a more 'modern' equity-aware design. Of course players have a variety of reasons for choosing to play (or not) female characters: Enjoyment, challenge, transgression, fantasy, arousal, role-play. The fact remains, however, that games continue to bake disempowering gender stereotypes right into the very appearance, combat style, and sonic presence of fighting heroines. The experience of playing as a female character is summarized below in a notable excerpt from a research memo from the project:

> There is absolutely no power fantasy as a woman in Soul Calibur. In Mortal Kombat, I feel like I get into it sometimes; having Sonya Blade kick ass for me is exciting to see in a way. But [in Soul Calibur] the seductress and warrior woman are both making these helpless whimpering sounds and even their attack sounds are breathy and lackluster. (Evans, 2017)

These nuances led us to engage in a closer reading of the processes of gendered sonic embodiment in arcade games, including the congruence between characters' in-fight and voice-off vocalizations, and the qualitative aspects of their battle cries by breaking them down into offensive versus defensive sounds.

2.4. Embodiment and Voice

Battle cries in games are possibly one of the most visceral aspects of the embodiment of avatars within the player–program dialogue; with audio-visually advancement in later iterations characters also emit more voice-off phrases during fight rounds: short remarks, taunts, and reactions that typify their particular personality. Voice-off remarks would fall into the wider trope of cinematic 'disembodied voice' whose history carries deeply embedded gendered practices of montage and representation. In her classic essay on the disembodied female voice, Mary Ann Doane (1985) explains that in film the 'fantasmic' female voice-over is marked as subordinate to the normativity of the authoritative male voice, and relegated to traditionally feminized functions representing emotional and subjective elements, interior monologue, and flashbacks. This categorization aligns well with the voice-off phrases that female characters 'speak' during fight sequences and their voice-over in cut scenes. These phrases are sometimes explicitly sexualized, hysterical, or naïve: again replicating the typologies of female voices in popular media (Clément, 2000; Silverman, 1988). For instance, while warrior women definitely battle cry in firm, mid-range confident tones, they are also heard uttering breathy lines such as: "I'm just doing my duty! Please don't take it personally…" (Chun Li), and "Shut up! Go away! Leave me alone!" (Cammy). The flippant dialogue and frequent use of helpless whimpers—particularly in the vocal profile of the sexy butt-kicking doll—only serve to undermine the fighting status of these women, despite what the backstory and character development might suggest. For instance, Xianghua's markedly infantilized battle cries reminiscent of Link's "Teyyyyahh!" are offset by her visual sexualization and accentuated further in the vocal presence of her daughter Leixia in SC V (2012) who constantly utters "Sorry!" and "Forgive me" while battling an opponent. Generally, in comparison with the gamut of male character voices featured in typical arcade fighting games, female avatars sound distinctly close-miked, breathy, with a lot of exhalation at the end of phrases (known in voice over work as 'pre life' and 'post life'), evoking urgency, self-doubt, and emotional affect. In this sense, while battle cries technically serve to sonify a fighter's prowess and exertion, in the case of female fighting avatars battle cries and voice-offs actually create incongruence with the characters' status owing to their gendered design. In order to do a closer reading of the gendered characteristics of battle cries, we used Adobe Audition to visualize the audio waveforms and spectrogram of a few select fights ranging from older to more recent titles (Figure 2); this was done as proof of concept and an attempt to nuance and complicate the content analysis portion of the research.

What we found is that incongruence of vocal presence between male and female characters extends to another dimension of battle cries: their tonal character and their narrative coding as offensive vs. defensive vocalizations. In a close reading of in-fight sounded elements across MK, SF, and SC, there seems to be almost no difference between when women take damage and when they're dealing damage to their opponent. In other words, even when sonic elements are almost equal, women simply sound most of the time as if they are being hit, while men make very few defensive cries, instead emitting offensive grunts and roars. Consider two micro-moments from SF IV and SC IV respectively (Figure 2):

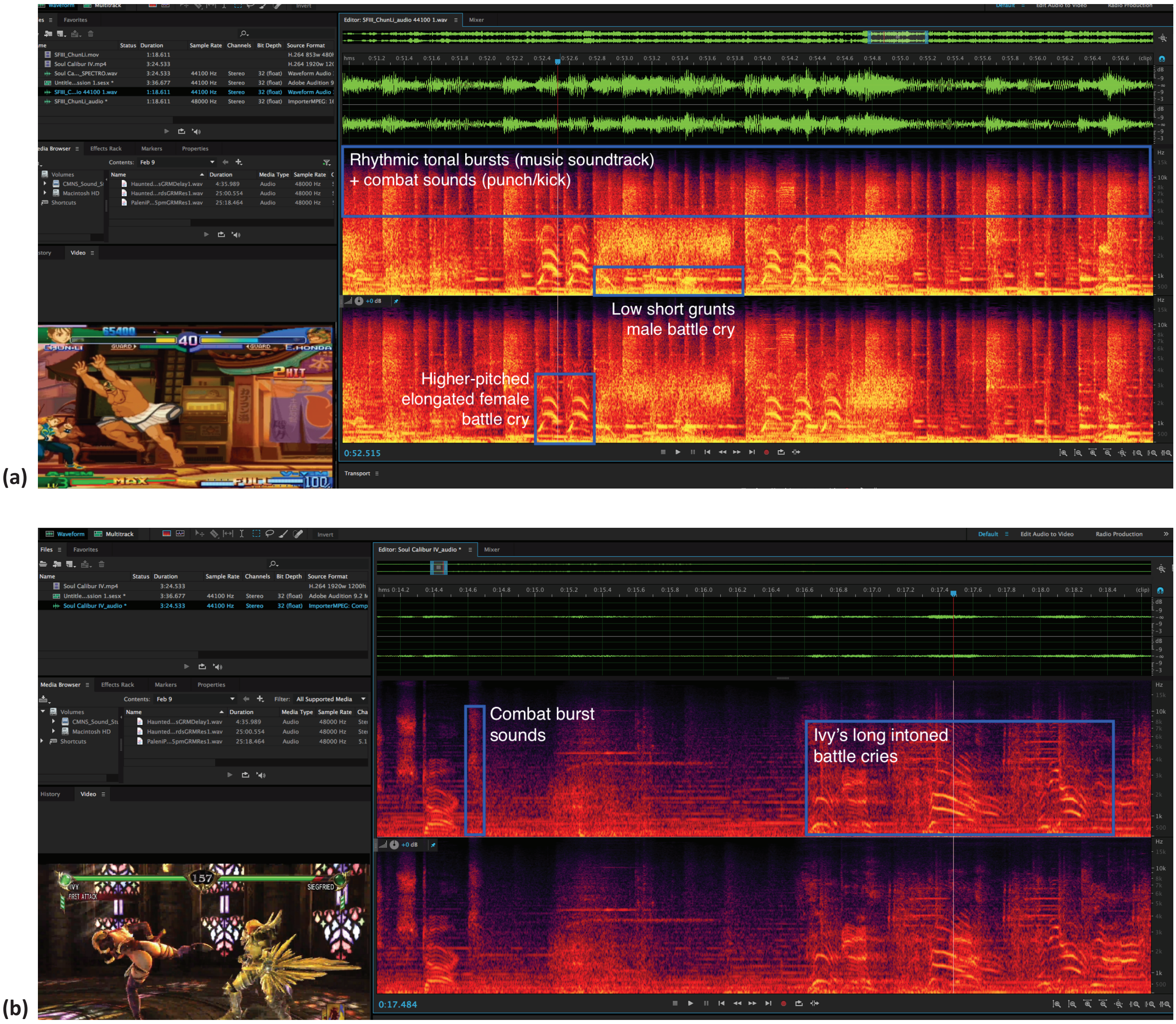

Figure 2. (a) Spectrogram of Chun Li fight section (SF IV); **(b)** Spectrogram of Ivy fight section (SC IV).

Compared to the short noise bursts of E. Honda's battle cries, Chun Li (a warrior vocal type) intones much longer battle cries descending in pitch, regardless of whether she is attacking, defending, or being hit. Even visually, as we can see in both combat screenshots, female vocalizations take on larger envelopes in the overall game soundscape: They demand more time and attention within the ecology of the gaming experience. This was an important finding as our coding schema of battle vocalizations didn't consider duration—just frequency of occurrence. Looking at the spectrograms provides grounds for future analysis from a temporal standpoint; in addition, it is significant to see almost no intoning in male grunts whereas women's battle cries are pronounced and contain almost musical harmonics.

The tonal character of these pitched battle cries is, historically, an invitation to a 'male gaze and ear' (Silverman, 1988) as a deliberate design choice that has persisted across media franchises. Oftentimes female vocalizations in games sound almost pornographic. How can they not—in Western hetero-patriarchal media culture sex is always potentially violent and violence is frequently sexualized (Corbett & Kapsalis, 1996; Creed, 1993); furthermore the 'aural sexuality' of the recorded female voice is enmeshed with the history of sound recording itself (Butkus, 2010). This is particularly clear in the SC spectrogram in terms of Ivy's (a seductress) long breathy guttural battle cries which are even longer and more nuanced in terms of tone and harmonics than Chun Li's (Figure 2). Of course the two games are different stylistically, however, one reason for this development is the increased audio-visual resolution and voice work sophistication in the more recent game title: Affirming once again the finding that women are heard more now than before, however, in stereotypically sexualized and/or disempowering ways that explicitly mark their feminization. While we can trace some of the origins of these exaggerated breathy feminine sounds to a genre cousin—anime—this trope also builds on the 'scream queen' idea in film where the height of the action—

whether horrific or pornographic—is punctuated by female screams (Bonenfant, 2014).

The effects of this kind of biased characterization can be farther-reaching than one might expect (Behm-Morawitz & Mastro, 2009). The way players talk about characters amongst themselves—on forums such as Steam or Reddit—speaks to an internalization of biased vocal representations of gender. A brief scan through the adjectives used by players to describe different gendered characters and their voices (both in positive and negative terms) helps illustrate this fact. For instance, tropes emergent from a Reddit thread (2016) discussing SF V character voices stages their traditionally negative qualities (shrill, weak, or irritating, etc.) in terms of sexuality or as comic relief ("sounds like a chain-smoker" or "nails on a chalkboard"). The connotations of strength, dignity, and guileless intelligence are reserved (in the players' perception) for male-voiced characters. Diminutives, overtly feminized terms, and condescending phrases appear much more frequently when discussing female character voices. Examples of adjectives and descriptors include the male boss voices being referred to as "natural" and "fun," and the female-voiced characters being referred to as "chick," "gal," "sweet," "baby," or alternatively "pitchy" (Reddit, 2015). Interestingly, these sentiments extend to discussions of the actors behind the character voices. Laura Bailey and Nolan North are both very well-known voice actors; however, in online discussions she "yelps" (in the negative), or is "comforting" (in the positive); while he is described as "incredible" and "a badass." (Reddit, 2015). The power of the disembodied voice is thus located in the symbolism of the voice itself. As Butkus (2010) notes, the media ventriloquism that is facilitated by the very fact of recording technology serves to mediate, and even legitimize, our experiencing these vocal sounds as e.g., irritating, pleasant, abject, arousing, weak, strong, etc. After all, they are simply 'sound effects'—abstracted instances of pure vocal symbolism delivered as rapid-fire feedback to the player. But are they? A body of literature on the emotive and psychological aspects of gaming suggests that para-ludic elements of game design such as sound, aesthetics, narrative, and representation (among others) are highly constitutive of the affective and emotional states of gameplay within the player–program dialogue (Bowman, 2018).

3. Battle Cries and Player–Avatar Sociality

According to Bowman (2018) technological demands propel game design to improve the rich and pleasurable experience for the player; interactivity-as-demand addresses the dialogical nature of player input and game program as a process that requires active cognitive, psychological, and cognitive states; physical demand touches on the embodied nature of this interactivity; and social and emotional demands refer to the inherent 'affective' experience of interacting with other agents such as avatars, environments, and players. Social and emotional demands are also inextricably connected to levels of immersion, engagement, and investment in the game world. Figure 3 offers an illustrative weighting of these demands in relation to battle cries in arcade games specifically. Given the process of recording and encoding sound effects banks in the game's platform, their technical demand is low: They are called up when needed, looped, randomized, and repeated; their interactional demand is, I propose, at least medium due to the active cognitive states of performing battle moves; these same battle moves entail even higher physical demands from the player. In terms of social and emotional demands I suggest battle cries elicit medium to high demand due to the arousal states that come from instant sonic feedback in quick-movement gameplay. The auditory voyeuristic pleasures of hearing sounds of pain, struggle, or victory—especially when these sounds are feminized, potentially sexualized, and within direct control of the player—can also be seen as forms of affective labor or demand. To be clear, this figure is an illustration of a hypothetical average player scenario; a different setting, context, player, or interpretation might yield slightly different ratings.

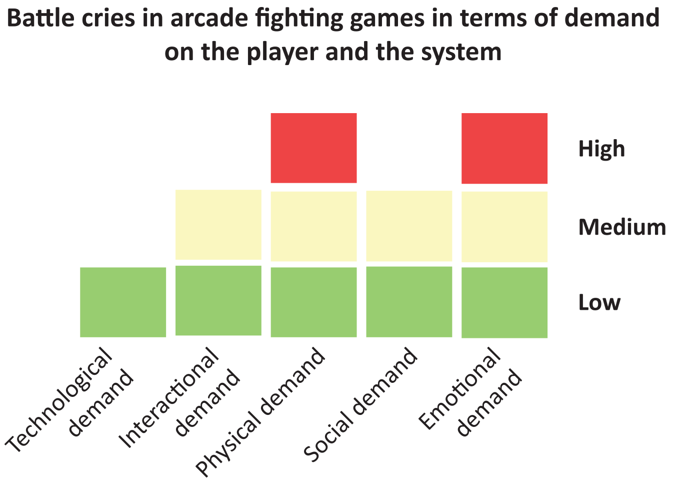

Figure 3. An illustrative breakdown of battle cries in arcade fighting games as demanding technologies.

As Bowman (2018, p. 10) notes, the "player–program dialogue" has an intuitive emotive dimension to it in that the player *feels* rather than thinks through controller actions. Social demands in games naturally boost arousal and while sociality is largely understood as gamers' experiences with other social actors (gamers) in virtual spaces, the player–avatar relationship is an important form of sociality (Banks, 2015). In arcade fighting games the avatar is both iconic/independent in their own right, and highly controllable by the player: A combination that mimics mediated puppetry with the avatar's battle cries, yelps, and grunts rewarding the player for gaming mastery. In order to focus on the social and affective dimensions of gendered battle cries, I offer another interpretive breakdown of arcade games in terms of their player–avatar experience matrix, using Banks and Bowman's (2016) proposed PAX scale (Table 1). Once again, this table is not meant to suggest that there is a fixed configuration of PAR/PAX, rather, it suggests an illustrative case study of battle cries as a specific interactional element that significantly impacts the ludic experience of arcade fighting games. The proposed scale blends several aspects of gameplay into an evaluative rating of investment, immersion and engagement in the game world. Anthropomorphic autonomy is arguably high in arcade fighting games: Since the narrative is not first-person based, a close identification between player and avatar isn't specifically encouraged or facilitated. Avatars have a symbolic life outside the game as part of the franchise and popular culture in general; they are not highly customizable and so in terms of the PAX scale, emotional investment in the player–avatar relationship would be minimal (Banks & Bowman, 2016). In terms of battle cries, arcade avatars are both seemingly independent, via randomization of feedback from battle cry audio banks, and at the same time persistent as ludic and aesthetic elements that are looped and repeatable. Even quantitatively, avatar vocalizations could take up to 85% of the battle's soundscape, so their affective power defines much of the player's experience during a fight sequence. In terms of suspension of disbelief, battle vocalizations can be characterized as hyper-real for both women and men, thus eliciting lower immersion on the PAX scale. Yet, the sense of player control (and thus, engagement and immediacy) are high owing to the feedback loop of controller-triggered avatar movements and avatar vocalizations as auditory rewards for the player.

Building on the PAX scale as a "model for examining mechanisms underlying affective and cognitive states during gameplay" (Banks & Bowman, 2016, p. 221), let's return to the idea of battle cries as gendered audible efforts and as mediated artifacts that structure identification between player and avatar. I frame this speculative discussion around the interplay of avatar identification and affective demands specifically. According to Banks (2013) there are four stable player–avatar relationships that determine much of the player's experience of emotional investment, immersion, and engagement during gameplay: Avatar as Tool; Avatar as Symbiote; and Avatar as Other. These states of avatar identification determine the levels of sociality that the player experiences (Bowman, 2018, p. 15) and it is important to note that affective demands are experienced as real even when virtual, i.e., happening inside the gameworld. The feedback system of battle cries as a sonification of avatar bodies thus allows us a unique approach to probe avatar identification as a form of demanding affective labor for players of any gender.

First, the voice is not neutral but a highly emotive form of feedback central to the player's very sense of self as they try on and occupy different avatar identities (Banks & Bowman, 2016). While the battle cry is an algorithmic recorded sound effect for the game, it is also the primary form of embodiment for the avatar, and to quote Christine Ehrick (2015), there is no such thing as a disembodied voice, because voice always hearkens to a body; the voice is a person, and the mediatized voice is historically indexical to technological politics (Sterne, 2003). In a highly interactive entertainment genre such as games—a media text filled with semiotic shortcuts—voice is a direct signifier for gender (not to mention race, class, etc.). Voice is the avatar itself and the avatar is a puppet directed by the player. The soundtrack can be viewed as a ventriloquist (Altman, 1980) that serves to disguise the cultural logic of game design from the player, instead immersing them in a fast-paced feedback loop of action and reward. Since voice is gendered, identifying with an avatar, even at a low level, is a kind of gender play. To that end film and media studies tell us that the mediated female voice can no more escape the connotations

Table 1. An interpretive chart of battle cries in arcade fighting games using the PAX scale.

Player–avatar sociality	PAX scale	Ludic elements	Battle cry features
Emotional investment	Low	Story is minimal, not first-person based	Battle sounds are constant, emotive
Anthropomorphic autonomy	High	No avatar customization, characters are established	Some randomization of battle sounds
Suspension of disbelief	Low	Focus on fights not story	Violent sounds and phrases are hyper-real
Sense of player control	High	Active control of characters and outcome	Direct connection between controller action and battle sound

of a male auteur than the female image can escape the male gaze (Silverman, 1988). What is more, the 'sound effect' of the female scream has its technological roots in pornography, and its cultural use as emotional climax in popular narratives makes it necessarily or at least potentially sexualized (Butkus, 2010). This makes the physically and interactionally demanding labor of playing an arcade fighting avatar already a gendered experience: this is why it matters that game women have gone from making very little sound to making a lot of sounds that primarily signal the sexuality, fragility, and audible effort of the virtual female body.

Given that battle cries are hyper-real in terms of vocal acting conventions, that is, they are exaggerated for both genders as well as for 'othered' characters such as monsters and hybrids, the gameplay experience of listening to female battle cries is one that engages the "reality principle" (Baudrillard, 1994) in particular ways. The 'reality principle,' introduced by Baudrillard, stipulates that hyper-reality in media functions in tandem with notions of 'reality,' whereby the othered hyper-reality of media constructs and reinforces the authentic reality of the outside-media world. In the case of battle cries, the exaggerated and sexualized female battle cries in arcade fighting games can be seen to function as distinct from 'what women really sound like' and thus further legitimize the aural objectification of stereotyped feminine aesthetics inside the gameplay experience. Presumably, for a heterosexual male player, there is both a satisfying recognition of female media tropes in the avatar vocalizations (e.g., the warrior, the witch, and the doll), and a subversive pleasure in enjoying them as direct auditory rewards for controller actions. For female players, hyper-real battle cries present the potential for conceiving of femininity as both 'other-than-myself' and as abject (Creed, 1993) when the power fantasy of playing a female avatar clashes with the reality of designer sonic stereotypes.

In this sense, the profound "distancing enacted by ventriloquism" (Nyerges, 2016, p. 116) that is part of the technological apparatus of battle cries, forces the player—male or female—to constantly slip between avatar identification states ranging from Avatar as Tool, Avatar as Symbiote, and Avatar as Other (Banks, 2015), thus disrupting the magic circle and synchronous flow states (Weber et al., 2009) of immersive gameplay. This slippage, I argue, is an enormously demanding affectation in terms of recognizing, resisting, enjoying, and rejecting sonic tropes as encoded performances of audible effort. Each of these avatar identification states elicit discreet affective reactions whereby virtual and actual worlds collide making virtual emotions real (Banks & Bowman, 2016). These 'mediated emotions' are also co-constructive of real affective attitudes such as how male (and female) players would perceive femininity: as weaker, more frail, in terms of compulsory sexualization, and as a marker of victimhood and otherness. As a medium with a high intervention potential, games could be at the forefront of social change in terms of disrupting entrenched media tropes of gender, race, class, ability, etc.; yet so much of game design is focused on avoiding "expectancy violations" (Bowman, 2018, p. 17) when in actuality, stereotypical, hyper-real design elements such as gendered battle cries force players of any gender into the affective labor of weaving in and out of immersion due to disruptions in avatar identification and emotional investment.

4. Conclusions

Despite advancements in technology, or perhaps because of them the same design choices persist when it comes to gendered voicing in videogames, and to use a sonic metaphor, the tech actually amplifies the problem. Reliance on high-quality voice acting rather than short synthesized bursts brings with it the endemic representational problems of cinema, and even earlier theatrical and operatic typologies (Clément, 2000; Doane, 1985) all in the name of greater realism and immersion in the gaming experience. And that's where the heart of this problem lies: These massive titles represent what 'powerful' women should look and sound like. In some situations, these women are the mascots of the game; they are cosplayed at conventions and are featured in popular media, making their representational politics critically important. What is telling once we start looking at voice is the way sounding out the gendered body opens up different ways of exploring intentional and canonic designs of technological embodiment. This work is meant to revisit Doane's (1985) suggestion that media technologies and conventions come together to create the gendered 'fantasmic body,' which, by way of being mediated and technological within regimes of male gaze and ear (Silverman, 1988), reproduces politics of disempowerment in female game characters. At a higher level, Sterne's (2003) appeal to consider the mediated voice at the intersection of technology, history, and discourse, is animated here in the historical permutations of female battle cries, hopefully making a unique contribution to our understanding of how videogames intersect with and advance (or undermine) cultural norms about gender embodiment. Given the limitations of this case study, further work using both content analysis and a more systematic approach to spectrogram analysis is necessary to build knowledge and identify future trajectories for media production and game design. This research is unique in that it extends traditionally visual rubrics of media representation of gender to the sonic dimension, complicated by the particular interactivity and embodiment that characterize the relationships between player, avatar, and gameplay on screen. Through playful engagement with deconstructing and reconstructing the gendered nature of battle cries I hope to make the issues of media representation in gaming more accessible and engage both academics and the game community in broader conversations.

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Conflict of Interests

The author declares no conflict of interests.

References

Altman, R. (1980). Moving lips: Cinema as ventriloquism. *Yale French Studies*, *60*, 67–79.

Banks, J. (2015). Object, me, symbiote, other: A social typology of player-avatar relationships. *First Monday*, *20*(2). https://doi.org/10.5210/fm.v20i2.5433

Banks, J., & Bowman, N. (2016). Emotion, anthropomorphism, realism, control: Validation of a merged metric for player–avatar interaction (PAX). *Computers in Human Behavior*, *54*, 215–223.

Beard, M. (2014). The public voice of women. *London Review of Books*, *36*(6), 11–14.

Behm-Morawitz, E., & Mastro, D. (2009). The effects of the sexualization of female video game characters of gender stereotyping and female self-concept. *Sex Roles*, *61*(11), 808–823.

Bizzocchi, J., & Tanenbaum, T. (2011). Well read: Applying close reading techniques to gameplay experiences. In D. Davidson (Ed.), *Well played 3.0* (pp. 218–315). Halifax: ETC Press.

Bonenfant, Y. (2014). On sound and pleasure: Mediations on the human voice. *Sounding Out!* Retrieved from https://soundstudiesblog.com/2014/06/30/on-sound-and-pleasure-meditations-on-the-human-voice

Baudrillard, J. (1994). *Simulacra and simulation*. Ann Arbor, MI: University of Michigan Press.

Bowman, N. (2018). *Video games: A medium that demands our attention*. New York, NY: Routledge.

Butkus, C. (2010). Depraved desire: Sadomasochism, sexuality and sound in mid-1970s cinema. In B. Johnson (Ed.), *Earogenous zones: Sound, sexuality and cinema* (pp. 66–88). Sheffield: Equinox Publishing.

Carson, A. (1995). The gender of sound. In A. Carson (Ed.), *Glass, irony, and God* (pp. 119–142). New York, NY: New Directions Books.

Cazden, J. (2017). Screaming for attention: The vocal demands of actors in violent interactive games. *Journal of Voice*, *31*(1), 1–2.

Clément, C. (2000). Through voices, history. In M. A Smart (Ed.), *Siren songs: Representations of gender and sexuality in opera* (pp. 17–28). Princeton, NJ: Princeton University Press.

Corbett, J., & Kapsalis, T. (1996). Aural sex: The female orgasm in popular sound. *TDR*, *40*(3), 102–111.

Creed, B. (1993). *The monstrous-feminine: Film, feminism, psychoanalysis*. New York, NY: Routledge.

Doane, M. (1985). The voice in the cinema: The articulation of body and space. In E. Weis & J. Belton (Eds.), *Film sound: Theory and practice* (pp. 162–176). New York, NY: Columbia University.

Droumeva, M. (2018). From Sirens to Cyborgs: The media politics of the female voice in games and game cultures. In K. Grey, G. Vorhees & E. Vassen (Eds.), *Feminism in Play* (pp. 51–67). Palgrave Macmillan.

Droumeva, M., Evans, K., Fertado, N., & Bangert, R. (2017). It gets worse…The female voice in videogames. *First Person Scholar*. Retrieved from http://www.firstpersonscholar.com/it-gets-worse/

Duran, M. (2018). Mortal Kombat characters from weakest to most powerful, officially ranked. *The Gamer*. Retrieved from https://www.thegamer.com/mortal-kombat-characters-weakest-strong-ranked

Ehrick, C. (2015). Vocal gender and the gendered soundscape. *Sounding Out!* Retrieved from https://soundstudiesblog.com/2015/02/02/vocal-gender-and-the-gendered-soundscape-at-the-intersection-of-gender-studies-and-sound-studies

Ensslin, A. (2011). *Recallin' Fagin: Linguistic accents, intertextuality and othering in narrative offline and online video games*. In G. Crawford, V. K. Gosling, & B. Light (Eds.), *Online gaming in context: The social and cultural significance of online games*. New York, NY: Routledge.

Evans, K. (2017). *Soul Calibur: Research memo* (Unpublished internal report).

James, R. (2016). Listening to sounds in post-feminist pop music. *Sounding Out!* Retrieved from https://soundstudiesblog.com/2016/02/15/listening-to-sounds-in-post-feminist-pop-music

Kennedy, H. W. (2003). Game studies—Lara croft: Feminist icon or cyberbimbo? On the limits of textual analysis. *Game Studies: The International Journal of Computer Game Research*, *2*(2). Retrieved from http://www.gamestudies.org/0202/kennedy

Lee, T. (2014). Street Fighter II's Chun-Li almost came with a shorter life bar. *Ubergizmo*. Retrieved from https://www.ubergizmo.com/2014/03/street-fighter-iis-chun-li-almost-came-with-a-shorter-life-bar

Loviglio, J. (2007). Sound effects: Gender, voice and the cultural work of NPR. *The Radio Journal—International Studies in Broadcast and Audio Media*, *5*(2/3), 67–81.

Nyerges, A. (2016). Hearing Hart Crane: In the shape of New York's noise. *Sound Studies*, *2*(2), 107–118.

Reddit. (2015). Who do you think is the best voice actor in mkx? [Reddit thread]. Retrieved from https://www.reddit.com/r/MortalKombat/comments/3knxoe/who_do_you_think_is_the_best_voice_actor_in_mkx

Reddit. (2016). What do you think are the worst voices in SFV and should be taken out of the game? [Reddit thread]. Retrieved from https://www.reddit.com/

r/StreetFighter/comments/5as80i/what_do_you_think_are_the_worst_voices_in_sfv_and

Ruberg, B. (2019). *Video games have always been queer*. New York, NY: NYU Press.

Silverman, K. (1988). *The acoustic mirror: The female voice in psychoanalysis and cinema*. Bloomington, IN: Indiana University Press.

Sterne, J. (2003). *The audible past: Cultural origins of sound reproduction*. Durham, NC: Duke University Press.

Weber, R., Tamborini, R., Westcott-Baker, A., & Kantor, B. (2009). Theorizing flow and media enjoyment as cognitive synchronization of attentional and reward networks. *Communication Theory*, *19*(4), 397–422.

Zakharine, D. (Ed.). (2013). *Electrified voices: Medial, socio-historical and cultural aspects of voice transfer*. Göttingen: Vandenhoeck & Ruprecht.

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Article

Cognitive and Behavioral Correlates of Achievement in a Complex Multi-Player Video Game

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Abstract
Over the past 30 years, a large body of research has accrued demonstrating that video games are capable of placing substantial demands on the human cognitive, emotional, physical, and social processing systems. Within the cognitive realm, playing games belonging to one particular genre, known as the action video game genre, has been consistently linked with demands on a host of cognitive abilities including perception, top-down attention, multitasking, and spatial cognition. More recently, a number of new game genres have emerged that, while different in many ways from “traditional” action games, nonetheless seem likely to load upon similar cognitive processes. One such example is the multiplayer online battle arena genre (MOBA), which involves a mix of action and real-time strategy characteristics. Here, a sample of over 500 players of the MOBA game League of Legends completed a large battery of cognitive tasks. Positive associations were observed between League of Legends performance (quantified by participants’ in-game match-making rating) and a number of cognitive abilities consistent with those observed in the existing action video game literature, including speed of processing and attentional abilities. Together, our results document a rich pattern of cognitive abilities associated with high levels of League of Legends performance and suggest similarities between MOBAs and action video games in terms of their cognitive demands.

Keywords
action video games; cognitive demand; individual differences; MOBA video games

Issue
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1. Introduction

There is a long history of interest in the cognitive, emotional, physical, and/or social demands that are inherent in complex real-world experiences. As one possible window into this issue, many disparate sub-domains within psychology have explored the extent to which individuals’ performance on highly multifaceted tasks can be predicted, at least partially, by a set of more primitive abilities or traits (Bowman, 2018; Brown, Zatorre, & Penhune, 2015; Titz & Karbach, 2014; Voss, Kramer, Basak, Prakash, & Roberts, 2010). Here, one general line of reasoning has been that if individuals who are top performers on a given complex task show advantages in a set of more primitive abilities, one possible reason for that relation is that the complex task places demand on those more primitive abilities. In other words, if the complex task places demand on certain abilities, individuals who are higher in those abilities will perform better on the complex task than individuals who are lower in those abilities (noting of course, that other possible causes exist for such a relation).

The complex experience of interest in the current work is video game experience. Essentially, as soon as the video game medium came into popularity, correlational studies were already being performed demonstrating enhanced cognitive abilities in video game players relative to non-players (Gagnon, 1985; Griffith, Voloschin, Gibb, & Bailey, 1983). The early work in this domain often considered video games as a unitary activity and contrasted “individuals who commonly played video games” against “individuals who did not play video games.” Yet as the video game industry evolved, reasonably distinct genres of video games emerged. Importantly, there has been evidence indicating that these genres differ in terms of their cognitive demands. In particular, one genre, known as the “action video game” genre (Green & Bavelier, 2003), has received the majority of the interest in the field of cognitive psychology. Action video games have been defined as games that require players to attend to a rapidly changing and highly cluttered environment as well as to make accurate decisions under time pressure as they engage with a wide array of incoming stimuli (Cardoso-Leite, Joessel, & Bavelier, in press; Spence & Feng, 2010). Prototypical examples of the action genre are first- or third-person shooter games. The proposal that action video games place extreme demands on speed of processing and attention in particular has been supported by the consistent finding of enhanced performance on, for instance, speed of processing and attentional control tasks in action gamers as compared to non-gamers (Appelbaum, Cain, Darling, & Mitroff, 2013; Colzato, van Leeuwen, van den Wildenberg, & Hommel, 2010). This correlational work has been further supported and augmented by intervention studies that have demonstrated that long-term training on action video games can enhance those core constructs (Feng, Spence, & Pratt, 2007; Strobach, Frensch, & Schubert, 2012; for recent meta-analyses on both expert/novice designs and intervention designs see, Bediou et al., 2018).

Much of the cognitive psychology literature on video games has been predicated on the idea that action video games were relatively unique in terms of their cognitive demands (at least as compared to many of the slower and more deliberate game genres of that period, such as turn-based strategy games or turn-based role-playing/fantasy games). Yet the past fifteen years have seen dramatic changes in the commercial video game landscape. For instance, over this time period, various new “hybrid” genres, that mix elements from the action genre along with one or more other genres, have come into increasing prominence (Dale & Green, 2017b). As an example, the majority of role-playing games (RPGs) today perhaps best fit within what is known as the action-RPG genre (Dale, Kattner, Bavelier, & Green, 2019). Action-RPG games include a mixture of traditional RPG elements (e.g., skill progression trees, dialogue, etc.) and traditional action elements (e.g., first-person shooter or third-person shooter combat). Similarly, strategy games today are typically real-time, rather than turn-based. Accordingly, it has been suggested that these new hybrid genres, like the games that have traditionally been labeled as “action video games,” also involve substantial cognitive demands. Consistent with this proposition, players of both the action-RPG and real-time-strategy genres have been observed to have many similar enhancements in speed of processing and cognitive control, as do avid action video game players (Dale & Green, 2017a; Dale et al., 2019; Kim et al., 2015). Furthermore, although there are fewer intervention studies on these new game genres, the studies that do exist have suggested that this relation is causal (Basak, Boot, Voss, & Kramer, 2008; Glass, Maddox, & Love, 2013).

Another new video game genre, one that has received comparatively little attention in the cognitive literature to date, is the primary interest of the current article—the multiplayer online battle area (MOBA) genre. Games that fall under the MOBA genre label have sometimes been referred to as action real-time strategy games. This latter label underscores the fact that MOBA games have components that share similarity with both the action video game genre and the real-time strategy game genre. One prominent example of the MOBA genre is the game League of Legends. At the start of a League of Legends game, players are divided into two teams consisting of between 3 to 5 individuals. As is true in first- and third-person shooter games, each player controls a single character called a “champion.” Each champion has a unique combination of base abilities and attributes that make them more or less suitable for different styles of gameplay. For example, some champion’s attributes and abilities make them particularly adept when fighting at close range with their enemies. Others are more suited for fighting from a distance or for healing and shielding their fellow teammates. Like many real-time strategy games, matches begin with the two teams on opposite sides of a map where their home base is located. Bases are connected across the diagonal of the game board by three “lanes.” These lanes are initially the only part of the board with clear visibility. Players use their champions to attempt to destroy the opposing team’s base. In order to reach the opposing team’s base, the players must work together to destroy defensive structures, as well as to kill members of the opposing team and various non-player enemies. Through this process, players gather resources that they can allocate in various ways to strengthen their champions or team.

Successful MOBA play therefore appears to involve many of the same cognitive demands that have been previously identified in action video games. MOBA players must act in cluttered and ever-changing game environments, they must constantly and efficiently switch between more focused attentional states (i.e., focus on just their champion) and more diffuse attentional states (e.g., taking in the entire game map), and they must do so under significant time constraints given the real-time nature of the game. Yet, empirical data explicitly showing such a link between MOBA play and cognitive demand is currently lacking.

Assessing whether MOBA games may have similar speed of processing and cognitive control demands as action games has clear value for the field going forward. Indeed, nearly every theoretical perspective that underlies the use of video games as cognitive training platforms emphasizes the role of various cognitive demands in the training games as the key to a successful intervention. Yet, in the literature to date, genre and cognitive demands remain highly confounded because the game genres that have been used to place sustained load upon the cognitive system have nearly always been action games. Therefore, finding video game types that place similar load upon the cognitive systems as do action video games opens up new options for testing the key causal hypotheses in the domain.

Here, we sought to identify cognitive and behavioral correlates of performance in League of Legends. Given that MOBAs are commonly considered a blend between action games and real-time strategy games, the majority of our a priori expectations were derived from the previous expansive literature on associations between action video game experience and cognitive performance, as well as the considerably smaller body of work on real-time strategy games and cognitive performance. In particular, as discussed above, most theory in the action video game domain has emphasized the load that action games place upon speed of processing and attentional abilities (Dye, Green, & Bavelier, 2009; Green & Bavelier, 2012). This theory is supported by empirical results documenting those particular sub-domains of cognition as being most strongly impacted by action video game play (Bediou et al., 2018). Thus, many of the tasks utilized here assess these particular cognitive skills (e.g., a simple reaction time task as a measure of speed of processing; the multiple-object tracking (MOT) task as a measure of attentional control). Furthermore, a recent theoretical perspective has argued that improvements in speed of processing and attentional control should, in turn, promote the ability to learn, especially when it comes to tasks that require integration of information through time and the discovery of statistical structure (i.e., should promote "learning to learn"; Bavelier, Green, Pouget, & Schrater, 2012). Given this theoretical perspective, we hypothesized that high League of Legends performers should also show an edge at a visual statistical learning (VSL) task (i.e., where one must learn to detect certain statistical regularities) and in a reinforcement learning task (i.e., where one must quickly learn reward statistics in order to strike the right balance between exploration and exploitation). Finally, the last task in our cognitive battery was chosen based upon a recent empirical paper on League of Legends players specifically, which found that League of Legends performance was associated with fluid intelligence (Kokkinakis, Cowling, Drachen, & Wade, 2017). We thus employed a deductive reasoning task that, while not a true fluid intelligence task, correlates with fluid intelligence and was short enough to fit in our extensive online battery. We note that in addition to these cognitive measures, we also took a variety of measures of personality traits, internal motivations, and mental health. Given the emphasis of this thematic issue on demand, we chose to focus the main article on the relations between League of Legends performance and cognitive abilities (the personality, motivations, and mental health measures were taken based upon previous research in, for instance, more social or clinical literatures). However, these other measures are described and reported in full in the Appendix (see also Table 1 for full list of measures).

2. Methods

2.1. Participants

Participants were recruited directly by the developer and publisher of League of Legends, Riot Games. Potential participants received a message that explained the study and directed interested participants to an online portal where the studies were run. A total of 1216 individuals initially enrolled in the study. From this initial pool of participants, 549 completed all three sessions of the study, although not every participant completed each task satisfactorily (see next sections for session details). Of these participants, 512 identified as male and 31 of these participants identified as female (the remainder preferred not to respond). Participants ranged in age from 18 to 56 years old, with a mean age of 23.6 years. Players were compensated for their participation with Riot Points, which is the in-game currency of League of Legends (i.e., Riot Points can be used to buy new champions, other in-game boosts, etc.).

2.2. Measure of League of Legends Performance

League of Legends players are rated according to their performance in a similar manner to an Elo rating system, which quantifies the probability that one player will beat another player. Because this rating is utilized in-game to automatically assign players to teams in such a way that the two teams have players of roughly equivalent skill, this rating is referred to as the "matchmaking rating" (MMR). After losing, especially to lower rated players, players may drop in their MMR; conversely, winning matches, especially against higher rated players, may result in an increase in MMR. There were 33 participants with missing MMR data, resulting in a total of 516 participants in our main analyses.

2.3. Overview of Tasks and Questionnaires

Participants completed three online sessions (see Table 1). These sessions involved answering question-

Table 1. The tasks and surveys completed by session.

Session 1	**Session 2**	**Session 3**
General demographics survey (age, gender, education, language, Socioeconomic Status (SES)	MOT task	Arrow task
State-trait anxiety index	Backwards digit span	VSL
Beck depression inventory	Odd-one-out task	Continuous performance test (CPT)
Big 5 personality inventory	Reinforcement learning task	Creative foraging task
Revised competitiveness index	Behavioral Inhibition System (BIS)/ Behavioral Activation System (BAS)	Video game addiction survey
	Adult ADHD scale	
	Need for cognition scale	

naires that evaluated aspects of personality and/or quantified certain lifestyle habits, and completing tasks designed to assess different cognitive capacities. The three sessions took on average approximately two hours in total to complete. Participants logged into the online portal via a unique login that was linked to their Riot ID (so that they could be compensated). All data collection was performed via this portal. The tasks/questionnaires were divided into separate sessions mainly to provide natural stop points if participants could not devote a full two hours at once to the tasks or otherwise needed a break (i.e., if they wanted to stop after one session and return to start the following session at a later time).

2.4. Measures of Cognitive Control

2.4.1. Multiple-Object Tracking Task

The MOT task is commonly utilized to measure attentional control (Yung, Cardoso-Leite, Dale, Bavelier, & Green, 2015). On each trial, 16 moving circles—some blue (targets) and some yellow (distractors)—appeared within a circular aperture. After two seconds, the previously blue circles switched to yellow making them visually indistinguishable from the distractors. Participants were told they needed to keep track of the previously blue circles. After four seconds, the circles froze in place and one circle was cued by turning white. The participant was then asked to indicate whether this circle was one of the initially blue target circles. The number of target circles varied between one and six and were presented in an intermixed fashion. The one target and six target conditions were each presented five times, while the two-through-five target conditions were presented ten times each, for a total of 50 trials per participant. To assess performance, we first removed reaction time outliers (reaction times less than 100ms or greater than 10000ms). We then calculated an inverse efficiency metric, defined as the mean reaction time (in seconds) of correct responses divided by the proportion of correct responses.

2.4.2. Continuous Performance Test Task

A CPT task (Rosenberg, Noonan, DeGutis, & Esterman, 2013) was employed as a measure of the ability to control/sustain attention through time. Participants were presented with a series of grayscale images of city and mountain scenes at the center of the screen. The images gradually transitioned from one to the next over the course of 800ms via linear pixel-by-pixel interpolation. Participants were instructed to press the space bar for each image of a city, and withhold any button presses for images of a mountain. 90% of all stimuli were of cities. To measure performance, we computed the sensitivity (d') score for each participant, calculated as z(hit rate) − z(false alarm rate). Note that to account for several participants being at perfect performance, we calculated the hit rate as (number correct + 0.5)/(total trials + 1). We excluded any participants with a negative d-prime, resulting in a total of 499 included participants.

2.4.3. Backwards Digit Span Task (Backwards Span)

The backwards digit span task was developed by Cambridge Brain Sciences (www.cambridgebrainsciences.com) to measure working memory. On each trial, participants were presented with a sequence of digits, shown one at a time (1000ms presentation followed by 500ms blank). After the last digit, they were asked to report the sequence they saw in reverse order by typing the digits on their keyboard. Feedback was given after each trial. The task was adaptive such that after a correct response, the span (number of digits) increased by one, while after an incorrect response, the span was decreased by one. Participants started the task with a span of four digits. Participants continued with the task until they produced three incorrect responses. Performance was measured as the mean number of digits across all correctly remembered sequences. We excluded participants with a score of zero span, resulting in 476 included participants.

2.5. Speed of Processing Measure: Arrow Task

The arrow task (Dale & Green, 2017a) was designed to assess simple speed of processing without the need to learn arbitrary button mappings. At the beginning of each trial, a tone was played for 1.75 seconds. This was followed by a variable delay period, ranging from one to two seconds (mean was 1.5 seconds). At the end of the delay period, an arrow was displayed, pointing either leftwards or rightwards. Participants were asked to press the arrow key on the keyboard corresponding to the arrow direction as quickly and accurately as possible. Participants were given six practice trials, and 60 test trials. We measured performance with an inverse efficiency metric calculated as the mean reaction time (in seconds) of correct responses divided by the proportion of correct responses, excluding reaction time outliers (reaction times less than 100ms or greater than 2000ms). A total of 516 participants completed this task.

2.6. Deductive Reasoning Measure: Odd-One-Out Task

The odd-one-out task, developed by Cambridge Brain Sciences (www.cambridgebrainsciences.com), was used to assess deductive reasoning. Importantly, performance on this task is also quite correlated with fluid intelligence. On each trial, participants were presented with nine sets of shapes, with each set varying in properties such as color, shape, and number of items. Participants were tasked with finding the set that was the most different from the others. They had three minutes to complete as many trials as they could. Early in the task, the odd one out was obvious (e.g., differed from the others in one parameter). As the task increased in difficulty, participants were tasked with taking several properties into account at the same time. Feedback was given after each trial. The final dependent measure was calculated as the number of correct responses made, minus the number of incorrect responses. We excluded participants with a score of less than −20, resulting in 508 included participants.

2.7. Learning Measures

2.7.1. Visual Statistical Learning

The VSL task (Siegelman, Bogaerts, Christiansen, & Frost, 2017) probes the ability to learn spatio-temporal patterns (often implicitly). Participants began the experiment with a 10-minute familiarization phase during which they viewed a collection of 24 abstract shapes in a continuous stream (shapes appeared for 800ms, with a 200ms break in between). Within the stream, and unbeknownst to the participants, the shapes were organized into triplets, each of which were presented 24 times. After familiarization, participants completed a testing phase. The testing phase began with a 34-trial block to measure pattern recognition. Participants were asked to select the patterns with which they were most familiar. After the recognition block, participants were asked to complete an eight-trial pattern completion block. Here they were shown a triplet with one item missing and were asked to select the shape that best-completed the pattern from the available options. The final dependent measure was the total number of correct responses across trials.

2.7.2. Reinforcement Learning Task

The reinforcement learning task we employed (Dale, Sampers, Loo, & Green, 2018) required participants to quickly learn reward statistics in order to strike the right relative balance between exploring (i.e., searching out new information) and exploiting (i.e., taking advantage of already obtained information). Participants were presented with a 10×5 grid of rectangular boxes on a grey background. At the trial start, each of the 50 boxes contained three question marks ("???"). When the participant clicked on a box, the question marks were replaced by a point value, which remained in place for the entirety of a trial, and that point value was added to the participant's score. Point values were generated by first simulating a normal distribution, then exponentiating the simulated values to produce a log-normal distribution. Those values were put into 75% of the boxes, with the remaining 25% of the boxes set to zero value. Participants were told that on each trial they had 50 total "clicks" and they were asked to accrue as many points as they could. The task thus required the participants to decide at each moment whether they wanted to click on a box with an unknown value (i.e., to explore) or to click on the uncovered box with the highest value (i.e., to exploit). Participants were given three total trials. The exploration score was the number of unique boxes clicked across all three trials. A total of 516 participants completed this task.

3. Results

3.1. Data Pre-Processing

Shapiro-Wilk tests indicated that the cognitive measures were not normally distributed, but were instead positively or negatively skewed. Given that our analytic approach assumed normally distributed data, we first estimated and applied one-parameter box-cox transformations to each linear model (Box & Cox, 1964). In brief, the box-cox transformation is defined as:

$$T(y) = \frac{y^{\lambda} - 1}{\lambda}$$

The procedure thus finds the value of lambda that maximizes the normality of the resulting data. Given that some measures included negative values, the box-cox with negatives transformation described in Hawkins and Weisberg (2017) was used, in order to adjust y to be strictly positive. The lambda values utilized are listed in Table A1. We will note that alternative methods of transforming data so as to produce more normal distributions (including Tukey's Ladder of Powers) provide qualitatively similar results. The same was true when employing non-parametric quantile, ranked regression and a general linear model approach using a gamma link relating MMR to cognitive skills while controlling for age (see Table A3), which likewise gave similar results to our parametric tests. All transformations were used with the *car* package in R.

3.2. Testing Predicted Relations with Cognitive Abilities

We chose to perform separate linear regressions for each dependent measure (rather than, for instance, utilizing a larger multivariate model) for a number of reasons. First, previous research predicted significant positive relations between League of Legends ability and each of the cognitive tasks that were employed. Thus, separate analyses were most appropriate for testing those specific predictions (e.g., a multivariate model tests something other than those specific predictions). Second, not only is there no a priori reason to combine across these tasks, for most of the tasks, there is in fact reason to believe that they do not tap exactly the same cognitive construct (i.e., there are many sub-processes falling under the broad label of "cognitive abilities," but they are not necessarily all theoretically linked to one another). For interested readers however, we report correlations across measures in the Appendix (Figure A1). We note that for each of the reported analyses below, the model included controlling for age (as age was significantly and strongly negatively correlated with MMR in our sample, see Table A2, in the Appendix). Given the paucity of females though (making up only around 5% of the sample), it was not possible to control for gender. Analysis of only male participants resulted in qualitatively similar results. We also performed an alternative analysis using general linear models, with comparable results (Appendix, Table A3).

All of our a priori predictions were born out in the data, with small to medium effect sizes and with some variations across cognitive constructs (Table 2). In particular, the strongest relations were seen between League of Legends performance and the arrow task, MOT task, and the reinforcement learning task (with effect sizes roughly in line with those observed previously in a meta-analysis of action video games; Bediou et al., 2018). Intermediate effects were observed for the CPT task, the backwards span task, and the odd-one-out task. The VSL task effect was the weakest, just reaching statistical significance. Importantly, for the reinforcement learning task, although our primary measure was exploratory choices, MMR was also positively associated with greater overall reward gained (i.e., fewer exploratory choices meant a tendency to learn the reward structure quickly and shut off exploration so as to maximize points gained).

4. Conclusions

As expected, greater levels of performance in League of Legends was associated with enhancements in both speed of processing and cognitive control abilities. Indeed, the two strongest relations with League of Legends skill were with the arrow task and the MOT task. Differences in speed of processing and in attentional control are amongst the more consistently reported observations in the action game literature. For instance, in terms of speed of processing, one review found that action gamers respond on average approximately 10% faster than non- gamers across a wide range of tasks (Dye et al., 2009). And in terms of attentional control, these abilities were associated with the largest effect sizes in a recent meta-analysis (Bediou et al., 2018). Therefore, while simple visual inspection of League of Legends gameplay might have suggested that substantial cognitive demands are involved, these empirical results strengthen the case that similar demands are placed on at least some cognitive sub-systems as do more traditionally identified action video games.

Outside of the speed of processing and attentional control domains, several other expected relations were

Table 2. Regression values between League of Legends MMR and cognitive abilities.

Category	Measure	F-value (df1, df2)	p-value (two-tailed)	Partial R^2
Cognitive control	MOT	14.03 (1,513)	< .001	.027
	CPT	6.22 (1,496)	.013	.012
	Backwards digit span	6.56 (1,473)	.011	.014
Speed of processing	Arrow task	26.63 (1,513)	< .001	.049
Deductive reasoning	Odd-one-out	7.21 (1,505)	.007	.014
Learning	VSL task	3.70 (1,513)	.055	.007
	Reinforcement learning task	19.38 (1,513)	< .001	.036

Notes: All analyses controlled for age, thus the F-value, associated p-value, and Partial R^2 are for the given measure after controlling for age, not for the full model; the direction of the effects has also been standardized for all tasks except the reinforcement learning task such that positive relations mean that higher levels of MMR go with better cognitive task performance (i.e., faster and/or more accurate); for the reinforcement learning task the negative relation indicates that higher levels of MMR go with lower levels of exploratory choices—as noted in the main text however, this resulted in overall more points earned in the task.

observed. First, consistent with previous work showing a relation between League of Legends performance and fluid intelligence (Kokkinakis et al., 2017), we observed a similar relation between League of Legends performance and deductive reasoning, although it was the weakest of the cognitive effects. Our data also supported the recent proposal that one knock-on effect of the improvements in speed of processing and attentional control seen in action video game play should be in the ability to learn to perform new tasks. Indeed, higher levels of League of Legends performance was associated with both better VSL and better performance on a reinforcement learning task, with the latter being numerically stronger than the former (Bavelier, Bediou, & Green, 2018; Bavelier et al., 2012).

Going forward, there are a number of potential follow-up purposes that can be explored. For instance, in certain areas of psychology, a great deal of effort has been spent in identifying relations between basic cognitive, perceptual, and motor abilities and the probability that an individual will reach satisfactory levels of performance in certain occupations, such as military pilots or unmanned drone operators (Lintern & Kennedy, 1984; McKinley, McIntire, & Funke, 2011). Because training individuals in many complex occupations can be time-consuming and costly, it often makes sense to pre-select for training only those individuals whose basic ability set suggests that they have a high likelihood of eventual success. Because MOBAs, and League of Legends in particular, are currently one of the most popular e-sport genres/games (Campbell, Toth, Moran, Kowal, & Exton, 2018), a greater understanding of the cognitive underpinnings of performance could potentially be utilized in similar ways as, for example, 40-yard dash times in athletics recruitment.

A second related follow-up would be to examine the potential for interventions meant to improve performance on the cognitive abilities identified here to in turn improve performance in League of Legends. Such an approach, for instance, underpins much of the literature on cognitive training meant to enhance performance in educational settings (Titz & Karbach, 2014). Correlational studies have repeatedly identified a number of core cognitive abilities as being associated with academic success as, for example, fluid intelligence, working memory, executive functions, etc. (Alloway & Alloway, 2010). The goal of many interventions in this domain is therefore to enhance those cognitive functions with the expectation that this will, in turn, enhance academic performance (i.e., testing the causal link). Similar future work could thus examine, for example, whether dedicated speed of processing training serves to enhance performance on MOBA games.

A third possibility for follow-up work is to examine the potential for League of Legends training itself to enhance the associated cognitive functions. This is, in essence, the inverse of the goal above. Indeed, the purely correlational methodology employed in the current work does not allow the directionality of the various associations to be inferred (or even whether the associations are causal in nature). Most contemporary theories on how one might enhance core cognitive abilities suggest the need to put consistent load upon those constructs (Singley & Anderson, 1989). While simple tasks may place load upon the constructs initially (and thus can be good measurement tools), long-term practice with such tasks can quickly result in automaticity, which necessarily entails a reduction in the associated cognitive load. For this reason, it has been argued that complex tasks may be better for training purposes than simpler tasks (Anguera & Gazzaley, 2015; Bavelier et al., 2018; Moreau & Conway, 2014); video games such as League of Legends would certainly qualify as complex.

We note that while the sample size in the current work is large, given the novelty of the approach, caution is warranted with regard to overinterpreting the results. While there were strong a priori predictions for many of the associations, even larger confirmatory work is likely warranted before moving on to other follow-up work based upon these results. Furthermore, single cognitive measures are, in practice, essentially never process pure (Engle, Tuholski, Laughlin, & Conway, 1999). In other words, even tasks that have been simplified as much as possible so as to load primarily one particular cognitive function, rarely do so perfectly. Thus, future work should expand the battery in such a way that would allow latent variable-type analyses to be conducted so as to better understand the relation between League of Legends performance and cognitive constructs, rather than the relation between League of Legends performance and individual cognitive tasks. Finally, there is strong interest, not just in terms of the predictors of asymptotic levels of performance in complex skills, but in predictors of the rate at which complex skills are learned. Thus, future work could also examine predictors of the full progression from novice player to asymptotic performance.

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Conflict of Interests

The authors declare no conflict of interests.

References

Alloway, T. P., & Alloway, R. G. (2010). Investigating the predictive roles of working memory and IQ in academic attainment. *Journal of Experimental Child Psychology*, *80*(2), 606–621.

Anguera, J. A., & Gazzaley, A. (2015). Video games, cognitive exercises, and the enhancement of cognitive abilities. *Current Opinion in Behavioral Sciences*, *4*, 160–165.

Appelbaum, L. G., Cain, M. S., Darling, E. F., & Mitroff, S. R. (2013). Action video game playing is associated with improved visual sensitivity, but not alterations in visual sensory memory. *Atten Percept Psychophys*, *75*(6), 1161–1167. https://doi.org/10.3758/s13414-013-0472-7

Basak, C., Boot, W. R., Voss, M. W., & Kramer, A. F. (2008). Can training in a real-time strategy video game attenuate cognitive decline in older adults. *Psychology and Aging*, *23*(4), 765–777.

Bavelier, D., Bediou, B., & Green, C. S. (2018). Expertise and generalization: Lessons from action video games. *Current Opinion in Behavioral Sciences*, *20*, 169–173. https://doi.org/10.1016/j.cobeha.2018.01.012

Bavelier, D., Green, C. S., Pouget, A., & Schrater, P. (2012). Brain plasticity through the life span: Learning to learn and action video games. *Annual Review of Neuroscience*, *35*, 391–416.

Bediou, B., Adams, D. M., Mayer, R. E., Tipton, E., Green, C. S., & Bavelier, D. (2018). Meta-analysis of action video game impact on perceptual, attentional, and cognitive skills. *Psychological Bulletin*, *144*(1), 77–110. https://doi.org/10.1037/bul0000130

Bowman, N. D. (Ed.). (2018). *Video games: A medium that demands our attention*. New York, NY: Routledge.

Box, G. E. P., & Cox, D. R. (1964). An analysis of transformations. *Journal of the Royal Statistical Society*: *Series B*, *26*(2), 211–252.

Brown, R. M., Zatorre, R. J., & Penhune, V. B. (2015). Expert music performance: Cognitive, neural, and developmental bases. *Progress in Brain Research*, *217*, 57–86.

Campbell, M. J., Toth, A. J., Moran, A. P., Kowal, M., & Exton, C. (2018). Chapter 10–eSports: A new window on neurocognitive expertise? *Progress in Brain Research*, *240*, 161–174.

Cardoso-Leite, P., Joessel, A., & Bavelier, D. (in press). Games for enhancing cognitive abilities. In J. Plass, R. E. Mayer, & B. Homer (Eds.), *Handbook of game-based learning*. Boston: MIT Press.

Colzato, L. S., van Leeuwen, P. J. A., van den Wildenberg, W. P. M., & Hommel, B. (2010). DOOM’d to Switch: Superior cognitive flexibility in players of first person shooter games. *Frontiers in Psychology*, *1*. https://doi.org/10.3389/fpsyg.2010.00008

Dale, G., & Green, C. S. (2017a). Associations between avid action and real-time strategy game play and cognitive performance: A pilot study. *Journal of Cognitive Enhancement*, *3*(1), 295–317.

Dale, G., & Green, C. S. (2017b). The changing face of video games and video gamers: Future directions in the scientific study of video game play and cognitive performance. *Journal of Cognitive Enhancement*, *1*(3), 280–294.

Dale, G., Kattner, F., Bavelier, D., & Green, C. S. (2019). Cognitive abilities of action-videogame and role-playing videogame players: Data from a massive open online course. *Psychology of Popular Media Culture*. Advance online publication. http://dx.doi.org/10.1037/ppm0000237

Dale, G., Sampers, D., Loo, S., & Green, C. S. (2018). Individual differences in exploration and persistence: Grit and beliefs about ability and reward. *PloS One*, *13*(9), e0203131. https://doi.org/10.1371/journal.pone.0203131

Dye, M. W. G., Green, C. S., & Bavelier, D. (2009). Increasing speed of processing with action video games. *Current Directions in Psychological Science*, *18*(6), 321–326.

Engle, R. W., Tuholski, S. W., Laughlin, J. E., & Conway, A. R. (1999). Working memory, short-term memory, and general fluid intelligence: a latent-variable approach. *Journal of Experimental Psychology: General*, *128*(3), 309–331.

Feng, J., Spence, I., & Pratt, J. (2007). Playing an action video game reduces gender differences in spatial cognition. *Psychological Science*, *18*(10), 850–855.

Gagnon, D. (1985). Videogame and spatial skills: An explatory study. *Educational Communication and Technology Journal*, *33*(4), 263–275.

Glass, B. D., Maddox, W. T., & Love, B. C. (2013). Real-time strategy game training: Emergence of a cognitive flexibility trait. *PLoS One*, *8*(8), e70350. https://doi.org/10.1371/journal.pone.0070350

Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature*, *423*(6939), 534–537.

Green, C. S., & Bavelier, D. (2012). Learning, attentional control and action video games. *Current Biology*, *22*(6), R197–R206. https://doi.org/10.1016/j.cub.2012.02.012

Griffith, J. L., Voloschin, P., Gibb, G. D., & Bailey, J. R. (1983). Differences in eye-hand motor coordination of video-game users and non-users. *Perceptual and Motor Skills*, *57*(1), 155–158.

Hawkins, D., & Weisberg, S. (2017) Combining the box-cox power and generalized log transformations to accomodate nonpositive responses in linear and mixed-effects linear models. *South African Statistical Journal*, *51*(2), 317–328.

Kim, Y.-H., Kang, D.-W., Kim, D., Kim, H.-J., Sasaki, Y., & Watanabe, T. (2015). Real-time strategy video game experience and visual perceptual learning. *Journal of Neuroscience*, *35*(29), 10485–10492. https://doi.org/10.1523/JNEUROSCI.3340-14.2015

Kokkinakis, A. V., Cowling, P. I., Drachen, A., & Wade, A. R. (2017). Exploring the relationship between video game expertise and fluid intelligence. *PloS One*, *12*(11), e0186621. https://doi.org/10.1371/journal.pone.0186621

Lintern, G., & Kennedy, R. S. (1984). Video game as a covariate for carrier landing research. *Perceptual and Motor Skills*, *58*(1), 167–172.

McKinley, R. A., McIntire, L. K., & Funke, M. A. (2011). Operator selection for unmanned aerial systems: comparing video game players and pilots. *Aviation, Space, and Environmental Medicine*, *82*(6), 635–642.

Moreau, D., & Conway, A. R. (2014). The case for an ecological approach to cognitive training. *Trends in Cognitive Sciences, 18*(7), 334–336. https://doi.org/10.1016/j.tics.2014.03.009

Rosenberg, M., Noonan, S., DeGutis, J., & Esterman, M. (2013). Sustaining visual attention in the face of distraction: a novel gradual-onset continuous performance task. *Attention, Perception, & Psychophysics*, *75*(3), 426–439. https://doi.org/10.3758/s13414-012-0413-x

Siegelman, N., Bogaerts, L., Christiansen, M. H., & Frost, R. (2017). Towards a theory of individual differences in statistical learning. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *372*(1711). https://doi.org/10.1098/rstb.2016.0059

Singley, M. K., & Anderson, J. R. (1989). *The transfer of cognitive skill*. Cambridge, MA: Harvard University Press.

Spence, I., & Feng, J. (2010). Video games and spatial cognition. *Review of General Psychology*, *14*(2), 92–104.

Strobach, T., Frensch, P. A., & Schubert, T. (2012). Video game practice optimizes executive control skills in dual-task and task switching situations. *Acta Psychologica*, *140*(1), 13–24.

Titz, C., & Karbach, J. (2014). Working memory and executive functions: Effects of training on academic achievement. *Psychological Research*, *78*(6), 852–868.

Voss, M. W., Kramer, A. F., Basak, C., Prakash, R. S., & Roberts, B. (2010). Are expert athletes 'expert' in the cognitive laboratory? A meta-analytic review of cognition and sport expertise. *Applied Cognitive Psychology*, *24*(6), 812–826.

Yung, A., Cardoso-Leite, P., Dale, G., Bavelier, D., & Green, C. S. (2015). Methods to test visual attention online. *JoVE (Journal of Visualized Experiments)*, *96*, e52470. https://doi.org/10.3791/52470

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Appendix

1. Methods for General Linear Model

We first entered MMR and AGE variables, and then used generalized linear models (with the canonical link function corresponding to a gamma distribution) where main effects of MMR and AGE predict the variety of cognitive skills.

Table A1. Box-cox transformations utilized to make data normally distributed.

Task	Lambda
Arrow Task	−2.17
Continuous Performance Test	1.77
Reinforcement	0.31
Multiple Object Tracking	−0.32
Backwards Span	−2.28
Odd-One-Out	1.56
Visual Statistical Learning	0.69

Table A2. Regression values between League of Legends MMR and age.

Measure	F-value (df1, df2)	p-value (two-tailed)	R^2
Age	79.93 (1,514)	< .001	.135

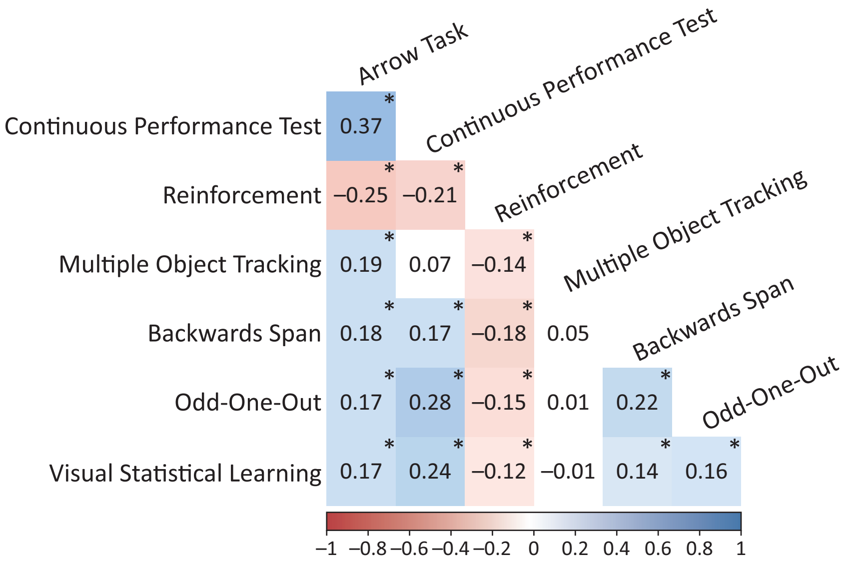


Figure 1. Values from general linear model between League of Legends MMR and cognitive abilities.

Table A3. Regression values between League of Legends MMR and age.

Category	Measure	t-value	p-value (two-tailed)	Effect Size r
Cognitive Control	Multiple-Object Tracking	3.83	< .001	.175
	Continuous Performance Test	−2.17	.031	−.098
	Backwards digit span	−2.16	.031	−.067
Speed of Processing	Arrow Task	4.86	< .001	.205
Deductive Reasoning	Odd-One-Out	−2.51	.012	−.108
Learning	Visual Statistical Learning Task	−1.96	.050	−.090
	Reinforcement Learning Task	4.56	< .001	.206

2. Additional Measures Taken

2.1. Methods for Additional Questionnaires Taken in Battery

2.1.1. Big 5 Personality Inventory

We utilized a ten-item questionnaire to assess the Big-5 personality dimensions (two items for each of the five dimensions: openness to experience, conscientiousness, extraversion, agreeableness, neuroticism; one item for the "low" end of the dimension, one item for the "high" end of the dimension; Rammstedt & John, 2007). Each question asked the participant to indicate how well a particular statement described them on a five-point Likert scale. The final dependent measures were calculated by adding the value of the response in the "high" question for a given factor to six minus the value of the response in the "low" question for that factor. Due to incomplete responses, 515 participants were part of the analysis.

2.1.2. Revised Competitiveness Index (Competitiveness)

The revised competitiveness index (Houston, Harris, McIntire, & Francis, 2002) probes the extent to which participants enjoy competition and/or show contentious competitive behavior (e.g., "I often try to outperform others"). Fourteen questions were answered on a five-point scale. The final dependent measure was the sum of the responses.

2.1.3. Behavioral Inhibition/Activation Scales (BIS–BAS)

The BIS/BAS scale (Carver & White, 1994) is used to assess what are commonly treated as two distinct motivational systems: Behavioral inhibition (tendency to avoid negative situations/punishment), and behavioral activation (motivation to achieve goals/receive positive outcomes). The questionnaire consists of 24 items to measure four sub-scales: One BIS subscale and three BAS sub-scales (drive; fun seeking; reward responsiveness). The final measures consisted of one measure for BIS and one for BAS created by summing over the respective sub-scales. 568 participants were counted, after excluding for missing MMR values.

2.1.4. Need for Cognition Scale

The Need for Cognition (short form; 18-item) scale (Cacioppo, Petty, & Kao, 1984) was utilized to assess the extent to which individuals seek out and enjoy difficult cognitive experiences (e.g., "I prefer complex to simple problems"). The final dependent measure was the sum of responses.

2.1.5. Creative Foraging Task

Our measure of creativity was a "creative foraging" task (Hart et al., 2017). Players were initially presented with ten green identical squares arranged in a horizontal line. They were then asked to create shapes by moving the squares to create other fully connected shape (squares are connected through a shared edge). Each movement of a square was considered a "step." They were told that their goal was to "explore the space of shifting shapes and discover those that you consider interesting and beautiful." At each step, they were allowed to save their current shape to a gallery by clicking a gray square at the top-right corner of the screen. After 15 minutes, participants were asked to choose the five most creative shapes from their gallery. This task produces a number of measures. For the current work we created an aggregate of the participant's exploration (measured as creating visually dissimilar shapes and spending more time between steps) and exploitation (creating visually similar shapes and spending less time between steps). Fewer participants completed this task, resulting in a total of 316 participants in our dataset.

2.1.6. State-Trait Anxiety Scale (Anxiety)

The questionnaire, adapted from the State-Trait Anxiety Inventory, Trait Version (Form Y; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) consisted of 20 questions answered on a four-point Likert scale that each addressed characteristics of anxiety (e.g., "I am nervous and restless"). The final dependent measure was the sum of responses.

2.1.7. Beck Depression Inventory II (Depression)

An 18-question version of the Beck Depression Inventory was utilized (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Each question asked participants which of four possible answers best described their current state at that moment. Rather than giving a value answer, the inventory provides four responses that range in severity (e.g. "I don't feel disappointed in myself"; "I am disappointed in myself"; "I am disgusted with myself"; "I hate myself"). The final dependent measure was the sum of the responses. Due to incomplete responses, 515 participants were part of the analysis.

2.1.8. Adult ADHD Self-Report Scale (ADHD)

We utilized Version 1.1 of the World Health Organization's Adult ADHD self-report scale (Spencer, Biederman, & Mick, 2007). Each of the six items in the scale asks participants to rate themselves on a five-point scale in terms of possible symptoms of ADHD (e.g., "How often do you feel overly active and compelled to do things, like you were driven by a motor?"). The final dependent measure was the sum of the responses. Due to incomplete responses, a total of 514 participants were included.

2.1.9. Video Game Addiction (VG Addiction)

The survey that was utilized (Eichenbaum, Kattner, Bradford, Gentile, & Green, 2015) included 13 questions modeled after the DSM-V criteria for pathological gambling, but applied to video game play (e.g. "In the past year, have you ever felt you could not stop playing video games?"). Participants could respond with "Yes" (coded as 1), "Sometimes" (coded as 0.5), "No" or "Don't Know" (both coded as 0). The final dependent measure was the sum of the responses.

2.2. Results for Additional Questionnaires Taken in Battery

Analyses between League of Legends MMR and various behavioral measures were conducted in a manner commensurate with those in the main manuscript; yet it is important to acknowledge these were exploratory (Table A2). Three of the relations were statistically significant without controlling for multiple comparisons (BIS, BAS, and extraversion). However, only BIS (higher levels of League of Legends performance going with greater behavioral inhibition) and extraversion (higher levels of League of Legends performance going with lesser extraversion) were significant after controlling for multiple comparisons (N = 14; critical p = .0036). We note that the strength of the various nulls is supported by the fact that other a priori expected trends, not relevant to the question of League of Legends performance, were observed in the data. For instance, certain personality traits are known to change with age (Roberts, Walton, & Viechtbauer, 2006) and these trends were consistently seen in our data (e.g., conscientiousness significantly increased with age; neuroticism, openness to experience and anxiety significantly decreased with age).

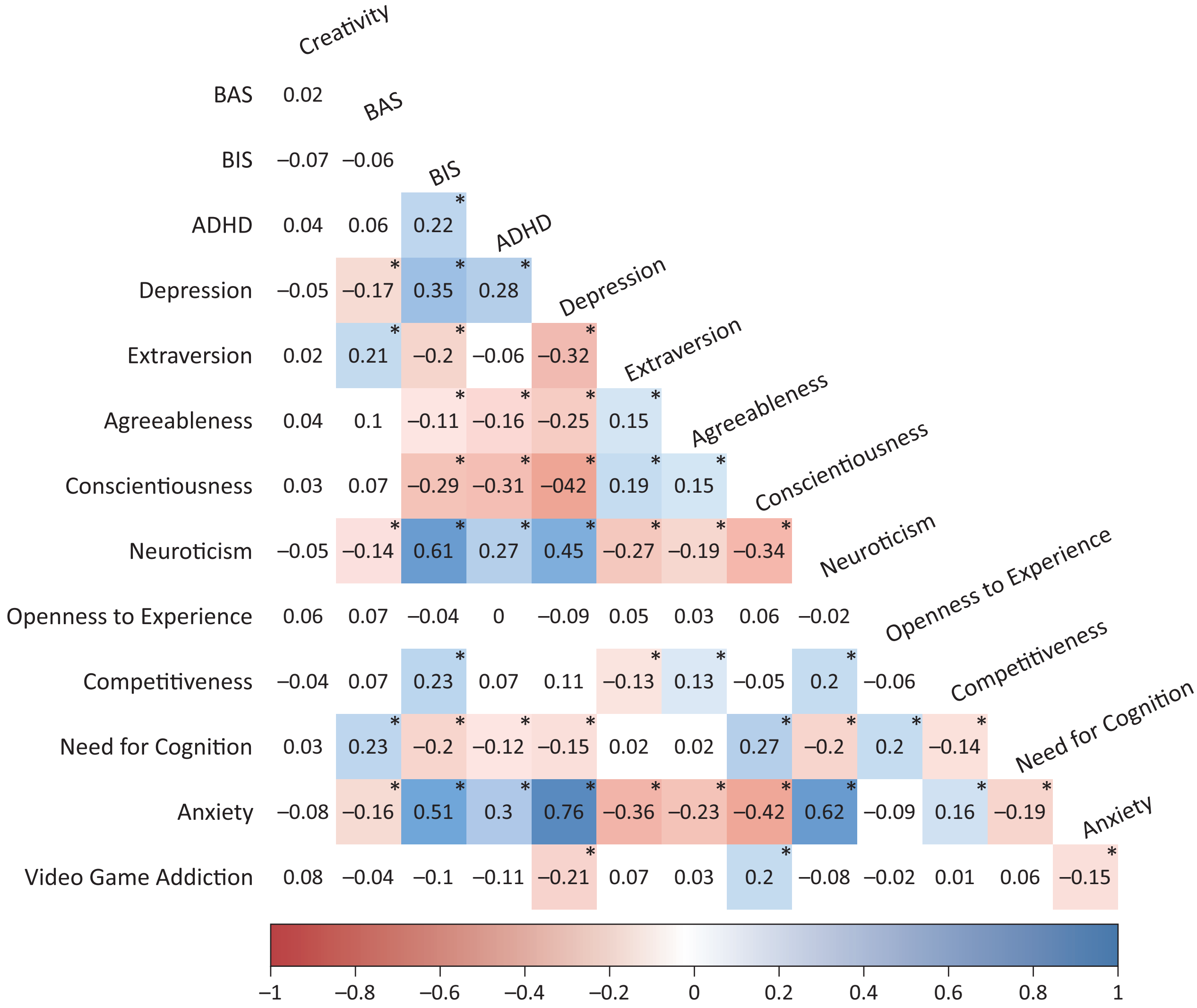
Table A4. Box-cox transformations utilized to make data normally distributed.

Task	Lambda
Extraversion	0.66
Conscientiousness	0.69
Agreeableness	1.48
Neuroticism	0.59
Open to Experience	1.16
Competitiveness	1.70
BIS	1.30
BAS	1.59
Need for Cognition	1.16
Creativity	−0.46
Anxiety	0.33
Depression	−1.05
ADHD	1.02
Video Game Addiction	0.06

Table A5. Regression values between League of Legends MMR and behavioral factors.

Category	Measure	F-value (df1,df2)	p-value (two-tailed)	Partial R^2
Personality	Extraversion	10.36 (1,512)	*.001	.020
	Conscientiousness	.98 (1,512)	.323	.002
	Agreeableness	.63 (1,512)	.428	.001
	Neuroticism	.75 (1,512)	.388	.001
	Openness to Experience	3.37 (1,512)	.067	.007
	Competitiveness	2.60 (1,513)	.108	.005
	BIS	10.52 (1,513)	*.001	.020
	BAS	6.38 (1,513)	.012	.012
	Need for Cognition	.060 (1,513)	.809	< .001
	Creativity	1.23 (1,276)	.267	.004
Mental/Clinical Health	Anxiety	.01 (1,513)	.907	< .001
	Depression	.61 (1,512)	.436	.001
	ADHD	.80 (1,510)	.327	.002
	Video Game Addiction	.40 (1,513)	.529	.001

Notes: All analyses controlled for age, thus the F-value, associated p-value, and partial R^2 are for the given measure after controlling for age. * denotes significant after controlling for multiple comparisons.



	Creativity	BAS	BIS	ADHD	Depression	Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness to Experience	Competitiveness	Need for Cognition	Anxiety
BAS	0.02												
BIS	−0.07	−0.06											
ADHD	0.04	0.06	0.22*										
Depression	−0.05	−0.17*	0.35*	0.28*									
Extraversion	0.02	0.21*	−0.2*	−0.06	−0.32*								
Agreeableness	0.04	0.1	−0.11*	−0.16*	−0.25*	0.15*							
Conscientiousness	0.03	0.07	−0.29*	−0.31*	−042*	0.19*	0.15*						
Neuroticism	−0.05	−0.14*	0.61*	0.27*	0.45*	−0.27*	−0.19*	−0.34*					
Openness to Experience	0.06	0.07	−0.04	0	−0.09	0.05	0.03	0.06	−0.02				
Competitiveness	−0.04	0.07	0.23*	0.07	0.11	−0.13*	0.13*	−0.05	0.2*	−0.06			
Need for Cognition	0.03	0.23*	−0.2*	−0.12*	−0.15*	0.02	0.02	0.27*	−0.2*	0.2*	−0.14*		
Anxiety	−0.08	−0.16*	0.51*	0.3*	0.76*	−0.36*	−0.23*	−0.42*	0.62*	−0.09	0.16*	−0.19*	
Video Game Addiction	0.08	−0.04	−0.1	−0.11	−0.21*	0.07	0.03	0.2*	−0.08	−0.02	0.01	0.06	−0.15*

Figure 2. Correlation matrix of behavioral factors. Note: Asterisks indicate $p < 0.01$.

References

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Arch Gen Psychiatry*, *4*(6), 561–571.

Cacioppo, J. T., Petty, R. E., & Kao, C. F. (1984). The efficient assessment of need for cognition. *Journal of Personality Assessment*, *48*(3), 306–307. https://doi.org/10.1207/s15327752jpa4803_13

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment. *Journal of Personality and Social Psychology*, *67*(2), 319–333.

Eichenbaum, A., Kattner, F., Bradford, D., Gentile, D. A., & Green, C. S. (2015). Role-playing and real-time strategy games associated with greater probability of internet gaming disorder. *Cyberpsychology, Behavior, and Social Networking*, *18*(8), 480–485. https://doi.org/10.1089/cyber.2015.0092

Hart, Y., Mayo, A. E., Mayo, R., Rozenkrantz, L., Tendler, A., Alon, U., & Noy, L. (2017). Creative foraging: An experimental paradigm for studying exploration and discovery. *PLoS One*, *12*(8), e0182133. https://doi.org/10.1371/journal.pone.0182133

Houston, J., Harris, P., McIntire, S., & Francis, D. (2002). Revising the competitiveness index using factor analysis. *Psychological Reports*, *90*(1), 31–34. https://doi.org/10.2466/pr0.2002.90.1.31

Rammstedt, B., & John, O. P. (2007). Measuring personality in one minute or less: A 10-item short version of the big five inventory in English and German. *Journal of Research in Personality*, *41*(1), 203–212.

Roberts, B. W., Walton, K. E., & Viechtbauer, W. (2006). Patterns of mean-level change in personality traits across the life course: A meta-analysis of longitudinal studies. *Psychological Bulletin*, *132*(1), 1–25. https://doi.org/10.1037/0033-2909.132.1.1

Spencer, T. J., Biederman, J., & Mick, E. (2007). Attention-deficit/hyperactivity disorder: Diagnosis, lifespan, comorbidities, and neurobiology. *Ambulatory Pediatrics*, *7*(Suppl. 1), 73–81. https://doi.org/10.1016/j.ambp.2006.07.006

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the state-trait anxiety inventory*. Palo Alto, CA: Consulting Psychologists Press.

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Article

(A)morally Demanding Game? An Exploration of Moral Decision-Making in a Purpose-Made Video Game

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Abstract

A purpose-made video game was used to measure response time and moral alignment of in-game moral decisions, which were made by 115 undergraduate students. Overall, moral decisions took between 4–6 seconds and were mostly pro-social. Previous gameplay, in-game, and post-game experiences predicted in-game moral alignment. Real-life moral salience was not related to in-game decision-making. The implications of these results are discussed in the context of the demands of video games and in-game moral decision-making models.

Keywords

decision-making; digital games; moral foundations theory; morality; purpose-made games; video games

Issue

This article is part of the issue "Video Games as Demanding Technologies" edited by Nicholas David Bowman (Texas Tech University, USA).

1. Introduction

One of the distinct features of video games is their interactivity (Bowman, 2018; Tamborini & Bowman, 2010). Recent research has suggested that interactivity is a process, involving the interaction between player and game (Bowman, 2018; Rutledge, 2013; Stromer-Galley, 2004). Moral decisions in video games demonstrate this process of interactivity between player and game; many in-game moral decisions often require players to choose from options which effect in-game outcomes. Furthermore, it has been suggested that this interactivity leads to different requirements, termed as the 'demands' of video games, which are categorized into types of efforts: social, emotional, cognitive, and two types of behavioral; exertion and controls (Bowman, 2016, 2018; Bowman, Wasserman, & Banks, 2018). Hence, the demands of video games connect well to morality and has implications for in-game behavior, as real-life morality can be examined through components such as moral judgment and action (Haidt & Joseph, 2008; Narvaez & Rest, 1995). Moral action could be related to the behavioral demands, especially the control demand (i.e., physically pushing a button to make a decision). Eden, Ewoldsen, Lee, and Beyea (2018) highlighted how physical demands are more than just pressing a button and can be behavioral affordances; which is how the individual perceives and behaves within games (i.e., the action[s] that can be taken, and how options are presented and sequenced). Previous methodological issues in moral decision-making research have been highlighted, for example, the accuracy of self-reported morality due to the gaps between moral judgment and action (American Psychological Association, 2015; Haviv & Leman, 2002). The benefits of exploring in-game decisions are that behavioral demands/affordances can be directly measured (Eden et al., 2018; Hodge et al., 2018).

Much of the previous research has used commercial games which can restrict aspects of the moral decision-making process and create biases, such as reward systems (Hodge et al., 2018). Some previous research attempted to addressed this, with a modified version of a commercial game (Joeckel, Bowman, & Dogruel, 2012, 2013). Modifying commercial games allows for these preexisting games to be altered and adapted for research purposes (Elson & Quandt, 2016; Hartmann, Toz, & Brandon, 2010; Mohseni, Liebold, & Pietschmann, 2015). However, there are still some limitations to modifying commercial games such as restrictions and biases. To further address some of these limitations, purpose-made games and Virtual Environments (VE) can be developed for research (Hartmann et al., 2010; Hodge et al., 2018; Huskey, Craighead, Miller, & Weber, 2018). A purpose-made game is a game created to a specification for research, in this instance a theory driven bespoke game was developed in a game engine to measure and record in-game moral decisions (Hodge et al., 2018). Game engines are well-suited for research as they provide complete control over the environment and the design of the game/VE (Lewis, & Jacobson, 2002). The present study aimed to explore the results of the data collected from the purpose-made game and to understand the in-game moral decision-making process.

Tamborini (2011, 2012) proposed the Model of Intuitive Morality and Exemplars (MIME) to explain the decision-making process with media, including video games. The MIME adopts the six Moral Foundations Theory (MFT) domains of: Care/Harm (C/H); Fairness/Cheating (F/C); Authority/Subversion (A/S); Sanctity/Degradation (S/D); In-group Loyalty/Betrayal (L/B); and Liberty/Oppression (L/O). These MFT domains are composed of virtues, triggers, emotions, and cognition; with moral decisions consisting of both intuitive and rational processes (Haidt, 2012; Haidt & Joseph, 2008). The MIME suggests moral judgment happens through media activating and influencing the moral domains salience (importance and hierarchy). Then intuitive/automatic processing of the media takes place, unless in conflict (e.g., moral violation or competing domains), where reflective and deliberation processes are activated to try and resolve the conflict, but this does not necessarily lead to a change in decision (Tamborini, 2011, 2012). This model draws on the dual-process theories; system 1, quick experiential, and system 2, slower rational (Hartmann, 2011; Kahneman, 2011).

1.1. Rationale

Tamborini, Bowman, et al. (2016, p. 13) highlight that research needs to develop a “dynamic understanding of in-game decisions.” Hence, through synthesizing the research on MFT, MIME, with the demands of video games, creates much value for the research, helping to understand the context and the theories that underpin in-game moral decision-making. Thus, the contribution of this research aims to explore aspects of the in-game decision-making process within a purpose-made game.

Time is used frequently in gameplay, such as requiring the player to respond with speed, as seen in fighting/beat ‘em up games, and as a design feature, such as timers and countdowns (Palmer, 2015; Swink, 2009). Sensory input to muscle response takes around 240 milliseconds (Swink, 2009). Moral intuitive decisions have been suggested to take around 500–1500 milliseconds (e.g., Tamborini, Lewis, et al., 2016), but there has been little research which has explored Response Time (RT) for in-game moral decisions. Furthermore, considering the dual-process theories (e.g., Hartmann, 2011), RT could add valuable insight into the in-game decision-making process. Therefore, questions still remain around the players response times to in-game moral decisions:

> RQ1: How long do in-game moral decisions take?

Moral positioning or alignment can represent in-game behavior—how good, evil, or neutral the players have chosen to be (Triberti, Villani, & Riva, 2015). Much of the previous research has focused on post-game effects including post-game moral behavior (American Psychological Association, 2015; Gollwitzer & Melzer, 2012; Saleem, Anderson, & Barlett, 2015). Ellithorpe, Cruz, Velez, Ewoldsen, and Bogert (2015) highlighted the reciprocal relationship between in-game moral decision-making and post-game behavior, through the process of moral licensing, that is, the rationalisation of allowing immoral behavior due to previous good behavior. The results suggested that if participants perceived the gameplay to be moral this predicted more anti-social behavior post-game (Ellithorpe et al., 2015). Other research has found previous gameplay experiences to be related to in-game behavior/experience such as players becoming morally disengaged in gameplay (Hartmann, Krakowiak, & Tsay-Vogel, 2014; Hartmann & Vorderer, 2010; Lange, 2014). Joeckel et al. (2013) found enjoyment was related to presence for both US and German participants, and gaming experience for US participants. However, it would have been interesting to know if presence and previous gaming experience related to in-game moral decisions. Previous research has also shown some overlap between in-game and real-life morality wherein choices were suggested to mirror real-life morality and a “strong moral presence” was found in video games (Weaver & Lewis, 2012, p. 613). Hence, more research is needed to understand what factors predict in-game moral decision-making:

> RQ2: Which factors of real-life MFT domains, previous gameplay, in-game and post-game experiences, will predict in-game moral alignment?

Real-life moral salience has been suggested to relate to in-game choices, particularly, the C/H domain which has been suggested to be intuitive (Joeckel et al., 2012, 2013; Tamborini, Bowman, et al., 2016). Joeckel et al. (2012, 2013) also suggested that non-salient domains were related to amoral decision-making (without morality which can have connotations of immorality). Consequently, more research is needed to understand the connection between real-life moral salience and in-game moral choices:

> RQ3: How will real-life moral salience relate to in-game moral choice and RT?

2. Method

2.1. Design

A mixed design quasi-experiment was used. The two dependent variables were the moral decisions from each of the 6 in-game MFT scenarios (see Appendix A):

> 1) The choices made (upholding/pro-social or violating/anti-social, for each in-game MFT scenarios). In-game moral alignment was calculated by subtracting violating choice from the upholding choice. A negative score equals more violating choices made and a positive score equals more upholding choices made.
>
> 2) RT was measured in milliseconds for each of the 6 MFT in-game decisions.

The predictor variables were divided into three groups real-life morality, previous gameplay, in-game and post-game questions (Appendix B).

2.2. Participants

115 undergraduate students took part and were recruited through opportunity and volunteer sampling (*M age* = 19.96; *SD* = 2.84). One participant withdrew during gameplay and thirteen were excluded for the following reasons: Moral Foundations Questionnaire (MFQ) exclusion criteria (two questions to measure inattention); leaving the room during the gameplay; and technical problems with the purpose-made game. This reduced the total to 101 participants. The majority reported a white background (78%), with the gender of the sample being 45% male. Ethical approval was obtained from the University's Research Ethics team, carried out within accordance of the University's Research Ethics Code of Practice.

2.3. Materials

The materials listed below in order of completion included the developed purpose-made game (Hodge et al., 2018) and the measures used in the questionnaire. The questionnaire was administered through an online survey tool, SurveyMonkey.

2.3.1. Pre-Game Questions

The MFQ32 (Graham, Haidt, & Nosek, 2008) created scores for each of the MFT domains and were calculated from a 6-point scale: C/H α = .69; F/C α = .65; L/B α = .71; A/S α = .74; S/D α = .84 (Graham et al., 2011); and L/O α = .62 (Hodge, 2018; Appendix C). These reliability alphas are only satisfactory/acceptable (Taber, 2018). It is acknowledged that the reliability scores have an effect on analyzing the data; therefore, calculating moral salience can support addressing this, as well as understanding the hierarchical structure of the MFT domains. Plus, moral salience has been suggested to underpin moral decision-making and was calculated by isolating both the highest and lowest scoring real-life MFQ domain(s) (Joeckel et al., 2012, 2013). Hence, categorical dummy variables represented if the MFQ domain was salient or non-salient (Yes/No) which was identified by manually isolating participant's highest and lowest scoring domains.

Participants were asked questions about their previous gameplay (Appendix B), which included the following questions: plays video games (Yes/No); if they would describe themselves as a gamer (Yes/No); length of time playing (0–52.50 hours); years playing games (0–26 years); number of genres played (0–19); experience and ability (1 = Beginner/a little, to 7 = Expert/much).

2.3.2. Purpose-Made Game

Using the Unreal engine, the game was a 3D photo-realistic first-person, role-playing game played on a PC. Each of the MFT foundations were represented by previously tested scenarios, located in separate rooms within the level (see Figure 1; Hodge et al., 2018). Once participants had located the Non-Player Character (NPC), the relevant MFT scenario was presented, then participants selected one of the two choices presented, either uphold/pro-social choice or violated/anti-social choice. For more information on the design of the purpose-made game, see Appendix A, Hodge et al. (2018), and Hodge (2018).

2.3.3. Post-Game Questions

Participants were asked to select a preferred moral alignment in their previous gameplay (Good/Bad/Neutral) that were coded (Yes/No). Although a previous gameplay question, to avoid bias, participants were asked this after playing the purpose-made game.

Avatar attachment and empathy questions were taken from the Temple Presence Inventory and rated on the following scale: 1 = Not at all, to 7 = Very much (α. = 84; Lombard, Ditton, & Weinstein, 2007; see Appendix B).

An adapted Game Engagement Questionnaire (GEQ), which consists of 19 questions (α = .85) and rated on the following scale: Yes = 2; Maybe = 1; and No = 0 (Brockmyer, et al., 2009), was used to measure the level of engagement in the purpose-made game.

The Positive Affect (α = .88) and Negative Affect (α = .85) Schedule (PANAS-X) each contained 10 items,

Figure 1. The six in-game MFT scenarios. Note: Top left clockwise—L/O, C/H, A/S, S/D, L/B, and F/C.

with the sub-measure Guilt score obtained from 6 items within the Negative Affect scale. The scale range included: 1 = Very slightly, to 5 = Extremely (Watson & Clark, 1999).

The Tangram help/hurt task was used to measure post-game pro-social and anti-social behavior. Participants were led to believe they were assigning and completing tangrams puzzles with a (fictitious) participant and if the other participant could complete 11 tangrams in 10 minutes, they won a prize. Participants selected how easy or difficult they made the task. A helping score was calculated from the number of easy puzzles greater than one, with the same process used for calculating the hurting score for hard puzzles. A help/hurt score (Tangram alignment) was calculated by subtracting the helping from the hurting scores (Saleem et al., 2015).

2.4. Procedure

Minor deception was used as participants were told the research involved decision-making, with the moral aspects of the research explained in the debrief. All data was collected in the laboratory in one session. Once the consent form had been signed the first questionnaire commenced (see Section 2.3.1). Then the purpose-made game was played in the lab. Once the game had finished participants completed the second questionnaire (see Section 2.3.3). Finally, the Tangram task was completed, followed by a debrief.

3. Results

To explore how moral decisions were made in a purpose-made game, Table 1 shows that in-game moral alignment was more pro-social and upholding (5 out of 6 domains) with RT on average taking at least 4 seconds. L/B then F/C had the longest RTs, which could be due to the layout of the VE as these two scenarios were closest to the beginning of the level.

The RT data had a positive skew, therefore a reciprocal transformation was applied to reduce the effect of slow responses while keeping power in the data: inverting the data to the speed of the decision per millisecond (Whelan, 2008). In-game moral alignment was

Table 1. Summary of descriptive statistics of the in-game moral decisions.

In-game decisions	*M*	*SD*	*t*	*df*	*p*	*d*
In game choice						
Upheld MFT (Pro-social)	5.19	0.81				
Violated MFT (Anti-social)	0.81	0.94				
In-game moral alignment	4.38	1.87				
RT (Seconds) by in-game MFT domain						
L/B	6.61	3.13	−2.15	99	.034	−.43
F/C	5.60	2.50	1.41	99	.161	.28
C/H	4.09	2.65	−3.22	6.28	.017	−2.57
S/D	4.01	1.78	−2.56	99	.012	−.52
L/O	4.24	2.18	−3.60	99	.719	−.72
A/S	4.63	2.86	1.49	99	.140	.30
Total decision time	29.33	10.17				
Total time in level	239.30	112.39				

significantly correlated with total decision time $r = .25$ ($p = .013$), suggesting the quicker the decisions, the more decisions which were upheld/pro-social. Independent t-tests on the speed of decision and choice made suggested that upholding/pro-social choices were significantly faster than violating/anti-social choices for the domains of: C/H with a large effect size; S/D with a medium effect size; and L/B with a small effect size.

3.1. RQ1: How Long Do In-Game Moral Decisions Take?

A repeated measures ANOVA was conducted on speed of decision with each of the in-game MFT domains. Greenhouse-Geisser values are reported as Mauchly's test of sphericity was violated χ^2 (14) = 50.90 ($p < .001$). Speed of decisions was significantly related to MFT domain $F(4.15, 414.68) = 21.87$ ($p < .001$) $\eta^2 = .18$. Post Hoc Bonferroni test suggests that the domain of in-game L/B and F/C were significantly different ($p = .015$) and slower than the other domains.

3.2. RQ2: Which Factors of Real-Life MFT Domains, Previous Gameplay, In-Game, and Post-Game Experiences, Will Predict In-Game Moral Alignment?

To explore what factors predicted moral alignment three multiple linear regressions were carried out. Table 2 shows that participants on average have been playing video games for around 7 years, with 6 types of genres and 6 hours of gameplay a week. Over two thirds of participants reported playing video games and a third identified as a gamer. Most of the participants wanted to help in the Tangram task. Avatar attachment and empathy were at the midpoint of the scale. Participants reported more negative affect than positive affect, and feelings of guilt were low.

To explore what factors predicted moral alignment, Table 3 shows the only significant predictor for the first regression was C/H, the model was not significant and only explained around 5% of the variance. The results of the second regression suggested the significant predictors were previous evil alignment and number of genres played had negative relationships with moral alignment whereas ability had a positive relationship. The third regression suggested empathy was a significant predictor with a positive relationship with in-game moral alignment whereas engagement had a significant negative relationship.

3.3. RQ3: How Will Real-Life Moral Salience Relate to In-Game Moral Choice and RT?

To explore the role of real-life moral salience and in-game decision-making, Table 4 shows the results of the participant's real-life moral salience listed in rank order. C/H was the most salient, S/D was the lowest, and A/S received the most violations. Chi-squared analysis on real-life salience (low or high) and in-game choice (violate or upheld) for each MFT domain suggested none of the real-life MFT domains were significantly associated with in-game MFT scenarios, with Cramer's V ranging from weak (S/D) to strong (C/H). Independent t-tests on speed of decision and real-life salience (Yes/No), suggested only participants with a non-salient L/B foundation were significantly slower than those who did not have L/B as a non-salient foundation with a small effect size.

4. Discussion

The results suggested that in-game moral decisions took between 4–6 seconds, were mostly pro-social (in-game MFT domains upheld), with violations taking longer. The following predictor variables were suggested to have a significant relationship with in-game moral decisions: MFQ C/H score, evil alignment, ability, number of genres played, empathy, and engagement. Previous gameplay, in-game and post-game regression models did predict in-game moral decisions but not real-life morality. The MFT domains that were upheld and salient were similar to previous research (Joeckel et al., 2012, 2013; Tamborini,

Table 2. Descriptive statistics of continuous and categorical predictor variables.

Variables	***M***	***SD***
Years playing	7.63	5.96
Number of genres played	6.04	5.00
Length of time	6.61	8.22
Gaming ability	3.40	1.79
Gaming experience	3.59	2.01
Tangram help score	4.74	3.03
Tangram harm score	1.32	1.82
Tangram alignment score	3.43	4.56
Avatar attachment	2.46	1.42
Empathy	3.30	1.60
Engagement (GEQ)	11.43	6.01
Positive affect score	14.51	4.56
Negative affect score	21.07	7.39
Guilt score	9.97	4.77
	Yes	**No**
Gaming status	79	22
Gamer	34	67
Previous gameplay alignment: Good	57	44
Previous gameplay alignment: Neutral	26	75
Previous gameplay alignment: Evil	18	83

Table 3. The three multiple linear regression models with in-game moral alignment.

Regression n models	**R^2**	**ΔR^2**	***p***	**Constant/ significant predictors**	**B**	**SE B**	**β**	***p***
1) Real-life morality MFQ	0.11	0.05	.090	Constant	2.00	1.24		
				C/H	0.82	0.31	0.32	.010
				F/C	−0.28	0.38	−0.10	.458
				L/B	0.03	0.35	0.01	.935
				A/S	0.30	0.33	0.12	.373
				S/D	0.08	0.29	0.04	.778
				L/O	-0.20	0.27	−0.08	.461
2) Previous gameplay	0.37	0.30	< .001	Constant	6.81	1.76		
				Number of genres played	−0.20	0.06	−0.53	.001
				Ability	0.48	0.23	0.46	.042
				Gaming status	0.78	0.50	0.17	.124
				Years playing	0.03	0.04	0.08	.538
				Gamer	−0.14	0.54	−0.04	.797
				Length of time	−0.01	0.03	−0.04	.771
				Experience	−0.16	0.25	−0.18	.507
				Previous neutral alignment	−0.66	0.39	−0.15	.090
				Previous evil alignment	−1.98	0.48	−0.41	<.001
3) In-game and post-game measures	0.18	0.12	.008	Constant	3.70	0.79		
				Positive affect	0.04	0.09	0.09	.701
				Negative affect	0.00	0.03	0.01	.923
				Guilt scale	0.02	0.09	0.04	.866
				Engagement (GEQ)	−0.08	0.04	−0.24	.035
				Tangram	0.08	0.04	0.18	.061
				Avatar attachment	−0.26	0.15	−0.20	.072
				Empathy	0.36	0.13	0.31	.008

Table 4. MFT salience with in-game moral choice and RTs.

MFT domain	Salience	Percentage of salience	Percentage of in-game MFT upheld	χ^2 (1)	*p*	*V*	*t*(99)	*p*	*d*
C/H	Highest	51.5	96.0	4.42	.052	.21	−0.59	.558	−.12
F/C	High	32.7	98.0	0.99	.451	.10	0.81	.423	.16
L/O	High	24.8	96.0	1.43	.255	.12	0.08	.938	.02
A/S	Low	21.8	67.3	2.09	.118	.14	0.54	.589	.12
L/B	Low	29.7	69.3	0.14	.440	.19	2.14	.035	.43
S/D	Lowest	58.4	91.1	3.78	.051	.04	−0.85	.400	−.17

Bowman, et al., 2016). Tamborini, Bowman, et al. (2016) suggested differences in MFT domains could be due to how they are processed/accessed. Interestingly, C/H and S/D were the quickest domains and at the extreme ends of salience, therefore, this could suggest that the highest and lowest salient domains are processed differently.

The results suggested participants preferred to be helpful both in-game and post-game, which could suggest similarities and/or reciprocal relationship between in-game and post-game behavior (e.g., Ellithorpe et al., 2015). Alternatively, as negative affect was higher than positive affect, this could have led to compensation by being helpful post-game (e.g., Ellithorpe et al., 2015; Gollwitzer & Melzer, 2012). Furthermore, empathy significantly predicted more pro-social choices and positive in-game alignment. Therefore, empathy could have a specific role in gameplay, which has been found previously (Grizzard, Tamborini, Lewis, Wang, & Prabhu, 2014; Grizzard, Tamborini, Sherry, & Weber, 2017). This could suggest the game was emotionally demanding, however, scores on other emotional measures, such as the PANAS, were low. Furthermore, if decisions were being rationalized (as reflected in the time taken), it was unlikely that system 1 was being used, which is more connected to emotional processes, and hence the purpose-made game was unlikely to be emotionally demanding (Hartmann, 2011; Kahneman, 2011). In contrast to empathy, game engagement had a significant negative relationship with pro-social choices and in-game alignment. This might suggest a trade-off is made between investment in the game and empathy e.g., empathy vs evil alignment (Triberti et al., 2015). Furthermore, this relates to the choice of the gut or the game, suggested by Joeckel et al. (2012, 2013), if participants chose empathy/gut they would uphold moral choices, whereas if they chose engagement in the game, they would make more violating choices. This trade-off could be explained by the demands of video games, as it demonstrates potential processes and interaction between player and game: i.e., which demand determines how the trade-off is managed/decided and which demands get overridden.

Since the data suggested that overall real-life morality did not predict in-game decision-making, it could indicate that participants were playing to their own preference and/or strategy. This is supported by previous research that found players have a preference for moral decisions, which tend to be pro-social (Lange, 2014; Triberti et al., 2015) and use strategies (Schell, 2014; Sicart, 2010). This could also be represented in the results of previous gameplay, explaining the most variance with evil alignment and ability being significant predictors and suggest previous preferences and strategies. Another possibility is that strategies are related to cognitive demands. Further support could be suggested from the RTs where participants could have been deliberating on these decisions and using system 2 (Hartmann, 2011; Kahneman, 2011; Tamborini, 2011). If system 2 was engaged this could have overridden emotional demands potentially for cognitive demands. Furthermore, these strategies may override/outweigh morality and could relate to moral disengagement and management in gameplay (Hartmann & Vorderer, 2010; Klimmt, Schmid, Nosper, Hartmann, & Vorderer, 2006). Another explanation is that the decisions in the purpose-made game were being rationalized and perceived as amoral: where participants (consciously or not) did not engage morality. One reason could be that participants were trying to understand new experiences/learn from the game; which could be reflected in L/B reporting the longest RTs as this was likely to be the first decision made.

Cognitive demands, such as skill, have been previously found to overlap with behavioral demands, such as performance in the game (Bowman, Weber, Tamborini, & Sherry, 2013) and likewise moral agency requires both moral judgment (cognitive) and action (behavior; Bandura, 2002). Eden et al. (2018) highlight the role of social aspects in behavioral affordances. Therefore, the role of empathy and interacting with NPCs in the purpose-made game could suggest social demands. Conversely, it is important to note that avatar attachment was low which could have influenced the social interactions and suggested a low social demand (Banks & Bowman, 2016).

One of the limitations of this study is that it took place in a laboratory and could be different from participants' normal video game experience. This could have also led to social desirability from participants playing the game to meet perceived expectations, rather than how they might normally play games. Additionally, participants could have picked an option based on what they might have found to be entertaining/fun. Also, the majority of participants selected pro-social/upholding choice, therefore, anti-social/violating choices were underrepresented. Due to time restrictions only NPCs that were required for interactions were included; adding more NPCs can enhance the realism, interactivity, and create a busier VE (Warpefelt & Verhagen, 2016). Also, participants may have not benefited from making fast decisions, as the game did not specifically facilitate quick responses, which could have influenced the speed of decisions. It is also acknowledged there are limitations within the MFT theory such as modularity of the foundations (Suhler & Churchland, 2011) and the participant sample only consisting of university students. The results of MFT salience had limitations from how it was calculated, in that the salient domains may not be significantly different from the next highest and lowest domains.

Many of the inconsistencies with previous research could be due to the complex nature of morality containing different components, therefore, highlighting the importance of understanding and mapping the demands of video games, for both commercial and purpose-made games. Tamborini, Bowman, et al. (2016) found that MFT domains influence in-game decisions; however, this influence is affected by the game design. Future research could explore in-game intuitive versus deliberative reasoning, and measure the demands of the purpose-made game to support understanding in-game experiences/decision-making.

5. Conclusions

Exploring in-game RTs and moral alignment in a purpose-made game with the demands of video games demonstrates the complex nature of in-game moral decision-making. The results suggested in-game decisions were mostly pro-social and took between 4–6 seconds, with previous gameplay, in-game, and post-game experiences predicting moral alignment. Overall, real-life morality and salience was not related to in-game decision-making in this study; rather in-game decisions seemed to be more rational and cognitively demanding and thus, not driven by intuitions.

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Conflict of Interests

The authors declare no conflict of interests.

References

American Psychological Association. (2015). *Task force on violent media technical report on the review of the violent video game literature*. Washington, DC: American Psychological Association. Retrieved from http://www.apa.org/news/press/releases/2015/08/technical-violent-games.pdf

Bandura, A. (2002). Selective moral disengagement in the exercise of moral agency. *Journal of Moral Education*, *31*(2), 101–119. https://doi.org/10.1080/0305724022014322

Banks, J., & Bowman, N. D. (2016). Emotion, anthropomorphism, realism, control: Validation of a merged metric for player–avatar interaction (PAX). *Computers in Human Behavior*, *54*, 215–223. https://doi.org/10.1016/j.chb.2015.07.030

Bowman, N. D. (2016). Video gaming as co-production. In R. Lind (Ed.), *Produsing 2.0: The intersection of audiences and production in a digital world* (Vol. 2, pp. 107–123). New York, NY: Peter Lang.

Bowman, N. D. (2018). The demanding nature of video game play. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 1–24). London: Routledge. https//doi.org/10.4324/9781351235266

Bowman, N. D., Wasserman, J., & Banks, J. (2018). Development of the video game demand scale. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 208–233). London: Routledge. https://doi.org/10.4324/9781351235266

Bowman, N. D., Weber, R., Tamborini, R., & Sherry, J. (2013). Facilitating game play: How others affect performance at and enjoyment of video games. *Media Psychology*, *16*(1), 39–64. https://doi.org/10.1080/15213269.2012.742360

Brockmyer, J. H., Fox, C. M., Curtiss, K. A., McBroom, E., Burkhart, K. M., & Pidruzny, J. N. (2009). The development of the Game Engagement Questionnaire: A measure of engagement in video game-playing. *Journal of Experimental Social Psychology*, *45*(4), 624–634. https://doi.org/10.1016/j.jesp.2009.02.016

Eden, A., Ewoldsen, D., Lee, J., & Beyea, D. (2018). Behavioral demands as behavioral affordances in video games. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention*. (pp. 92–107). London: Routledge. https://doi.org/10.4324/9781351235266

Ellithorpe, M. E., Cruz, C., Velez, J. A., Ewoldsen, D. R., & Bogert, A. K. (2015). Moral license in video games: When being right can mean doing wrong. *Cyberpsychology, Behavior, and Social Networking*, *18*(4), 203–207. https://doi.org/10.1089/cyber.2014.0599

Elson, M., & Quandt, T. (2016). Digital games in laboratory experiments: Controlling a complex stimulus through modding. *Psychology of Popular Media Culture*, *5*(1), 52–65. https://doi.org/10.1037/ppm0000033

Gollwitzer, M., & Melzer, A. (2012). Macbeth and the joystick: Evidence for moral cleansing after playing a violent video game. *Journal of Experimental Social Psychology*, *48*(6), 1356–1360. https://doi.org/10.1016/j.jesp.2012.07.001

Graham, J., Haidt, J., & Nosek, B. (2008). Questionnaires.

MoralFoundations.org. Retrieved from http://www.moralfoundations.org/questionnaires

Graham, J., Nosek, B. A., Haidt, J., Iyer, R., Koleva, S., & Ditto, P. H. (2011). Mapping the moral domain. *Journal of Personality and Social Psychology*, *101*(2), 366–385. https://doi.org/10.1037/a0021847

Grizzard, M., Tamborini, R., Lewis, R. J., Wang, L., & Prabhu, S. (2014). Being bad in a video game can make us more morally sensitive. *CyberPsychology, Behavior & Social Networking*, *17*(8), 499–504. https://doi.org/10.1089/cyber.2013.0658

Grizzard, M., Tamborini, R., Sherry, J. L., & Weber, R. (2017). Repeated play reduces video games' ability to elicit guilt: Evidence from a longitudinal experiment. *Media Psychology*, *20*(2), 267–290. https://doi.org/10.1080/15213269.2016.1142382

Haidt, J. (2012). *The righteous mind: Why good people are divided by politics and religion*. New York, NY: Vintage.

Haidt, J., & Joseph, C. (2008). The moral mind: How five sets of innate intuitions guide the development of many culture-specific virtues, and perhaps even modules. In P. Carruthers, S. Laurence, & S. Stich (Eds.), *The innate mind, volume 3: Foundations and the future* (pp. 367–391). Oxford: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780195332834.003.0019

Hartmann, T. (2011). Players' experiential and rational processing of virtual violence. In K. Poels & S. Malliet (Eds.), *Moral issues in digital game play* (pp. 135–150). Leuven: Acco.

Hartmann, T., Krakowiak, K. M., & Tsay-Vogel, M. (2014). How violent video games communicate violence: A literature review and content analysis of moral disengagement factors. *Communication Monographs*, *81*(3), 310–332. https://doi.org/10.1080/03637751.2014.922206

Hartmann, T., Toz, E., & Brandon, M. (2010). Just a game? Unjustified virtual violence produces guilt in empathetic players. *Media Psychology*, *13*(4), 339–363. https://doi.org/10.1080/15213269.2010.524912

Hartmann, T., & Vorderer, P. (2010). It's okay to shoot a character: Moral disengagement in violent video games. *Journal of Communication*, *60*(1), 94–119. https://doi.org/10.1111/j.1460-2466.2009.01459.x

Haviv, S., & Leman, P. J. (2002). Moral decision-making in real life: Factors affecting moral orientation and behaviour justification. *Journal of moral education*, *31*(2), 121–140. https://doi.org/10.1080/0305724022014324 1

Hodge, S. E. (2018). *Press trigger for morality: An exploration into the role of moral development, moral decision-making and video game play* (Unpublished Doctoral thesis). Bournemouth University, Poole, UK.

Hodge, S. E., McAlaney, J., Gatzidis, C., Anderson, E. F., Melacca, D., & Taylor, J. (2018). Applying psychological theory to in-game moral behaviors through the development of a purpose-made game. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention*. (pp. 108–125). London: Routledge. https://doi.org/10.4324/9781351235266

Huskey, R., Craighead, B., Miller, M. B., & Weber, R. (2018). Does intrinsic reward motivate cognitive control? A naturalistic-fMRI study based on the synchronization theory of flow. *Cognitive, Affective, & Behavioral Neuroscience*, *18*(5), 902–924. https://doi.org/10.3758/s13415-018-0612-6

Joeckel, S., Bowman, N. D., & Dogruel, L. (2012). Gut or game? The influence of moral intuitions on decisions in video games. *Media Psychology*, *15*(4), 460–485. https://doi.org/10.1080/15213269.2012.727218

Joeckel, S., Bowman, N. D., & Dogruel, L. (2013). The influence of adolescents' moral salience on actions and entertainment experience in interactive media. *Journal of Children and Media*, *7*(4), 480–506. https://doi.org/10.1080/17482798.2013.781513

Kahneman, D. (2011). *Thinking, fast and slow*. New York, NY: Farrar, Straus and Giroux.

Klimmt, C., Schmid, H., Nosper, A., Hartmann, T., & Vorderer, P. (2006). How players manage moral concerns to make video game violence enjoyable. *Communications*, *31*(3), 309–328. https://doi.org/10.1515/COMMUN.2006.020

Lange, A. (2014). 'You're just gonna be nice': How players engage with moral choice systems. *Journal of Games Criticism*, *1*(1), 1–16. Retrieved from http://gamescriticism.org/articles/lange-1-1

Lewis, M., & Jacobson, J. (2002). Game engines in scientific research: Introduction to special issue. *Communications of the ACM*, *45*(1), 27–31. https://doi.org/10.1145/502269.502288

Lombard, M., Ditton, T. B., & Weinstein, L. (2007). Measuring presence: The temple presence inventory (TPI). *Matthew Lombard*. Retrieved from http://matthewlombard.com/research/p2_ab.html

Mohseni, M. R., Liebold, B., & Pietschmann, D. (2015). Extensive modding for experimental game research. In P. Lankoski & S. Björk (Eds.), *Game research methods: An overview* (pp. 323–340). Pittsburgh, PA: ETC Press.

Narvaez, D., & Rest, J. (1995). The four components of acting morally. In W. Kurtines & J. Gewirtz (Eds.), *Moral behavior and moral development: An introduction* (pp. 385–400). New York, NY: McGraw-Hill.

Palmer, J. (2015). Time for a timer! Effective use of timers in game design. *Gamasutra*. Retrieved from https://www.gamasutra.com/blogs/JackPalmer/20151019/256526/Time_for_a_timer__Effective_use_of_timers_in_game_design.php

Rutledge, P. B. (2013). Arguing for media psychology as a distinct field. In K. E. Dill (Ed.), *The Oxford handbook of media psychology*, (pp. 43–61). New York, NY: Oxford University Press.

Saleem, M., Anderson, C. A., & Barlett, C. P. (2015). Assessing helping and hurting behaviors through the Tangram help/hurt task. *Personality and Social Psychology Bulletin*, *41*(10), 1345–1362. https://doi.org/10.1177/0146167215594348

Schell, J. (2014). *The art of game design: A book of lenses*. Boca Raton, FL: CRC Press.

Sicart, M. (2010). *Wicked games: on the design of ethical game play*. In B. T. Christensen, S. Boztepe, & T. Kristensen (Eds.), *Proceedings of the 1st DESIRE network conference on creativity and innovation in design* (pp. 101–111). Aarhus: DESIRE Network.

Stromer-Galley, J. (2004). Interactivity-as-product and interactivity-as-process. *The Information Society*, *20*(5), 391–394. https://doi.org/10.1080/01972240490508081

Suhler, C. L., & Churchland, P. (2011). Can innate, modular "foundations" explain morality? Challenges for Haidt's moral foundations theory. *Journal of cognitive neuroscience*, *23*(9), 2103–2116. https://doi.org/10.1162/jocn.2011.21637

Swink, S. (2009). *Game feel: A game designer's guide to virtual sensation*. Burlington: Morgan Kaufmann Publishers.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Tamborini, R. (2011). Moral intuition and media entertainment. *Journal of Media Psychology: Theories, Methods and Applications*, *23*, 39–45. https://doi.org/10.1027/1864-1105/a000031

Tamborini, R. (2012). A model of intuitive morality and exemplars. In R. Tamborini (Ed.), *Media and the moral mind* (pp. 43–74). London: Routledge. https://doi.org/10.4324/9780203127070

Tamborini, R., & Bowman, N. D. (2010). Presence in video games. In C. C. Bracken & P. Skalski, (Eds.), *Immersed in media: Telepresence in everyday life* (pp. 87–109). New York, NY: Routledge.

Tamborini, R., Bowman, N. D., Prabhu, S., Hahn, L., Klebig, B., Grall, C., & Novotny, E. (2016). The effect of moral intuitions on decisions in video game play: The impact of chronic and temporary intuition accessibility. *New Media & Society*, 1–17. https://doi.org/10.1177/1461444816664356

Tamborini, R., Lewis, R. J., Prabhu, S., Grizzard, M., Hahn, L., & Wang, L. (2016). Media's influence on the accessibility of altruistic and egoistic motivations. *Communication Research Reports*, *33*(3), 177–187. https://doi.org/10.1080/08824096.2016.1186627

Triberti, S., Villani, D., & Riva, G. (2015). Moral positioning in video games and its relation with dispositional traits: The emergence of a social dimension. *Computers in Human Behavior*, *50*, 1–8. https://doi.org/10.1016/j.chb.2015.03.069

Warpefelt, H., & Verhagen, H. (2016). A typology of non-player characters. *Proceedings of 1st international joint conference of DiGRA and FDG.* Dundee: Digital Games Research Association and Society for the Advancement of the Science of Digital Games.

Watson, D., & Clark, L. A. (1999). *The PANAS-X: Manual for the positive and negative affect schedule-expanded form*. Iowa City, IA: University of Iowa. https://doi.org/10.17077/48vt-m4t2

Weaver, A. J., & Lewis, N. (2012). Mirrored morality: An exploration of moral choice in video games. *CyberPsychology, Behavior & Social Networking*, *15*(11), 610–614. https://doi.org/10.1089/cyber.2012.0235

Whelan, R. (2008). Effective analysis of reaction time data. *The Psychological Record*, *58*(3), 475–482. https://doi.org/10.1007/BF03395630

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Appendix

1. Appendix A: The Purpose-Made Game and the Six MFT In-Game Scenarios

1.1. Game Synopsis

The purpose-made game was designed to reduce and remove biases, as such the game does not have a strong focus on narrative. The environment and NPCs were designed and made to look as realistic as possible. Due to the large size of the purpose-made game files there is a dedicated computer lab to run these types of experiments. At the beginning of the game participants were given instructions on how to play the game, including that they will be making decisions in the game. There was also a short tutorial at the beginning to demonstrate the only options that participants will be presented within the game. The keyboard controlled the movements of the participants in-game avatar's body (only avatar's hands seen by participants) and to interact with NPCs. The mouse controlled where the avatar's head was looking. Left and right buttons on the mouse were how participants made the in-game choice and corresponded to the in-game presentation of the choices.

Each scenario was in the form of short vignettes. The text in italics was presented to participants in the game; the in-game vignette followed by the two options for each MFT domain. The descriptions that were used for validating the vignette have also been included to add context, since this would have been seen in the gameplay.

1.1.1. Scenario Care/Harm

Description: You see a person is injured and holding their abdomen, crying while they are slumped on the ground.

In-Game vignette: *[Sobbing] Ouch, ouch I am injured; these heavy books fell on me, ouch.*

Pro-social choice—Upholds MFT: *Help the injured person, pick up books and help them up.*

Anti-social choice—Violates MFT: *Hurt the injured person more, drop more books on them.*

1.1.2. Scenario Fairness/Cheating

Description: You see a person is struggling to share out coins equally (with another), because some are damaged, smaller, and worthless.

In-Game vignette: *[Sighs] These coins are difficult to share out equally, some are damaged and worthless.*

Pro-social choice—Upholds MFT: *Help restore the coins' value and divide them equally.*

Anti-social choice—Violates MFT: *Damage more coins and divide the coins unequally.*

1.1.3. Scenario Loyalty/Betrayal

Description: You see a person is giving others each a chest containing a written private promise, and all swear to secrecy.

In-Game vignette: *[Whispers] In these chests is a private promise, all agreed to swear to secrecy.*

Pro-social choice—Upholds MFT: *Put locks on the chests and protect the promise.*

Anti-social choice—Violates MFT: *Destroy the chests, open and display the promise.*

1.1.4. Scenario Authority/Subversion

Description: You see a General is holding a pair of boots which are scuffed and orders them to be sorted out.

In-Game vignette: *[Commands] You! This scuffed pair of boots on the windowsill, sort them out!*

Pro-social choice—Upholds MFT: *Mend and polish the boots, to sort them out.*

Anti-social choice—Violates MFT: *Damage the boots more, not sorting them out.*

1.1.5. Scenario Sanctity/Degradation

Description: You see a person is trying to maintain the waste system that contains sewage, which is leaking out.

In-Game vignette: *[Sighs] This waste system needs to be maintained and is leaking sewage.*

Pro-social choice—Upholds MFT: *Fix and strengthen the waste system and cleanse the area.*

Anti-social choice—Violates MFT: *Destroy and damage the waste system causing more leakage*.

1.1.6. Scenario Liberty/Oppression

Description: You see a person is trying to construct and open a stage to allow for people's free expression.

In-Game vignette: *[Sighs] This stage is difficult to construct and open for people's free expression.*

Pro-social choice—Upholds MFT: *Help create the stage to allow for free expression.*

Anti-social choice—Violates MFT: *Destroy the stage to control and stop free expression.*

2. Appendix B: Predictor Variables

Table 5. Individual predictor variables for the three regression models.

Regression model	Predictor variables	Response/range	N
Real-life morality	MFQ32 scores:		
	— Care/Harm (C/H)	0–5	101
	— Fairness/Cheating (F/C)	0–5	101
	— Authority/Subversion (A/S)	0–5	101
	— Sanctity/Degradation (S/D)	0–5	101
	— (In-group) Loyalty/ Betrayal (L/B)	0–5	101
	— Liberty/Oppression (L/O) scores	0–5	101
Previous video game play	Plays video games	Yes/No	101
	Would describe themselves as a gamer	Yes/No	101
	Previous good alignment	Yes/No	101
	Previous bad alignment*	Yes/No	101
	Previous neutral alignment	Yes/No	101
	Length of time	0–52.50 hours	101
	Years playing	0–26 years	100
	Number of genres played*	0–19	101
	Experience	0–7	101
	Ability*	0–7	101
Post-game questions	Empathy* (2 item):	0–7	101
	1. How much did you empathize with the characters in the game?		
	2. How connected did you feel with the other characters in the game?		
	Avatar Attachment (3 item):	0–7	101
	1. How much did you identify with your avatar?		
	2. How attached did you feel with your avatar?		
	3. Did you feel that avatar was you?		
	Tangrams help/hurt task	−9–9	101
	Engagement (GEQ)*	0–32	101
	PANAS-X	10–50	101
	— Guilt score	6–30	101

Notes: Forced entry method was used on all three regressions as no hierarchy was applied to the input of variables. * denotes a significant predictor.

3. Appendix C: Liberty/Oppression Scale

The Liberty/Oppression scale items followed the same format as the rest of the MFQ (Graham, Haidt, & Nosek, 2008)

3.1. Part 1—Moral Relevance

Whether or not someone was controlled by another person.

Whether or not someone was restricted by their government.

Whether or not someone was free to choose how to live their life.

3.2. Part 2—Moral Judgment

People should not be oppressed by their government.

People should not be forbidden to make their own decisions.

People have the right to disagree with those in power.

Although the Cronbach's Alpha was satisfactory/acceptable ($\alpha = .62$) and similar to the other MFQ domains (Graham et al., 2008; Taber, 2018). It is acknowledged this is a new scale and has not had the level of testing and validation of the other MFT domains. For more information on the development of the scale see Hodge (2018).

References

Graham, J., Haidt, J., & Nosek, B. (2008). Questionnaires. *MoralFoundations.org*. Retrieved from http://www.moralfoundations.org/questionnaires

Hodge, S. E. (2018). *Press trigger for morality: An exploration into the role of moral development, moral decision-making and video game play* (Unpublished doctorate dissertation). Bournemouth University, Poole, UK.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

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Article

Interaction Tension: A Sociological Model of Attention and Emotion Demands in Video Gaming

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Abstract
Video gaming actively demands players' attention, affording positive experiences like flow. Recent research has suggested to extend analysis from cognitive and physical to the social and emotional demands of gameplay. This article argues that Erving Goffman's concept of interaction tension offers a promising theoretical model for social demands. We report a re-analysis of qualitative interview data on the social norms of video gaming corroborating the model. As suggested by Goffman (1961) for gaming, video gaming features rich social norms regarding involvement. When spontaneously experienced and normatively demanded involvement misalign, players experience self-conscious disinvolvement and engage in unenjoyable, effortful self-control of their experienced and displayed involvement.

Keywords
gaming; Goffman; interaction tension; self-control; social demands; video games

Issue
This article is part of the issue "Video Games as Demanding Technologies" edited by Nicholas David Bowman (Texas Tech University, USA).

1. Introduction

Gaming, at least the desirable kind, binds our attention: We call it immersive, absorbing, engaging, or involving (Cairns, Cox, & Nordin, 2014; Calleja, 2011). But how do games accomplish that? And why, in the age of the attention economy, do we so gladly part with this ever-scarcer resource?

Following flow theory, humans enjoy "order in consciousness" (Csikszentmihalyi, 1990, p. 39), yet consciousness naturally drifts toward disorder: Unmet desires, worries, aversions, and self-consciousness split and divert our attention (Csikszentmihalyi, 1990, p. 37). Hence, we seek out gaming and other "flow activities" because their "clearly structured demands…impose order" (Csikszentmihalyi, 1990, p. 58) and ensure that "attention is completely absorbed" (p. 53). Mood management theory similarly argues that people improve their mood by selecting media with a high intervention potential, the ability to absorb attention such that none is left to ruminate on negative thoughts (Reinecke, 2016)—and games have been found to provide just that (Bowman & Tamborini, 2015).

1.1. The Demands of Games and Challenging Media

Past applications of flow and mood management theory to games have focused cognitive and physical demands on attention (Sweetser & Wyeth, 2005), like solving puzzles or fast hand-eye coordination in jump-and-run games. Bowman's (2018a) recent "interactivity-as-demand" perspective suggests to extend this towards a more general theory. Games and interactive media, he argues, put cognitive and physical, but also emotional and social demands on users, which mediate their various experiential effects, not just attentive binding. This demand perspective is currently drawing academic attention, evident in a topical edited book (Bowman, 2018b) and the present thematic issue. It strongly overlaps with recent attempts to re-conceptualize challenge in games and media. Cole, Cairns, and Gillies (2015) for instance identified distinct functional versus emotional challenges in games, which map onto cognitive and emotional demand. Denisova, Guckelsberger, and Zendle (2017) distinguish cognitive, physical, and emotional game challenge, which map one-to-one to cognitive, emotional, and physical demands. Relatedly, eudaimonic media research suggests that audiences actively seek out "challenging media" for meaning and personal growth (Bartsch & Hartmann, 2017). Here, challenge is conceptualized as "the extent to which users perceive they need to apply self-regulatory resources to control both cognitive and affective processes while processing media content" (Eden, Johnson, & Hartmann, 2018, p. 355).

1.2. Social Demands: From Separable Stimuli to the Constitutive Sociality of Gaming

Arguably the most novel demand dimension proposed by Bowman (2018a) are social demands, "the extent to which a system triggers an implicit or explicit response in the user to the presence of other social actors." Under this heading, he comprises phenomena like social facilitation, presence, relatedness need satisfaction, but also self-presentation and social norms and pressures. Bowman, Wasserman, and Banks (2018) subsequently developed and validated a video game demand scale, finding a discrete social demand factor comprising six items, which significantly correlated with relatedness need satisfaction. In the same volume, Peña (2018) presented a framework factoring out different social demands as "any component of the communicative process…that has an impact on the quantity and quality of the social ties of players and game audiences." In parallel, Bopp, Opwis, and Mekler (2018) identified "social challenges" as a subset of 'conventional' and emotional challenge in gameplay, comprising social conditions that produce a challenge (e.g., others ganging up or difficult team communication), managing other players' emotion, and genuine social emotions, chiefly pride in oneself and anger at others.

Useful as these accounts are, they present more of a first descriptive classification of related phenomena than theoretical models identifying distinct mechanisms that link these phenomena together: The 'social' of social demands variously refers to social antecedents (mediated or cued presence of other social actors in Bowman [2018a], Bowman et al. [2018]; social conditions in Bopp et al. [2018]) and social consequences (social ties in Peña [2018]; social emotions in Bopp et al. [2018]; social gratifications and need satisfaction in Bowman [2018a]). In addition, Peña (2018) and to some extent Bowman (2018a) present social demands as analytically separable from other forms of demand (e.g., Bowman [2018a, p. 15], "it is plausible that social demands can represent their own unique source"). In this, their metaphorical use of the word "demand" strangely elides its literal meaning: "An act of demanding or asking by virtue of right or authority" (Demand, n.d.). A demand is a communicative action drawing on a social norm to compel another person to act in a certain way.

Against this stand ethological, anthropological, sociological, and developmental play research (Burghardt, 2005; Henricks, 2015; Pellegrini, 2009) and sociomaterial accounts of video gaming (Stenros, 2015; Taylor, 2009) which argue that (video) gaming is always already social. 'Gaming' and 'games' are social categories constituted by shared meanings and actions, just like 'money' or 'marriage.' We need to be actively socialized into perceiving and realizing the affordances of game hardware and software (Hung, 2011). And what we do and feel during gaming is subject to a rich tapestry of specific norms. Playing any game requires us to enact these social orders, where 'gaming' or 'Pong' is a thing, where crossing this pixel line with that pixel dot is counted as 'scoring a point,' and where doing so is an appropriate reason to be cheerful (Sniderman, 1999). In other words, whatever a game object 'demands' of a player, the object and its demands are always already made out of matter as much as social norms, practices, and understandings, whose ongoing reproduction is mutually expected and sanctioned by the members of our society.

Is there a way to reconcile a demand perspective with this constitutive sociality of gaming? This article proposes that sociologist Erving Goffman's model of interaction tension provides just such a coherent theory of how constitutive social demands impact player experience. In brief, Goffman (1961) argues that when interacting with others, states of enjoyment, boredom, or (un)self-consciousness arise not just from the activity itself, but from the relative alignment of spontaneous and normatively demanded attentive and emotional involvement. In demand perspective terms, the social demands of games can be conceptualized as the social norms of 'proper' attentive-emotional involvement in gaming, with 'norm-fitting' as a social-psychological mediator of player experience.

To illustrate the applicability of interaction tension to video gaming, after introducing the model, we here report a re-analysis of qualitative interviews with German adult players around social norms for attentive and emotional involvement in video gaming. Our data broadly corroborates but also qualifies Goffman's model in that misaligned spontaneous and demanded involvement is experientially characterized by effortful self-control more than boredom and self-consciousness, and that it can also be experienced during solitary gaming. We discuss wider ramifications for the demand perspective on video gaming as well as flow and mood management theory: Broadening the focus from game stimuli to social dynamics and contexts, including self-control as an important mediating process, and working out how social demands systemically structure the attention and emotion demands of game play.

2. Theory: Interaction Tension

Goffman's (1983) work centers on the interaction order, the specific social ordering that obtains when two or more people can immediately perceive and respond to each other's actions. Such response-present interaction uniquely affords joint attention, which enables the symbolic and finely coordinated action essential to human culture (Seeman, 2011).

To guide action and sense-making in response-present interaction, social groups develop a shared repertoire of frames, reoccurring types of situations such as 'going to the doctor' or 'lecture' (Goffman, 1986). Every frame entails roles that can (and have to) be taken on by actors and define what conduct is expected and appropriate for each role-taker. During socialization, children not only internalize frames and roles, but also become aware of and construct their self from others' responses, become emotionally invested in this self, and adopt the values of their group regarding desirable self traits: They learn to care about face, "an image of self delineated in terms of approved social attributes" (Goffman, 1967, p. 5). Social emotions like pride or embarrassment are the affective dimension of assessing how relevant others assess our self (Scheff, 2000; Turner & Stets, 2006). They motivate us to act properly in response-present interaction, to fulfil role expectations, present a desirable self, show due regard to the other's self, and keep interaction flowing smoothly (Goffman, 1967, pp. 5–112).

By its nature, working response-present interaction requires mutual involvement. Goffman (1963, p. 36) defines involvement as "cognitive and affective engrossment" in an activity. As social animals, we have a natural propensity to get unselfconsciously involved in joint attentional foci. Such joint involvement mutually signals that the focal activity is worth and appropriate to unselfconsciously attend to (Goffman, 1967, pp. 113–167). Strong joint involvement fuels social cohesion and mobilization (Goffman, 1967, p. 113), as seen in e.g., raving sports fans watching a match together (Hatfield, Cacioppo, & Rapson, 1994; von Scheve & Salmela, 2014). Conversely, without joint involvement, response-present interaction quickly breaks down.

Therefore, as part of frames, social groups develop norms around "the structure of involvement in the situation" (Goffman, 1963, p. 193), who may legitimately open, join, leave, or close what kind of joint focal activity, and how deeply involved one may and ought to become in it. For most situations, the "expression of a particular allocation [of involvement] is obligatory" (Goffman, 1963, p. 37). Even worse, there is an "obligation of spontaneous involvement" (Goffman, 1967, p. 115). Take a party conversation: Not only are we expected to visibly attend and emotionally respond to the other—we also need to pull this off without it appearing belabored. Outwardly spontaneous involvement in conversation shows proper regard to the conversation partner, the norms of conversation, and maintains our face as a skilled conversationalist (Goffman, 1967, p. 114). Every type of situation asks for striking a different involvement depth: neither too distanced, nor too engrossed. Adults in particular are "obliged to express a margin of disinvolvement" (Goffman, 1967, p. 122).

And this leads us to interaction tension (Goffman, 1953, pp. 243–257, 1961, pp. 41–45). Whenever we interact with others, our spontaneous involvement aligns more or less well with the situation's normative expectations. If people's spontaneous involvement aligns with norms, people can allow themselves to stop reflexively monitoring and controlling their involvement (Goffman, 1986, p. 378). The resultant positive experience is "euphoric ease" (Goffman, 1961, p. 42). However, the sad normal state of affairs is "dysphoric tension," "some discrepancy between obligatory involvements and spontaneous ones" (Goffman, 1961, p. 44). This leads participants to experience "alienation from interaction" (Goffman, 1967, p. 113): They feel bored, awkward, uneasy. They have to effortfully fabricate an involvement display that fits the situation against their inclinations, and they are likely to become self-conscious about this fabricated face, the thoughts and feelings of the other participants, and whether the situation is 'working.' This alienation is just as contagious as engrossment (Goffman, 1967, pp. 125–129).

Now just like flow theory suggests that the structure of gaming activity affords flow, Goffman (1961, p. 43) argues that in gaming, "euphoric interaction is relatively often achieved: gaming is often fun." This is because games are purpose-designed to spontaneously excite and bind deep joint involvement, and the situational norms of gaming allow and demand just such deep joint involvement. As a result, the existence of involvement norms disappears from participants' awareness. The paradox of gameplay is that it is "shared, obligatory, spontaneous involvement" (Goffman, 1961, p. 43).

In summary, Goffman provides an integrated model of the social-psychological dynamics of social norms, attention, and emotion in gameplay: When co-present participants' involvement is spontaneously excited and bound by the situation's sanctioned focal activity, they reproduce and amplify each other's involvement and experience positive unselfconscious ease. When their spontaneous involvement mismatches situational obligations, they experience dysphoric tension and become alienated from interaction (drifting with their attention, bored, self-conscious), which is likewise contagious, while participants try to overtly display spontaneous involvement in the legitimate focal activity.

3. Method

Clear as this model may be, it was developed from field observations of mid-20th century Shetland Island communities and US casinos. To explore its fit with contemporary video gaming, we conducted a focal re-analysis of a larger data set of interviews with German adult video game players on the social norms of gaming (reported in Deterding, 2014).

Following Maxwell (2004), the original study developed an initial conceptual framework to structure data collection and analysis. Specifically, it started from key dimensions of situational norms as theorized in frame analysis (Goffman, 1986): settings, objects, roles, internal organization, metacommunication, attention, emotion, rules for action and communication, and situational boundaries. Because social norms are typically taken-for-granted and therefore hard to elicit, the original study used semi-structured episodic interviews (Flick, 1997) to elicit a broad range of 'critical incidents' where participants remembered a norm violation, which typically makes norms consciously available. We then probed participants to expand on the violated norm. Second, inspired by the grounded theory principle of constant comparison (Corbin & Strauss, 2008), the study intentionally recruited participants who engaged in both 'canonical' leisurely gameplay and 'atypical' gameplay-as-work performed by game journalists, game designers, game researchers, and esports athletes. Participants were asked to recall 'typical' kinds of leisurely gameplay situations they engage in, to then compare these to the counterpart in non-leisurely work-as-play, thus foregrounding norm differences. To ensure all our concepts were grounded in data, the study followed the grounded theory principles of constant comparison and theoretical sampling (Corbin & Strauss, 2008): It gathered and coded data in parallel, comparing each new datum against existing concepts, revising, dropping, or adding concepts as required by the data, adapting interview script and participants based on emerging questions until we reached theoretical saturation.

All interviews were conducted in German with adult native German-speaking participants across Germany between March 2011 and May 2012. Participants were purposely sampled for diverse backgrounds in age, gender, experience across game genres, devices, and social contextures. We conducted 19 interviews (about 1,900 minutes total recordings) until we reached saturation, in line with prior findings (Guest, Bunce, & Johnson, 2006). We transcribed recordings together with field notes and coded them using the qualitative data analysis software MAXQDA. This produced 3,241 coded segments across 181 initial codes, which resulted in 24 focused codes, 6 axial categories and the central theme of "gaming modes." This theme captured that we found no single uniform set of norms for video gaming, but rather five different sub-types of leisurely gaming and four different sub-types of gaming-as-work, each with their own internally coherent set of norms that would support the sub-type's purpose. E.g., we found a socializing gaming mode whose norms where structured around experiencing social connection, or a competitive mode around achievement display before others, or an esports training mode structured around improving skill. As will become apparent, involvement norms similarly varied with gaming modes.

For the present article, we re-analyzed the data set described above. Since Goffman (1961) identified involvement as emotional and attentive engagement resulting in unselfconscious engrossment, we started reanalysis from 447 passages coded for 'emotion norms,' 'attention norms,' and 'tension/flow.' 'Attention norms' and 'emotion norms' were predefined focused codes that structured data generation, collection, and analysis, and proved analytically distinct throughout the iterative collection-coding-analysis process. The code 'tension/flow' emerged from the data as 'experiences of self-control and self-awareness,' which we only later, during write-up, formally connected to Goffman's terms because of their mutual fit, inviting additional coding cycles sensitized by the interaction tension model. As such, the present study constitutes an instance of "double-fitting" (Baldamus, 1972) between empirical material analysis and conceptual framework, in which iteratively switching between the two mutually refines and differentiates each one—a qualitative analysis approach characteristic for Goffman's own work (Williams, 1988).

Interview transcripts and field notes in the German original as well as the code tree of the present study are available at https://osf.io/3w4js. All data quoted below is translated from the German original.

4. Results

4.1. Involvement Norms

4.1.1. Mandatory Spontaneous Involvement

Congruent with Goffman, we found a rich landscape of norms regulating video gaming involvement. Maybe the most basic norm of leisurely gaming voiced by participants is that one ought to spontaneously want to play:

> Interviewer: Is there something you shouldn't do during playing?
>
> P1: I don't know, if you want to do something else, then you should do something else. And if you want to play video games, then you should play a video game.

Enjoyment was seen as the legitimate official purpose of leisurely gaming. While this was voiced as a mere expectation in single-player gaming, it turns into a positive normative demand in multi-player gaming, as satisfying gaming was seen to depend on the others mustering some minimum visible involvement: "People of course also have to be there with a minimum stake, in wanting and tactics…because otherwise the game collapses'' (P3).

4.1.2. Social Interaction of Involvement

Four ways personal involvement affected the involvement of others emerged. First, distracted players tend to break the flow of gameplay and create boring pauses by missing their turn. Second, their inattentiveness leads them to play sub-optimally, making either for a poor teammate or boring opponent, as the following passage nicely illustrates:

> P7: We played soccer, so we played Pro Evolution Soccer 2012, with several friends, online, against each other. So we were a two-player team in our living room, and in Vienna friends of us were sitting, and we played against them. And the one did indeed look on his mobile phone from time to time, and then I told him: 'Hey, let that be! I don't want to lose here, against them.' You're quite captivated there, and—it was similar when I once, with my friends, every two weeks we play, we make a gaming night and play Golf together, Tiger Woods. And it's annoying when people don't press 'continue.' That is, when they, like, talk with each other or want to go have a smoke or something like that, so that's, that impedes the game flow, simply because you don't get further.

Participants reported social contagion as a third way others' involvement affected their own. As one put it, in solitary StarCraft play, they would just 'breathe off' excitation, whereas in playing seated together with a teammate, expressing shared emotion would intensify it:

> P10: When I play StarCraft alone at home and win, then I also say 'Puh' [exhales]. But that way [playing with their friend], you also work each other up a little. That is because you, like, communicate so much with each other and…also curse verbally somehow about the enemy…and then after a, after a win, then you also make a high five. So there the experience is something totally different.

Others' verbal or bodily display of emotional involvement amplifies and validates one's own. Says an esports athlete:

> P15: Especially when you play on LAN…you rejoice more, because you see your teammates, you can, when he [got] something important, you can shake him and say, like, 'Great, man!' But it's just like that when you see your team lose….Then all five [of the team] sometimes sit like [makes depressed face] and are just upset. And yes, the emotions are a bit higher.

Conversely, displaying continuous negative affect was seen to 'infect' others' mood. Asked whether they remembered an "inappropriate" way of playing, P2 named "people who are simply in the mood for nothing. Who document that [laughs] then, from 'Ahhh, that's stupid' or, when it's their turn, somehow are frustrated the whole time."

Fourth and finally, participants in a known or visibly bad mood made co-present others conscious about their lacking enjoyment, which led co-present others to inhibit their usual behavior. As P15 explains, "when a player from my team…had just broken up with his girlfriend, then [he is] a little down….When you notice that, [you] shouldn't taunt him on top of that."

4.1.3. Involvement Display

As individual involvement depends on that of the others, participants voiced a normative expectation to not just experience but also display fitting involvement: "One should show fun. So if you don't connect to the game and don't enjoy it, one should still somehow show that it was a nice situation to interact with friends" (P9).

These required displays were especially pronounced around wins and losses:

> P2: Yes, so in a group game, in a group game it is expected that you show elation when you have achieved something, somehow….You should certainly also be appropriately frustrated when something doesn't work, and not say: 'Ahh, who cares.' And then…in group situations like with the Kinect, there it's certainly also the case that you should appropriately be happy for somebody else, if somebody made a new high score, because that's certainly socially, like, desired.

Besides 'working up' appropriate involvement, participants also reported actively inhibiting felt emotions in order to save face in the situation. As P5 noted on playing multiplayer online shooters:

> P5: So when I'm continually killed by the same player, then you effectively develop such a kind of hatred…that's effectively also an admission that you are inferior [pause]. But that I wouldn't say [openly].
>
> Interviewer: What kind of reaction do you show instead?
>
> P5: Nothing….There I completely contain myself. Because that, that is, as I said, such a matter of honor.

That said, the social norms of leisurely gaming typically allow for more intense emotion expressions than everyday conversation, because the gaming frame earmarks them as 'non-serious,' not targeted at the actual biographical person of the other. Says one participant:

> P4: Anger, aggression, when you're playing video games together…those are all things accompanying gameplay, that are often also playful….Nothing that is wrong or so.
>
> Interviewer: [D]o you remember a situation where someone took that the wrong way?
>
> P4: No, no, no. That's with the people with whom I've played up to now, so that they [pause] take that in a way that shows me [that] they see that similarly. Evaluate that in the same way, are apparently [pause] socialized similarly, know that that's part of gaming and not meant in a malign manner, is even part of the whole.

In sum, participants described striking a precarious balance of disinvolved involvement—trying to win but not 'too much,' visibly celebrating wins and bemoaning losses, and yet not 'really' minding either. To fail at this balance is to count as a "sore winner" or "sore loser." Either of which is problematic because it again spoils the others' involvement, as this participant explains:

> P17: No, you are a sore loser if you, if you burden the others with your own frustration. That means, when you vent your anger…and you're in a sour mood and that becomes a burden for the others….I mean, that you get angry when you lose, that's alright. That's normal….But when you then become annoying for the others…then, then I find that a sore loser.

4.2. Attention Norms

4.2.1. Attentive Access

From his field studies of casino gambling, Goffman (1986, pp. 133–136) noted that players and bystanders are expected to limit their attentive access to certain legitimate information streams and not access certain other, legitimately 'hidden' streams, such as the hand of another Poker player. These attentive access norms were supported by material arrangements like removing mirrors from the walls. We found similar norms and practices in video gaming. As one interviewee described a multiplayer LAN party:

> P5: Yes. Looking on the screen is taboo.
>
> Interviewer: Ha. [That means?]
>
> P5: [Yes, naturally] I mean, not, not on your own screen, that's obvious [laughs]. So of course you may look on your own screen, but the tables are placed in a way…that the screens always stood with their backs to each other. So that you really only saw your friend and could not look on the screen of the other person.

4.2.2. Attentive Focus and Depth

While participants concurred that some spontaneous involvement was expected in any leisurely gaming, norms starkly differed when it came to the expected focus and depth of attention: what to attend to, and what forms of distraction or interruption would be acceptable. These norms seemed to functionally align with the legitimate purpose of the situation. For instance, they differed with the degree to which the game played would require undivided attention. In a turn-based social game like FarmVille, interruptions and distractions didn't matter:

> Interviewer: [I]s it okay to be interrupted with FarmVille?
>
> P12: Yes, most definitely. 'Cause there's nothing that necessarily happens during that.

Compare this with a competitive real-time multi-player game like StarCraft:

> Interviewer: How would you have told whether one of you was distracted or not?
>
> P10: Well, [pause] actually already just somehow looking away from the screen…turning my head to you and talk. That would actually already be distraction…because then for perhaps five seconds or so I don't see what's happening there. What under certain circumstances can already be decisive in the game.

Normatively expected focus and depth of attention also varied with gaming mode (Deterding, 2014). In gaming modes valuing player peak performance—hardcore, competitive, and esports tournament gaming—participants reported strong and strongly enforced expectations to maintain intense unfailing attentive focus on gameplay via the legitimate interface. In social gaming, by contrast, such deep, exclusive gameplay focus was seen as inappropriate: Here, gameplay is a means for social connection. Hence, participants are expected to maintain attention of the others' current emotional states and engage in the legitimate main involvement of conversation:

> Interviewer: Is there something you have to do during party gaming to play 'correctly'?
>
> P9: I believe [it is] to have enough of a distance from the game and you're still aware in what context the whole thing takes place, namely in an amicable frame, in, in a party frame. To be jolly and not too focused and fully focus on it and no communication happens, then it really failed, I would say. Because it's really about getting to interact with each other, having fun, communicating, being able to laugh about it, being able to laugh about yourself. I would say, if somebody would fully shut himself off and focuses exclusively on it and doesn't interact with co-players, then I would say it failed, yes.
>
> Interviewer: Focus on what [exactly]?
>
> P9: [On the] game, on the action. If somebody is completely in his own world and fully shut off and takes it too over-ambitiously, I would say. Yes. I would say, the way I play Battlefield, I really wouldn't be fit for social contact [laughs]. Yes.

4.3. Conditions of Interaction Tension

4.3.1. Response-Present Others

Participants uniformly reported that response-present others would make involvement norms salient and lead them to manage their involvement display. Conversely, being alone led them to not manage their displayed involvement:

> P9: So if I feel unobserved, in my private rooms, then I can show any emotion, because there would be nothing inappropriate in doing so, because I wouldn't offend anyone with it. At most I would offend myself [laughs].

This was voiced as one reason why multiplayer online games would sometimes invite disinhibited display: The game would not transmit bodily emotion display, and even if players were to express e.g., anger over voice or text chat, anonymity would save their face:

> P19: So there [in online games] I let my emotions run free. You can do that there, because you don't speak to the other. So you can't directly hurt them. So you also drop curse words…you would never say in the face of a colleague.

4.3.2. Gaming versus Public Frames and Audiences

Notably, response-present others evoked different norms depending on the type of frame and audience. It is largely taken for granted but significant that most leisurely gaming takes place within physically shielded private places like a living room, either alone or surrounded by co-players and an audience who are all aware of and have at least implicitly assented to the fact that the current situation is video gaming. This sets and licenses joint expectations around gaming-typical involvement and makes displayed behavior intelligible. As one player noted, when he played StarCraft online on his laptop communicating with his team members via Voice over Internet Protocol in his mother's kitchen, he would feel embarrassment when his mother entered the room, who did not know the game:

> P10: If somebody, somebody who has now clue about, no view of the game and hears me talking. So that's somehow awkward for me, because somebody who doesn't know what I'm doing just hears these weird, cryptic communicative lumps of language from me.

This issue becomes even more salient in non-gaming encounters. In "public traffic" like bus stops, markets, or trams, norms demand adults to pay and draw minimal overt attention (Goffman, 1963). In public, players are exposed to an unknown audience that may not understand nor approve of 'gaming.' Hence, participants stated that they would strongly inhibit their involvement displays in public:

> Interviewer: If you play a mobile game…in comparison to playing at home alone…is there a difference in what emotions you can or are allowed to express?
>
> P7: Since I am then mostly in a public surrounding, loud screaming or throwing that thing in the corner are not an option. Although you would really want to do it, you have to restrain yourself a bit there and, let's put it this way, appear a bit more suited for public.

Similarly, a participant reported that during her work hours as a game designer at the office, although playing a game was part of her official professional duties, she would fit her emotion display to the office frame:

> P9: Because I am sitting with two other colleagues in the office. And there, a certain behavior codex is desired. I don't want my colleagues to [see me] curse loudly or bang my hand on the table [which she would do playing at home]. A certain body posture is simply proper. So I can't just let myself slump in the chair in front of the computer, as it sometimes happens at home, when I relax. Instead I'm sitting upright and straight and really try [laughing] to make an interested impression. And yes, that's a different composure toward the game.

4.3.3. Solitary Dysphoric Tension

Interestingly, our data showed that involvement norms could also become salient and cause dysphoric tension during solitary play. We mainly observed this during work-at-play. Participants would experience a spontaneous pull to let themselves become unselfconsciously involved in gaming, but their current work frame made salient that they ought to engage with the game in a disengaged, analytic fashion, e.g., to analyze it as a game designer or review it as a game journalist. As one game journalist described his experience:

> P1: So I really think that [pause] that when I'm playing reviewingly…that I am somehow taking part cognitively in a different way. That means, beforehand I'm already in this mood: 'Okay, I do, I work now, and I try to grasp intellectually what is going on here now.' And in a normal non-reviewing gaming situation exactly that is a great advantage for me, that I don't try to grasp things intellectually, but instead let myself be drifted by the sensual impressions, and that can of course emotionally evoke very different things, yes? For instance, at the end of Metal Gear Solid 4 I cried like a baby, because it was a completely different situation than for Peter, who, he wasn't yet with the game magazine then, but he reviewed the game back then. [O]f course I have to capture these emo-

> tions, but I can't give myself so fully into them that over that I forget to bring that into words.

4.4. Experiences of Interaction Tension

The previous quote nicely highlights the major experiential quality participants reported with regard to interaction tension. Goffman (1961) suggested that high or dysphoric interaction tension was characterized by attentive drift, boredom, and awkward self-consciousness, and low tension or euphoric ease by unselfconscious attentive and emotional absorption. Interestingly, our data showed little awkward self-consciousness associated with dysphoric tension. Boredom was more frequently reported, when social or professional norms demanded that one continued to play despite a lack of spontaneous interest: "The thing that you play with people in coop [cooperative mode], and you don't want to anymore, and another person still wants to" (P3). Far more salient for dysphoric tension was the experience of unpleasant, effortful self-control, be it to force continued attention on the activity, inhibit emotional responses, or maintain analytic distance. Playing for work, for instance, a game journalist stated that "[I] must not let myself drift" (P1), emotions "are more inhibited, so…the game experience is markedly more inhibited at the office, because I cannot let myself go" (P9, a game designer), and "if that is necessary, that I play every day, even if I don't want to, then I force myself to do it" (P13, esports athlete). All this resulted in an overall more muted, distanced, and less emotionally intense experience, "less ambitious, more passive" (P9).

Descriptions of euphoric ease interestingly align strongly with flow theory, down to the very words people use for it:

> P3: You notice it when you don't notice anything anymore…when the state of unselfconsciousness sets in and you get into this flow…certain emotions [pause] come up in…a more pure form. That is, when you let yourself fall or something, and simply savor that, then it may be that you…certain things are simply more intense.

"Letting yourself go" or "letting yourself fall" were frequent turns of phrase for moments of low interaction tension, especially in solitary gaming, indicating that again, self-control is a crucial experiential dimension of interaction tension.

5. Discussions and Conclusion

5.1. Main Findings

Our data broadly supports Goffman's interaction tension model for contemporary video gaming. First, we indeed found a nuanced set of social involvement norms. In leisurely gaming, gameplay ought to be spontaneously involving, and players ought to display a delicate balance of disinvolved involvement to optimally support mutual involvement: showing investment in winning to make the others' investment feel justified, yet not becoming so over-involved as to overlook the other's feelings or burden them with one's frustration. Players ought to limit their attention to legitimate information channels. And they ought to maintain an attentive focus and depth matching the functional requirements of the game and the situation's official purpose (e.g., socializing versus competing). Thus, we found that involvement norms are modulated by gaming modes, games, audiences, and settings, which Goffman did not suggest. Also, while response-present others made involvement norms salient, people reported dysphoric tension even in solitary play, namely when internalized professional norms demanded analytic detachment while the game afforded unselfconscious engrossment.

Second, we observed several social involvement dynamics. Yet where Goffman only identified self-consciousness dynamics, we observed additional dynamics of emotion contagion through emotion display, and distraction leading players to create undesired breaks in gameplay, or playing suboptimally.

Third and finally, as suggested by Goffman, we found that low interaction tension was experienced positively, and high tension negatively. Here, our data qualifies Goffman's claim that dysphoric tension chiefly revolves around boredom and self-consciousness: For our participants, effortful self-control of attention and emotion and a consequential dampening of emotional intensity was far more pronounced and negatively valued. Meanwhile, their reports of euphoric ease aligned closely with flow states, which brings us back to the beginning.

5.2. Contextualisation

We opened this article with the question of how video games absorb our attention and why we find such absorption desirable. Flow theory answers that cognitively and physically demanding activities absorb attention, which affords positively valenced order in consciousness and blocks attention-wandering to negatively valenced worries and self-conscious concerns (Csikszentmihalyi, 1990). Bowman (2018b) and others have suggested extending such analyses from physical and cognitive to emotional and social demands. So, what does interaction tension, as we found it in contemporary video gaming, add to this debate?

For one, it contributes a genuine social-psychological construct for social demands. Following Goffman, we can specify one kind of social demands of gaming as social involvement demands or the norms for 'appropriate' gaming involvement. There are certainly many other kinds of social demands in gameplay, but these appear conceptually and mechanistically distinct.

Notably, second, this kind of social demand is not a separable 'add-on' to cognitive (including attentive) and emotional demands, as suggested by Peña (2018) or Bowman (2018a): they pre-structure and co-constitute them. There are social demands on attention (cognition) and emotion, in presence and absence alike: The absence of salient social demands in solitary play is just as impactful as their presence in multiplayer encounters. Furthermore, social demands are not exhausted by what is triggered by a game or even other co-present players: They also always already arise from internalized norms about gaming and the gaming mode in question, as instances of interaction tension in solitary professional play demonstrated. Put differently, the emotional and attentive demands of video games arise at the intersection of material features, subjective dispositions, and social contextures (Elson, Breuer, & Quandt, 2014). Interaction tension captures exactly this kind of higher-level dynamic or relational phenomenon.

It concurs with flow and mood management theory that activities that spontaneously afford involvement block worry and self-consciousness, but adds a crucial social-psychological loop: To be flow-affording or intervening, activities need to align not just with players' subjective dispositions (e.g., matching game challenge and player skill), but also with the social norms of the surrounding situation. Misalignment not only affords boredom or self-consciousness: Often, social norms will compel players to engage in effortful self-control (Baumeister, Vohs, & Tice, 2007) to align overt behavior with norms, and that is negatively valenced. Bopp et al. (2018) found that players sometimes needed to actively self-regulate intense negative emotions to 'function' in-game or out-of-game. Eudaimonic media research posits that people sometimes willingly self-control to engage with demanding media that promise personal growth (Eden et al., 2018). Our findings suggest that media-related self-control is not just a practical matter of functioning or a price worth paying for personal growth: People dislike the strain of self-control involved in fitting displayed involvement into social norms. Therefore, they actively seek out or create media reception situations in which spontaneously afforded and socially demanded involvement align, such as watching a 'tearjerker' home alone or in the anonymity of a darkened movie theatre, where crying in public is both accepted and unnoticed.

5.3. Limitations

The qualitative nature and small, culturally, and temporally homogeneous sample of the present study limits its generalizability. We also note that the present article reports a re-analysis of qualitative data from an original study with a different focal theme (Deterding, 2014). While said original study stopped data collection on reaching theoretical saturation, the codes and themes of the present study are not necessarily fully theoretically saturated.

5.4. Outlook

A next step is to perform quantitative studies across divergent contexts to test the relations proposed in interaction tension. Should these bear out, interaction tension is arguably only the first opening of the social-psychological dynamics of gameplay. For instance, the model fits and identifies a potential systematic place for other important social-psychological phenomena and mechanisms like social emotions (Turner & Stets, 2006), joint attention (Seeman, 2011), emotional contagion (Hatfield et al., 1994), or collective emotions (von Scheve & Salmela, 2014) within video gaming. The literature on these phenomena specifies, but also qualifies and at times goes beyond the relations captured by Goffman—just as the social norms of gaming include but exceed involvement and its display.

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Conflict of Interests

The author declares no conflict of interests.

References

Baldamus, W. (1972). The role of discoveries in social science. In T. Shanin (Ed.), *The rules of the game: Cross-disciplinary essays on models in scholarly thought* (pp. 276–302). London: Tavistock Publications.

Bartsch, A., & Hartmann, T. (2017). The role of cognitive and affective challenge in entertainment experience. *Communication Research*, *44*(1), 29–53. https://doi.org/10.1177/0093650214565921

Baumeister, R. F., Vohs, K. D., & Tice, D. M. (2007). The strength model of self-control. *Current Directions in Psychological Science*, *16*(6), 351–355.

Bopp, J. A., Opwis, K., & Mekler, E. D. (2018). "An odd kind of pleasure": Differentiating emotional challenge in digital games. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*. New York, NY: ACM. https://doi.org/10.1145/3173574.3173615

Bowman, N. D. (2018a). The demanding nature of video game play. In N. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 1–23). New York, NY: Routledge.

Bowman, N. D. (Ed.). (2018b). *Video games: A medium that demands our attention*. New York, NY: Routledge.

Bowman, N. D., & Tamborini, R. (2015). "In the mood to game": Selective exposure and mood management processes in computer game play. *New Media & Society*, *17*(3), 375–374. https://doi.org/10.1177/

1461444813504274

Bowman, N. D., Wasserman, J., & Banks, J. (2018). Development of the video game demand scale. In N. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 207–232). New York, NY: Routledge.

Burghardt, G. M. (2005). *The genesis of animal play: Testing the limits*. Cambridge, MA: MIT Press.

Cairns, P., Cox, A., & Nordin, A. I. (2014). Immersion in digital games: Review of gaming experience research. In M. C. Angelides & H. Agius (Eds.), *Handbook of digital games* (pp. 337–361). Hoboken, NJ: John Wiley & Sons.

Calleja, G. (2011). *In-game: From immersion to incorporation*. Cambridge, MA, and London: MIT Press.

Cole, T., Cairns, P., & Gillies, M. (2015). Emotional and functional challenge in core and avant-garde games. In *Companian Proceedings of the 2015 Annual Symposium on Computer–Human Interaction in Play* (pp. 121–126). New York, NY: ACM. https://doi.org/10.1145/2793107.2793147

Corbin, J., & Strauss, A. L. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (3rd ed.). Los Angeles, CA, London, New Delhi, and Singapore: Sage.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper and Row.

Demand. (n.d.). In *Oxford English Dictionary*. Retrieved from https://www.oed.com/view/Entry/49580

Denisova, A., Guckelsberger, C., & Zendle, D. (2017). Challenge in digital games: Towards developing a measurement tool. In *Proceedings of the 2017 CHI Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 2511–2519). New York, NY: ACM. https://doi.org/10.1145/3027063.3053209

Deterding, S. (2014). *Modes of play: A frame analytic account of video game play* (Unpublished Doctoral dissertation). Hamburg University, Hamburg, Germany. Retrieved from http://ediss.sub.uni-hamburg.de/volltexte/2014/6863

Eden, A., Johnson, B. K., & Hartmann, T. (2018). Entertainment as a creature comfort: Self-control and selection of challenging media. *Media Psychology*, *21*(3), 352–376. https://doi.org/10.1080/15213269.2017.1345640

Elson, M., Breuer, J., & Quandt, T. (2014). Know thy player: An integrated model of player experience for digital games research. In M. C. Angelides & H. Agius (Eds.), *Handbook of digital games* (pp. 362–387). Hoboken, NJ: John Wiley & Sons.

Flick, U. (1997). *The episodic interview: Small-scale narratives as approach to relevant experiences*. London: LSE Methodology Institute.

Goffman, E. (1953). *Communication conduct in an island community*. Chicago, IL: University of Chicago.

Goffman, E. (1961). *Encounters: Two studies in the sociology of interaction*. Indianapolis, IN: Bobbs-Merrill.

Goffman, E. (1963). *Behavior in public places: Notes on the social organization of gatherings*. New York, NY: The Free Press.

Goffman, E. (1967). *Interaction ritual: Essays on face-to-face behavior*. New York, NY: Pantheon Books.

Goffman, E. (1983). The interaction order. *American Sociological Review*, *48*(1), 1–17.

Goffman, E. (1986). *Frame analysis: An essay on the organization of experience*. Boston, MA: Northeastern University Press.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods*, *18*(1), 59–82. https://doi.org/10.1177/1525822X05279903

Hatfield, E., Cacioppo, J. T., & Rapson, R. L. (1994). *Emotional contagion*. Cambridge: Cambridge University Press.

Henricks, T. S. (2015). *Play and the human condition*. Champaign, IL: University of Illinois Press.

Hung, A. C. Y. (2011). *The work of play: Meaning-making in video games*. New York, NY: Peter Lang.

Maxwell, J. A. (2004). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks, CA: Sage.

Pellegrini, A. D. (2009). *The role of play in human development*. New York, NY: Oxford University Press.

Peña, J. (2018). A communication model of the social demands in video games. In N. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 125–144). New York, NY: Routledge.

Reinecke, L. (2016). Mood management theory. In P. Rössler, C. A. Hoffner, & L. van Zoonen (Eds.), *The international encyclopedia of media effects* (pp. 1–13). Hoboken, NJ: John Wiley & Sons. https://doi.org/10.1002/9781118783764.wbieme0085

Scheff, T. J. (2000). Shame and the social bond: A sociological theory. *Sociological Theory*, *18*(1), 84–99.

Seeman, A. (Ed.). (2011). *Joint attention: New developments in psychology, philosophy of mind, and social neuroscience*. Cambridge, MA: MIT Press.

Sniderman, S. (1999). Unwritten rules. *The Life of Games*. Retrieved from http://www.gamepuzzles.com/tlog/tlog2.htm

Stenros, J. (2015). *Playfulness, play, and games: A constructionist ludology approach*. Tampere: Tampere University Press.

Sweetser, P., & Wyeth, P. (2005). GameFlow: A model for evaluating player enjoyment in games. *Computers in Entertainment*, *3*(3). https://doi.org/10.1145/1077246.1077253

Taylor, T. L. (2009). The assemblage of play. *Games and Culture*, *4*(4), 331–339. https://doi.org/10.1177/1555412009343576

Turner, J. H., & Stets, J. E. (2006). Sociological theories of human emotions. *Annual Review of Sociology*, *32*(1), 25–52. https://doi.org/10.1146/annurev.soc.32.061604.123130

von Scheve, C., & Salmela, M. (Eds.). (2014). *Collective emotions*. Oxford: Oxford University Press.

Williams, R. (1988). Understanding Goffman's methods.

In P. Drew & A. Wootton (Eds.), *Erving Goffman: Exploring the interaction order* (pp. 64–88). Cambridge and Oxford: Polity Press.

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Article

Elements of Infrastructure Demand in Multiplayer Video Games

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Abstract

With the advent of organized eSports, game streaming, and always-online video games, there exist new and more pronounced demands on players, developers, publishers, spectators, and other video game actors. By identifying and exploring elements of infrastructure in multiplayer games, this paper augments Bowman's (2018) conceptualization of demands in video games by introducing a new category of 'infrastructure demand' of games. This article describes how the infrastructure increasingly built around video games creates demands upon those interacting with these games, either as players, spectators, or facilitators of multiplayer video game play. We follow the method described by Susan Leigh Star (1999), who writes that infrastructure is as mundane as it is a critical part of society and as such is particularly deserving of academic study. When infrastructure works properly it fades from view, but in doing so loses none of its importance to human endeavor. This work therefore helps to make visible the invisible elements of infrastructure present in and around multiplayer video games and explicates the demands these elements create on people interacting with those games.

Keywords

eSports; infrastructure; infrastructure demand; multiplayer video games; video games

Issue

This article is part of the issue "Video Games as Demanding Technologies" edited by Nicholas David Bowman (Texas Tech University, USA).

1. Introduction

Video games have long been sites of interaction and competition. A decade after the creation of one of the first video games—SpaceWar! (completed in 1962)—devoted fans gathered to participate in an Intergalactic SpaceWar Olympics intended to prove whose skill with the prolific game was greatest (Brand, 1972, p. 1). Popular games such as Space Invaders and Tetris also saw tournaments spring up around them after their releases, mostly organized by enthusiasts in celebration of those games. Bowman's (2018, p. 16) four dimensions of demand in video games—cognitive, emotional, physical, and social—are readily visible in these early communal gaming spaces.

The advent of larger multiplayer environments in always-online games as well as organized eSports tournaments represents an evolution of multiplayer video game play. The excitement of players and fans in interacting with favorite games still exists, as does their dedication to mastering those games. However, the nature of contemporary multiplayer video games produces an augmented set of requirements for players, developers, publishers, spectators, and other video game actors, due in large part to the infrastructure required to support what have become massive, multi-million-dollar global products, events, and experiences. Examining the elements of infrastructure in such games provides an opportunity to augment Bowman's (2018) conceptualization of demand in video games by identifying and exploring a new and complementary category of 'infrastructure demand' of games.

This article thus describes how the infrastructure increasingly built around video games creates demands upon those interacting with these games—as players, spectators, facilitators, and developers, among others—and we argue that these demands are particularly visible, and thus productively explicable, in contemporary multiplayer games. We follow the method described by Susan Leigh Star (1999, p. 380), who writes that infrastructure is as mundane as it is a critical part of society and as such is particularly deserving of academic study. When infrastructure works properly it fades from view, but in doing so loses none of its importance to human endeavor. This work therefore helps to make visible the invisible elements of infrastructure present in multiplayer video games, explicates the demands these elements create on people interacting with those games, and suggests the scholarly value of conducting such a deep dive into the infrastructural elements of multiplayer video games.

2. Demand in Early Multiplayer Games

The First Intergalactic SpaceWar Olympics, a small gathering of around two dozen enthusiasts, was held on October 19th, 1972, at the Stanford Artificial Intelligence Laboratory, and is emblematic of multiplayer video game play organized for the love of the game. The SpaceWar Olympics have been claimed as both the first video game tournament and the first eSports tournament ever held, but it is more defensible to say that it was the first well-documented video game tournament. The detailed account that we have of the event comes from a *Rolling Stone* article—"Spacewar: Fanatic Life and Symbolic Death Among the Computer Bums", written by the prolific Stewart Brand (1972), founder of the *Whole Earth Catalog*, its digital counterpart the *Whole Earth 'Lectronic Link*, and more recently co-founder of the Long Now Foundation. Though well-known for a variety of reasons, this chronicle of the SpaceWar Olympics serves for our purposes to highlight Bowman's (2018) four dimensions of demand—cognitive, emotional, physical, and social—as they are visible in small-scale communal video game play.

Bowman (2018, p. 11) describes physical demand as "the extent to which a system requires the user to exert discrete or holistic physical effort." This physical demand upon players of SpaceWar! and its Olympians is perhaps most apparent, with Brand (1972, p. 50) writing of their experience "locked in life-or-death space combat computer-projected onto cathode ray tube display screens, for hours at a time, ruining their eyes, numbing their fingers in frenzied mashing of control buttons"; there need be no debate that video game play is physiologically engaging, whether in 1972 or 2019. The cognitive demand upon players—"the extent to which the user is required to implicitly or explicitly rationalize or understand the game" (Bowman, 2018, p. 5)—is also evident, as Brand recounts the highly diverse strategies employed by each of the five players in one match, some taking advantage of mechanical firing techniques they developed and others leaning in to intimate knowledge of the gravitational well present in the arena. Some players in the Spacewar Olympics used mind games directed at their opponents to get the upper hand rather than superior mechanical skill, a fact that captures the social demand evident at the event, wherein the "system triggers an implicit or explicit response in the user to the presence of other social actors" (Bowman, 2018, p. 13). In the two-on-two event, Brand provides a rich account of team banter, ranging from "Good work" to evidence of sudden and perhaps inevitable betrayal—"NO! You killed me!" and the response, "Being partners means never having to say you're sorry." (Brand, 1972, p. 1). Emotional demand—"the extent to which a video game causes the user to have an implicit or explicit affective response to the game"—is perhaps less visible as directly originating from the game rather than from the tournament environment itself (Bowman, 2018, p. 8). However, the gameplay of Spacewar! was evocative, and we readily see this fourth category of demand in the tension, exultation, and frustration elicited by the Olympic competition itself as players interact with each other.

The Spacewar! Olympics were sponsored—by *Rolling Stone*—but only to the extent that Brand wanted to make sure the event was successful. In practice this meant providing beer and light snacks and funding the grand prize—a year's free subscription to *Rolling Stone*. The reason Brand organized *Rolling Stone*'s involvement, however, was not primarily to celebrate the game, but rather to highlight the wide-reaching technological change that he saw beginning to happen on university campuses and in government research labs across the United States—the laying of the groundwork of a new class of computer infrastructure (Baker, 2016). "Ready or not," he begins his article, "computers are coming to the people" (Brand, 1972, p. 1). Video games, Brand thought, were a particularly good case with which to see the benefits of this infrastructure: "They manifested so many amazing things about what was becoming possible with computers" (Baker, 2016), and competitive multiplayer video games even more so. How might this type of video game play, then, make visible a fifth demand of video games—infrastructure?

3. Infrastructure Demand

To illustrate the potential form and applications of the category of infrastructure demand, we turn to the work of Susan Leigh Star and others disentangling a different class of demanding technologies—the infrastructure that makes up our built world. There is much scholarship on the centrality of infrastructural concerns to organized video game play. Taylor and Witkowski (2010) explore the realm of LAN-enabled video game play—LAN standing for local area network—by examining LAN parties, gatherings of players to experience networked local multiplayer play; LAN parties are a prime example of the layered infrastructures, digital and not, that support video game play, and through participant observation they provide rich accounts of how those infrastructures function together to support complex gaming spaces. Witkowski (2012) writes further about this complex interplay in an examination of Counter-Strike tournaments and interactions between the physical infrastructure supporting the game, such as keyboards and monitors, the infrastructure supporting players and their bodies, such as medical and fitness equipment, and the infrastructure of the game itself, such as the maps that matches are played upon and the visuals and sounds which communicate information to players at rapid speeds. Spilker, Ask, and Hansen (2018) examine of the layers of media infrastructure increasingly extant around video games; they describe Twitch.tv as a site in which audiences and media technologies intermingle, supported by the platform's infrastructure and in service to the enjoyment of games. Scully-Blaker, Begy, Consalvo, and Ganzon (2017) also write about Twitch, and through interviews they conduct with streamers on the platform we can see that the site itself is becoming infrastructure in its own right, and thus a critical part of an increasingly platformized gaming ecosystem.

Central to our formulation of infrastructure demand is Susan Leigh Star's (1999) methodological work in *The Ethnography of Infrastructure*. Star's approach in examining infrastructure is to invert the default perspective by focusing not on topics of systems, but on the "truly backstage elements" (Star, 1999, p. 380) that enable the network of systems to function. To this end, Star (1999, pp. 381-382) defines infrastructure by describing nine of its specific properties: embeddedness; reach or scope; built on an installed base; transparency; becomes visible upon breakdown; is fixed in modular increments, not all at once or globally; learned as a part of membership; links with conventions of practice; and embodiment of standards. Scholars of a variety of other systems have found application of these properties useful as a way to identify and open up the 'black box' of infrastructure and in so doing theorize that infrastructure's importance to systems at large. Dourish and Bell (2007) use the properties as a lens to examine the connection between sociality and ubiquitous computing as they relate to the organization and experience of space. Mark and Su (2010) apply them in examining changing work practices for 'nomadic workers,' individuals whose jobs require them to travel frequently. Arena, Arnaboldi, and Palermo (2017) make use of the properties to critically theorize enterprise risk management and boundary objects in accounting. Finally, Hartmann (2017) cites them as a useful starting point in asking questions about electrical power supply in an age of increasing smartphone use. We now suggest the utility of bringing Star's properties of infrastructure directly into discussions about video games, helpful as they are in conceptually breaking down otherwise complex and at times opaque systems. Discussions about the infrastructure of games, and the importance of that infrastructure, are not new. Bowman's conceptualization of demand in video games is new, however, and we believe it can be productively augmented with the following explication of infrastructure demand: the extent to which a video game system requires other, organizing systems to function.

For our purposes, we shall summarize each of Star's properties and then contextualize them in the gaming and eSports space to better convey the breadth of this topic and the degree to which these infrastructural features place important demands upon gaming, sometimes boosting other sources of demand and sometimes creating their own unique demands.

3.1. Embeddedness

The systems most commonly thought of as infrastructure are those highly integrated into our society, like water, electricity, and transportation. These systems are connected to so many other systems that it is difficult to separate them cleanly from the other systems they rely upon. Electrical power has long been a requirement in video games, and this power consumption has a meaningful impact on electrical consumption globally, amplifying demands upon our climate and environment (Schatz, 2018). Internet access is now a mandatory infrastructural system to engage in most multiplayer video game experiences, and even in single-player experiences, as in the controversy over the always-online requirement of the 2013 game SimCity (Yin-Poole, 2013). Video games consoles have marketed themselves by making appeals to this embeddedness, as seen in the 6th generation of consoles (especially the PS2 and Xbox) portraying themselves as home entertainment systems that fulfill the role of DVD players. The current 8th generation from Sony and Microsoft (PS4 and Xbox One) are fully integrated into the video streaming landscape and let users access services like Netflix and Twitch. Video streaming itself, whether on Twitch, YouTube, Mixer, or other services, has become highly embedded into our eSports landscape, with the ideas of a professional gamer and a professional streamer becoming blurred. Tournaments are streamed on these platforms, and many professional eSports competitors stream in addition to their eSports work, even to the extent of abandoning professional play to professionally stream (Nordmark, 2018).

3.2. Reach or Scope

Infrastructural systems stretch beyond single points in space and time and it does us little good to investigate specific moments of play without considering the larger systems at work. The moment of a major comeback in a tournament is not only an experience felt by those players, but also an experience mediated by all of the media systems watching that tournament. The commentators paid by the tournament contextualize the moment as it is watched physically by tournament attendees but also digitally by viewers on other platforms. The way in which these systems shape that moment is difficult to understand by solely examining the experience of the competitors and requires a broader understanding of the demands present.

This property of infrastructure also prompts us to be wary of explanations of infrastructural systems that focus only on a specific case, as infrastructural demands, while far-reaching, will not be universal. Latency is a particularly visible expression of infrastructure in online games, but the efficacy of particular solutions will vary wildly based on the game in question and the user conditions. Sheldon, Girard, Borg, Claypool, and Agu (2003) argue that latency is not as strong a concern in real-time strategy games as in first-person shooter games, specifically using the case of Blizzard's Warcraft III. This finding was partially contradicted by Véron, Marin, and Monnet (2014), who investigated latency in multiplayer online battle arenas (MOBAs), a genre developed out of a mod for Warcraft III. The relevance of latency in both cases was dependent upon the use cases of these games more so than any innate property of the games. Sheldon et al. (2003) did not focus on high-level multiplayer play, and competitive play in the just-released Warcraft III had not developed to the point of requiring extremely high actions per minute, which would in turn require low latency. MOBAs have genre differences that contribute to a greater need for minimizing latency, but audience expectations are also important. The need to think about infrastructure is present in multiplayer games, but this need should also be well-contextualized to the state of the game and its users.

3.3. Built on An Installed Base

Infrastructure is not built in isolation; it is intended to be integrated with other systems. Console ownership is one of the few infrastructural concerns publicly addressed by the gaming industry, as games succeed or fail based partially on the success or failure of their platform(s). On an individual level, the experience of a game may be more or less enjoyable based on the infrastructural features of that platform (e.g., frames per second, field of view, control comfort, etc.). The social dimensions of games are also partially dependent upon what systems the game chooses to rely upon. The indie game Towerfall initially did not possess an online mode, featuring only local multiplayer. This choice, motivated likely by the cost to implement effective netcode and servers, shaped the social environment in which this game could exist, encouraging it to be viewed more like a party game than a competitive multiplayer game.

The PC marketplace is presently experiencing controversy based upon this installed base property. Valve's near-monopoly of the PC digital download space with their platform of Steam is being challenged by other companies, most notably with Epic's Epic Games Store. The pushback against this competition has been enormous, and while much of it can be attributed to non-infrastructural concerns, some of this criticism of Epic can be attributed to a lack of infrastructural features. As Grayson (2019) notes, "[the Epic Games Store is] as barren as they come in terms of features, with next to nothing in the way of community tools, cloud saves, achievements, wishlists, mod support, user reviews, forums, or other longtime Steam standards." These lacking features are not simply an issue for the storefront, as these features have become infrastructural concerns for the games themselves, especially for community interaction purposes. The lack of this expected infrastructure helps to explain the enormous pushback against Epic's competition.

Another issue highlighted by this property is the increasing difficulty of preserving video games. The infrastructural systems games are built upon are particular to certain points in time and space, which renders the creation of archives of video games highly challenging. Even ignoring the physical degradation of components, video games are created with a variety of infrastructural assumptions which may no longer be true. Necessary drivers might no longer exist, connecting cables might no longer be manufactured, necessary supplementary materials might be lost, etc. Even for more recent releases, compatibility issues represent considerable difficulty for consumers to play games as the infrastructure of software and hardware changes. CD Projekt's GoG.com (formerly Good Old Games) is able to find a place in the increasingly crowded game distribution marketplace partially because it provides support for legally buying and playing old games whose release versions will no longer run well on modern systems. Even this may not be sufficient for multiplayer games, however, as user configuration tweaks cannot revive needed dedicated servers or proprietary network protocols. Kaltman (2016, p. 2) writes about precisely this issue, suggesting that digital distribution and network contingent games are combining to create, for archivists, "an untenable nightmare" because of the need to increasingly preserve, restore, or emulate the infrastructure upon which games are built before effort can be spent on preserving the game itself; this is further complicated by the proprietary nature of much of this infrastructure, which adds legal questions to an already complicated endeavor.

3.4. Transparency

The usual explanation for the lack of attention paid to infrastructural concerns is that infrastructure is by design transparent. Though dozens of systems are needed for a viewer to tune into a Twitch stream of an eSports tournament, the viewer is interested not in those systems, but rather the match. Similarly, narratives of video game development often focus on designers who create new systems rather than the workers keeping those systems functional. This dynamic helps support the continued exploitation of workers within the video game industry, as is well demonstrated by periods of continual crunch that Epic Games has demanded of their workers to keep the game Fortnite functioning (Campbell, 2019). The lens of infrastructure is valuable for adding to discussions of the exploitative nature of the video games industry, both for examining abuses towards workers (Dyer-Witheford & De Peuter, 2009) and for explorations of the exploitation of players as distributed labor (Ekbia & Nardi, 2017).

Paradoxically, infrastructure and the work of specialists eminently aware of its inner workings often demands that it not be seen, and so despite the increase of maintenance work within the video game industry from the current trend towards live services, infrastructure remains usually invisible. Consequently, the work required to maintain and operate these systems is often unacknowledged, save when something goes wrong.

3.5. Becomes Visible upon Breakdown

When infrastructure systems fail, they suddenly become noticeable. Though it is not always clear which system has necessarily failed in the interconnected network of infrastructure, the existence of an infrastructure becomes immediately apparent. A tournament planned for months in advance may be disrupted by internet outages, as seen in a 2012 League of Legends tournament where the always-online nature of the game required multiple restarts of matches as the venue intermittently lost internet access (Tassi, 2012). Such interruptions inflict a psychological toll on competitors, especially as the typical transparency of infrastructural systems trains players to not worry about platforms such as Steam or Battle.net going down during a heated moment. Infrastructure failure can cause a spike in negative experiences as a result of increased demands of all dimensions upon players and the people supporting them. Despite the increased visibility of infrastructural systems upon failure, the interconnected nature of infrastructural systems does not allow for easy pinpointing of what part of the infrastructure has failed, and the work required to repair these systems remains specialized and difficult. Moments of breakdown are useful to critically examine, however, as they provide unique windows into the inner workings of otherwise hidden systems and structures.

3.6. Is Fixed in Modular Increments, Not All at Once Or Globally

As befits the interconnected nature of infrastructural systems, it is not possible to correct breakdowns in infrastructure in totality. Fixes are always made to pieces of these systems, which send ripples throughout the rest of the network. The simplistic request common on gaming forums for the developers to 'fix the netcode' is not possible without changing many other variables. Some code will always be older than other code, and games will always rely upon pieces of infrastructure best described either figuratively or literally as crumbling. As in many cases of infrastructure work, the effort of maintainers is not well-rewarded, especially in the exploitative environment of the video game industry (Dyer-Witheford & De Peuter, 2009). The proper maintenance of video game infrastructure, therefore, is another type of demand that affects players and developers alike.

The gradual development of video game infrastructure renders investigations of past iterations of online games challenging. The game itself will undergo regular patches that change features, and this regular iteration can make the state of the same game years apart radically different. While games like World of Warcraft have dedicated communities that record the patch history of the game, even this fails to account for unannounced or undocumented changes to the game. In some cases, old versions of the game simply do not exist any longer. The history of Final Fantasy XIV is an example of this challenge. This game was radically redesigned following an unsuccessful first release, and the development along the 1.X branch prior to the 2.X rerelease is difficult to study, let alone to play, even for those with access to the developers themselves (O'Dwyer & Jayne, 2017).

3.7. Learned as A Part of Membership

An important consideration for the development of social demands in games is not just the experience of play, but the experience of learning infrastructural norms from other players. For children, learning the rules and norms of a new Minecraft server is not just a social requirement for fitting into a new group of people, but an infrastructural requirement for them to understand how and when they are permitted to use server commands and what lines of authority have been set up to deal with infrastructural concerns. It is also possible to understand the development of so-called 'metas'—agreed upon norms of acceptable and/or optimal play choices—in competitive games as an infrastructural demand. While social demands surround the choice to use or not use meta playstyles, a meta is a type of infrastructure that becomes learned by joining and becoming part of a community of players, and there are often social consequences for ignoring or pushing against these norms. A longer discussion of the infrastructure of the meta, part technological and part social, is presented below.

3.8. Links with Conventions of Practice

Moving further away from physical notions of infrastructure, the norms and conventions of the game industry can also be considered infrastructure. Design elements are limited by the conventional practice of the game industry, providing the benefits of 'intuitive' (or more accurately, 'conventional') interface and control schema, but also limiting design choices. Sometimes these limitations impose additional physical demand on players by forcing them to use challenging control systems to play a game that violates some of these conventions, as when a controller layout mandates the use of certain straining hand postures to optimally play. This problem may simply be a physical demand of the game, but it is also interpretable as a unique infrastructure demand for playing a game that is integrated into a certain infrastructural system. Perhaps switching to a different control system would alleviate these concerns, but support for such differences is another infrastructural requirement that the developer would have to incorporate.

The Nintendo Switch provides an interesting object of investigation for this subject, as its position as a hybrid console/handheld platform links it to two (or perhaps three) different lineages of conventions. While there are many different design implications from this, the choice of control system is perhaps the most explicit. The options to play in the handheld or docked modes, coupled with the choices of attached Joy-Cons, detached Joy-Cons, or a Pro controller reveal differing ideas about how games are supposed to be played. Designers have interesting limitations when designing for the Switch, as these different conventions necessitate either the rejection of certain conventions or the accommodation of multiple options at once. Games like Tetris 99 can be linked to a particular convention (original Tetris controls) and argue for a certain control scheme (detached Joy-Cons) being closer to the conventional ideal, but this is a negotiated and social process.

3.9. Embodiment of Standards

Likewise, the choices made to create a game in a certain way are often the embodiment of other infrastructural standards that are forced upon developers. The choice of platform, game engine, or user interface is often dictated by the standards of larger bodies like console manufacturers or publishers. While a game engine provides affordances for developers, it also embodies the standards of its creator, and if an engine is licensed from someone else, there may be conflicts between these standards and those desired by the developer. This problem is harshly stated by Schreier (2019) discussing the development of Anthem: “Many of the features those developers had taken for granted in previous engines, like a save-load system and a third-person camera, simply did not exist in [the Frostbite engine].” While the narrative of the failure of Anthem is complex, the game engine embodying different standards of game development was an infrastructural problem that put considerable demands on development time and resources. Those infrastructure demands for developers can then become demands for players, as the creation of fixes to resolve a calcified development problem often falls to players. Thus, a game can create demands for players before it is even played.

4. Overwatch League

What sort of work can be done with an eye towards infrastructure demand? Blizzard Entertainment’s Overwatch League (OWL), an eSports institution, provides a good example case to demonstrate the value of narratives told within the framework of infrastructure demand, specifically of a case where infrastructure demands push developers in contradictory directions. Overwatch is a first-person shooter whose standard mode of play sees teams of six players face off against each other to complete various objectives on maps set in a fictionalized Earth by playing some combination of three hero roles—Damage, Tank, and Support. Blizzard announced the formation of the OWL at Blizzcon 2016, a convention dedicated to the company’s games. Summerley (2019, p. 5) notes that this was in fact the same year that that the game itself launched, making the game and League a unique and useful “case where a developer has managed almost every aspect of a game’s journey into a sport including rapid commercialization and professionalization” and, of interest to us, the development of its infrastructure. The scholarship examined earlier reveals the infrastructural issues that affect organized competitive video game play on stage and at events dedicated to the practice. Certainly, the OWL, as an example of a large, well-funded competitive program, evinces such issues as well. But what more can be revealed if we follow the threads made visible to us with the lens of infrastructure demand? In what other ways does infrastructure matter in the competitive video game ecosystem, and why should scholars of games be interested in asking these questions? The following case will illustrate.

Our point of entry is the concept of the meta, introduced earlier. Metas within games are themselves infrastructure, working to construct norms and assumptions about what ‘proper’ gameplay is; various metas have developed in Overwatch over the course of the game’s existence, and it is in the story of one of the most recent—GOATS—that we can examine thornier questions of infrastructure demand. This is a case about the breakdown of infrastructure, which not only renders it visible but also uncovers the web of embedded systems and practices that Star tells us to expect when taking a deep dive into such studies. The case of OWL demonstrates a situation in which the infrastructure demands of Overwatch as eSport do not match the demands of Overwatch as game played by a large and diverse player base. This dissonance between the two demands has made itself known in struggles around the mechanical balance of the game as well as questions about who the game is for; an important point to be made about infrastructure demand is that it is variable based upon who experiences it.

The game of Overwatch offers two major play modes—‘Quick Play’ and ‘Competitive.’ The latter is a ranked mode of play that assigns a visible numerical skill rating (SR) to players based upon their performance in the mode, taking into account wins and aptitude with their chosen heroes. The SR ranges between 1 and 5000, and within that range exist different ranks (named ‘Bronze,’ ‘Silver,’ ‘Platinum,’ ‘Diamond,’ ‘Master,’ and ‘Grandmaster’), usually at every increment of 500. The efficacy of various strategies and heroes in the game varies significantly across ranks, as does the population of players. In February of 2018, Overwatch Lead Designer Jeff Kaplan revealed the percentage of Overwatch players who had attained each rank with an image showing that 62% of the game's player base had an SR lower than the numerical halfway point of 2500 (Kaplan, 2018). By comparison, OWL players, if they play the Competitive mode, are almost certain to attain a rank that puts them in the top 1% of players, according to Kaplan's (2018) post.

Herein lies our infrastructure question: For whom should the game be designed? It might seem reasonable for Overwatch's developers to spend much of their time balancing the game's mechanics and supporting systems around the majority of the player base to ensure an enjoyable experience. But OWL requires that the game, when played by some of its most skilled players, also be enjoyable to watch, since spectatorship is critical in sustaining any professional sport. There exists a tension here, because the game is a single artifact and the same rules and mechanics of the game apply whether a player is on stage or at home, in Silver or Grandmaster. This situation is a perennial problem in eSports games, and reconciling this tension is still a significant challenge, and one with which Blizzard has made some unusual choices. OWL attempts to solve this problem by selectively choosing when new versions of the game are used by the tournament, thus allowing professional players to play one version of the game while non-professional players play another. This choice undermines the sense of Overwatch as a specific game and has led to player complaints about enjoyment watching OWL, since it often meant an old version of the game was being played (Czar, 2018). Central here is the point that the same single design decision regarding a particular hero, map, or fundamental mechanic in the game will create different and perhaps irreconcilable demands for different groups in the OWL and Overwatch community.

This tension is perhaps most visible in the variety of changes to the game made by Blizzard in an attempt to move away from one particular dominant strategic composition of heroes—GOATS, which consists of three Tank heroes and three Support heroes. It is outside the scope of this article to tell the whole story of GOATS, but it is sufficient to say that its use in high level OWL play was extremely effective, best defeated with mirrored use of the GOATS composition, difficult to successfully emulate by the majority of the Overwatch player base due to its complexity, and generally agreed by OWL viewers to be decidedly uninteresting to watch (Van Allen, 2019). GOATS mirror matches became the norm in OWL, to the detriment of professional players of Damage heroes, who had no place in GOATS, and viewers, who knew exactly what to expect from each match. While other factors were at play, the primacy of GOATS certainly contributed to the declining viewership numbers that OWL was experiencing at the time, despite the incredible resources Blizzard was investing in spreading OWL to as many platforms as possible, from its own client to Twitch, China's Zhanqi.tv, and on ESPN (Miceli, 2019).

Blizzard alternately attempted to displace the dominant GOATS by: (1) weakening some of the heroes in the composition to open up opportunities for more than the six heroes in GOATS to be seen on stage at one time; (2) changing the mechanics of one type of health in the game upon which GOATS heavily relied—armor—in an attempt to open up counterplay; and most recently (3) restricting the number of each role of hero that can be played on a team in Quick Play and Competitive while also preventing the switching of heroes across different roles during play. This last change, known as 2-2-2 because it limits all teams to two heroes of each role, has been the most dramatic in reconfiguring the way the game functions and in determining how its most popular modes can or cannot be played. Overwatch players had also been asking for this change outside of the context of OWL, since the structure imposed by 2-2-2 was believed to solve other issues with the game, but it is inarguable that part of its implementation was a direct challenge to GOATS, which had become ingrained in OWL and feeder competitions for the League.

Conceptualizing these changes to the game as infrastructural fixes, we can become aware of the ripple effects they have had upon the game and in turn its players. The act of adjusting the power of heroes (the first change—balancing) carries implicit assumptions on the part of developers about how those heroes are used by players; that use is not uniform across the player community or across ranks. This means that demands on players vary as they learn how to play and play against newly balanced heroes; changes that alter the meta in one way in one rank can alter it in other ways at other ranks, and this was the case as balance fixes cascaded through the game. The second act—changing a core game mechanic—brought with it more extreme results. Armor reduces the amount of damage a hero would take with a very specific mathematical formula. Change the formula, and suddenly interactions involving any hero with armor change as well. Determinations of which hero is strong versus another shift, which necessitates changes in strategy, team compositions, and the social dynamics associated with choosing those compositions at the start of a match. All are a form of infrastructure, and all feel the effects of a change in just one. The long-term results of the third act—changing the structure of the teams—are still to be seen at time of writing. We can read in Blizzard's official announcement of the change a sensitivity to multiple types of demand at play in Overwatch:

> A lot of important decision-making happens in the 40 seconds before a match even begins, as everyone selects their heroes and responds to others' role choices. It's not uncommon for players—who may all have different goals and play styles—to feel tension, pressure, disappointment, or even hostility as a team composition comes together. The Role Queue system is designed to help take the edge off this process, ultimately leading to matches that feel fairer and more

> fun, where players are in roles that they want to be in. (Blizzard Entertainment, 2019)

While marketed as a purely positive change, limiting the number of each hero role in each team has shaken standard conventions of practice within the game. While shaking the infrastructural meta for OWL was the point of this change, this alteration was applied broadly, with aftershocks felt by the rest of the game's players. Anecdotally, many players, at home and in the League, believe that 2-2-2 removes a core element of the game—the ability to dynamically and creatively determine the composition of one's team to outmaneuver one's opponents—and in so doing will fundamentally weaken it. Some players who identified themselves as 'flex' players, those skilled in switching roles fluidly before and during a match as they determined situations dictated, saw the infrastructure of the game change to eliminate their preferred practice. Their mode of play is no longer possible in the game's Quick Play and Competitive modes and many of these players have felt alienated as a result. It has yet to be seen what long-term effect 2-2-2 will have on OWL's success; the enjoyment of OWL spectators, and the livelihoods of OWL commentators and professional players depend on it, fundamental as it is to Overwatch's gameplay. Such is the nature of infrastructure; there may be 'backstage elements' yet to reveal themselves as this case unfolds.

5. Conclusion

This conceptualization of infrastructure demand may also help elucidate broader concerns for video games. While Blizzard may conceptualize their investments in expanding the viewership of Overwatch onto new platforms as a sort of infrastructure investment, thinking of changes to their game systems as infrastructural shifts would help in recognizing when their decisions demonstrate infrastructural conflict. The infrastructure they are building for OWL, whether in game versions or in sweeping balance changes, conflicts with the infrastructure already established for non-professional play. The problems Blizzard is trying to solve are not isolated issues; they are part of interconnected infrastructure, and changes to these systems will have effects on other systems, both social and technological.

In the previous sections, we communicated through multiple levels of analysis that there are many ways to apply the concept of infrastructure demand to video game research. Its value comes from its broad applicability to experiences at multiple levels and in multiple modes of interaction with video games. These include player experiences, which are the primary focus of the four types of demand laid out above—cognitive, emotional, physical, and social—but also the experiences of game developers, eSports facilitators, and more, which are shaped by infrastructure demands that may not be visible at first glance. Within the context of video games as a source of demand, infrastructure may inform our understanding of existing sources of demand by proposing new interpretations, as in the example of physical demand and controllers, while also enabling the exploration of new questions of demand, such as considering the environmental cost of video games, which would be difficult to conceptualize under a purely individualistic understanding of the study of video games. This conceptualization may also benefit designers of games by allowing for a broad and interconnected understanding of the systems requisite for a game to function. Thinking of the meta of a video game as infrastructure is not only a semantic adjustment. It makes tangible what otherwise might be thought of as arbitrary social conventions. Not only do these demands upon a game have weight, but attempts to change them must also be taken with care, as they are still connected to other systems; one well-intentioned solution to a problem might cause a break in numerous other places.

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References

Arena, M., Arnaboldi, M., & Palermo, T. (2017). The dynamics of (dis)integrated risk management: A comparative field study. *Accounting, Organizations and Society*, *62*, 65–81.

Baker, C. (2016). Stewart Brand recalls first 'Spacewar' video game tournament. *Rolling Stone*. Retrieved from https://www.rollingstone.com/culture/culture-news/stewart-brand-recalls-first-spacewar-video-game-tournament-187669

Blizzard Entertainment. (2019). Introducing role queue. *Blizzard*. Retrieved from https://playoverwatch.com/en-us/news/23060961/introducing-role-queue

Bowman, N. D. (Ed.). (2018). *Video games: A medium that demands our attention*. Oxford: Routledge.

Brand, S. (1972, December 7). SPACEWAR: Fanatic life and symbolic death among the computer bums. *Rolling Stone*.

Campbell, C. (2019). How Fortnite's success led to months of intense crunch at Epic Games. *Polygon*. Retrieved from https://www.polygon.com/2019/4/23/18507750/fortnite-work-crunch-epic-games

Czar, M. (2018). The patch problem in Overwatch League. *Daily Esports*. Retrieved from https://www.dailyesports.gg/the-patch-problem-in-overwatch-league

Dourish, P., & Bell, G. (2007). The infrastructure of experience and the experience of infrastructure: Meaning and structure in everyday encounters with space. *Environment and Planning B: Planning and Design*, *34*(3), 414–430.

Dyer-Witheford, N., & De Peuter, G. (2009). *Games of empire: Global capitalism and video games*. Minneapolis, MN: University of Minnesota Press.

Ekbia, H. R., & Nardi, B. A. (2017). *Heteromation, and other stories of computing and capitalism*. Cambridge, MA: MIT Press.

Grayson, N. (2019). Why people are so mad about the Epic Games Store. *Kotaku*. Retrieved from https://kotaku.com/why-people-are-so-mad-about-the-epic-games-store-1833848770

Hartmann, M. (2017). Circuit(s) of affective infrastructuring. In J. Vincent & L. Haddon (Eds.), *Smartphone cultures* (pp. 11–24). Oxford: Routledge.

Kaltman, E. (2016). Current game preservation is not enough. *How They Got Game*. Retrieved from https://web.stanford.edu/group/htgg/cgi-bin/drupal/?q=node/1211

Kaplan, J. (2018). Competitive mode tier distribution. *Blizzard*. Retrieved from https://us.forums.blizzard.com/en/overwatch/t/competitive-mode-tier-distribution/972

Mark, G., & Su, N. M. (2010). Making infrastructure visible for nomadic work. *Pervasive and Mobile Computing*, *6*(3), 312–323.

Miceli, M. (2019). Overwatch League Twitch viewership continues to slide as stage three starts. *The Esports Observer*. Retrieved from https://esportsobserver.com/owl-twitch-stage-three-2019

Nordmark, S. (2018). Live streamer or competitive gamer—Which career makes the most sense? *Dot eSports*. Retrieved from https://dotesports.com/general/news/esports-vs-streaming-money-career-31144

O'Dwyer, D., & Jayne, J. [Noclip]. (2017, June 23). *Final Fantasy XIV documentary part #1—"One point O"* [Video file]. Retrieved from https://www.youtube.com/watch?v=Xs0yQKI7Yw4

Schatz, B. (2018). Video games consume more electricity than 25 power plants can produce. *Mother Jones*. Retrieved from https://www.motherjones.com/environment/2018/11/video-games-electricity-carbon-footprint

Schreier, J. (2019). How BioWare's anthem went wrong. *Kotaku*. Retrieved from https://kotaku.com/how-biowares-anthem-went-wrong-1833731964

Scully-Blaker, R., Begy, J., Consalvo, M., & Ganzon, S. C. (2017). Playing along and playing for on Twitch: Livestreaming from tandem play to performance. In *Proceedings of the 50th Hawaii International Conference on System Sciences* (pp. 2026–2035). Honolulu, HI: University of Hawaii.

Sheldon, N., Girard, E., Borg, S., Claypool, M., & Agu, E. (2003). The effect of latency on user performance in Warcraft III. In *Proceedings of the 2nd Workshop on Network and System Support for Games* (pp. 3–14). New York, NY: ACM.

Spilker, H. S., Ask, K., & Hansen, M. (2018). The new practices and infrastructures of participation: How the popularity of Twitch.tv challenges old and new ideas about television viewing. *Information, Communication & Society*. Advance online publication. https://doi.org/10.1080/1369118X.2018.1529193

Star, S. L. (1999). The ethnography of infrastructure. *American Behavioral Scientist*, *43*(3), 377–391.

Summerley, R. (2019). The development of sports: A comparative analysis of the early institutionalization of traditional sports and e-sports. *Games and Culture*. Advance online publication. https://doi.org/10.1177/1555412019838094

Tassi, P. (2012). Internet meltdown at LoL world championships shows eSports has a problem. *Forbes*. Retrieved from https://www.forbes.com/sites/insertcoin/2012/10/08/internet-meltdown-at-lol-world-championships-shows-esports-has-a-problem

Taylor, T. L., & Witkowski, E. (2010). This is how we play it: What a mega-LAN can teach us about games. In *Proceedings of the Fifth International Conference on the Foundations of Digital Games* (pp. 195–202). New York, NY: ACM.

Van Allen, E. (2019). What is GOATS in Overwatch, and why are fans so upset with it? *Polygon*. Retrieved from https://www.polygon.com/2019/2/25/18239845/overwatch-goats-meta-triple-tank-explainer

Véron, M., Marin, O., & Monnet, S. (2014). Matchmaking in multi-player on-line games: Studying user traces to improve the user experience. In *Proceedings of Network and Operating System Support on Digital Audio and Video Workshop* (p. 7). New York, NY: ACM.

Witkowski, E. (2012). On the digital playing field: How we "do sport" with networked computer games. *Games and Culture*, *7*(5), 349–374.

Yin-Poole, W. (2013). Maxis attempts to explain why SimCity is always-online as players discover code for 20-min offline force-shutdown timer. *Eurogamer*. Retrieved from https://www.eurogamer.net/articles/2013-03-18-maxis-attempts-to-explain-why-simcity-is-always-online-as-players-discover-code-for-20-min-force-shutdown-timer-for-offline

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Article

Reducing Extrinsic Burdens on Players of Digital Games: An Integrated Framework

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Abstract
Increasingly complex gameplay and gameworlds are placing greater demands on players, while grander approaches to help them cope, such as heads-up displays (HUDs), maps, notifications, and real-time statistics, may often create even more layers of complexity, and thus burdens, further detaching players from core gameplay. In this article, we distinguish between 'intrinsic' (fundamental to gameplay) and 'extrinsic' (peripheral or extraneous to gameplay) game elements, where the latter may be seen to increase burdens on players unnecessarily, subsequently affecting engagement. We propose a framework, comprising core, interaction, and interface layers, that reveals how extrinsicality may be minimised to better facilitate intrinsic gameplay and engagement.

Keywords
digital games; flow; framework; gameplay; immersion; involvement; player engagement; presence

Issue
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1. From Demands to Burdens in Digital Games

Fun has been found to be a prevalent motivation among gamers (Reid, 2012), albeit not universally applicable to all (Jørgensen, 2016), and a key element of the entertainment that games provide is through the provision of multiple challenging and competitive situations that players feel a necessity to resolve (Vorderer, Hartmann, & Klimmt, 2003). As Bernard Suits (1978) defined it:

> To play a game is to engage in activity directed towards bringing about a specific state of affairs, using only means permitted by rules, where the rules prohibit more efficient in favour of less efficient means, and where such rules are accepted just because they make possible such activity. (p. 34)

The overcoming of obstacles of some kind is therefore a major aspect of most gameplay. However, as digital games have developed, technology has extended the realms of what is possible, enabling more complex gameplay and vaster gameworlds, ranging from single player to large-scale multiplayer gaming, including multiplayer first-person shooters (Pirker, Rattinger, Drachen, & Sifa, 2018), multiplayer online battle arenas (MOBAs; Mora-Cantallops & Sicilia, 2018), and e-Sports (Martončik, 2015), such that digital games now often require a considerable amount of time to learn and play (Bouchard, 2015). For example, massively multiplayer online role-playing games (MMORPGs) have endless narratives and a never-ending system of goals and achievements, leading to prolonged and extended engagement with the game as players continually challenge their abilities (Gray &

Huang, 2015). It is not surprising, then, that a recent international survey (Limelight Networks, 2019) found that more than half of players have missed sleep and more than a third have missed a meal due to gaming. It is clear that many modern games now require much more from their players than they have historically.

Such complexity places significant demands on players' intelligence. For example, expertise in MOBAs has been correlated with fluid intelligence due to the strong demands on memory, tactics, and strategy over hand-eye coordination (Kokkinakis, Cowling, Drachen, & Wade, 2017), and it has also been demonstrated that player performance deteriorates over periods of sustained engagement, even where collaboration with others may help overcome fast-paced, complex tasks and where player experience may reduce the effects (Sapienza, Zeng, Bessi, Lerman, & Ferrara, 2018). Digital games have been found to have more complex effects on stress outcomes as they do not share the same characteristics as other mental stressors due to the interactive player experience (Porter & Goolkasian, 2019). Alternative approaches have sought to develop ever grander approaches to providing players with information to help them cope with increasingly vaster and intricate gameworlds, such as heads-up displays (HUDs), maps, notifications, and real-time statistics. Even the addition of a third hand (controlled by the foot) into a game has been trialled (successfully) for reducing physical and mental burdens (Abdi, Burdet, Bouri, Himidan, & Bleuler, 2016). However, when not implemented carefully, these approaches often result in additional layers of complexity being added on top of the game, thereby further increasing the burden on players and creating additional barriers that may detach them from the core gameplay.

At the other extreme, particularly on smartphones and in browsers, we have witnessed the emergence of casual games (Juul, 2010), abstract persistent progressive massively multiplayer asynchronous games (APPMMAGs), which have little story and no vividly-expressed gameworld (Bouchard, 2015), and idle or incremental games, which incorporate extended periods of just waiting where the player's participation is optional and may even be redundant (Cutting, Gundry, & Cairns, 2019; Fizek, 2018). Such games especially appeal to those who prefer simpler game mechanics and more acceptable, accessible, and flexible gameplay experiences (Kultima, 2009). Indeed, a large factor driving the enjoyment of mobile gaming has been found to be persistent ease of use, primarily arising from a simple interface and gameplay (Merikivi, Tuunainen, & Nguyen, 2017), and casual single-player games in particular have now risen to become the most popular type of game worldwide (Limelight Networks, 2019).

Hence, as digital games place an ever-increasing combination of interactive, cognitive, emotional, physical, and social demands on players (Bowman, 2018), what were once reasonable and appropriate demands for digital games, necessary in order for them to provide sufficient entertainment, may now be seen as shifting towards being burdens, which players may be struggling to cope with on multiple dimensions and may be considered unnecessary. The notion that the gameworld itself is an interface (Jørgensen, 2013) is an important one here. Jørgensen argues that information integrated into the gameworld is part of it, regardless of how it is presented, and it exists to support meaningful gameplay and help the player understand its workings. Thus, the gameworld need not be natural or offer fictional coherence, but needs to provide clear, consistent and context-appropriate information for meaningful gameplay in order to create a sense of engagement and attachment. Hence, burdens should not be forced to be alleviated by reducing the complexity of gameworlds or game mechanics (as in APPMMAGs and many casual games), nor by making gameworlds more transparent so that they appear as unmediated as possible, nor by offering 'narrative' or 'easy' modes to circumvent complex gameplay in favour of a story or exploratory experience (e.g., as in Red Dead Redemption 2, The Witcher 3, Mass Effect Andromeda, and Assassin's Creed Odyssey). Rather, we argue that this should be achieved by striking a balance, such that meaningful gameplay is facilitated, not hindered, and unnecessary burdens to it are alleviated in an effective manner. As Salen and Zimmerman (2003) posit, the goal of game design is to create meaningful play, and this meaningful play emerges from the relationships between player actions and system outcomes when those relationships are both discernible (the result of the game action is communicated to the player in a perceivable way) and integrated into the larger context of the game (actions have immediate significance and also affect play experiences at a later point). Therefore, we may consider a burden to be anything within the gameworld which causes an overhead that hinders, compromises, or does not facilitate meaningful play, and thus impairs player engagement.

To better understand how unnecessary burdens may be alleviated in an effective manner, we find it valuable to distinguish between 'intrinsic' and 'extrinsic' elements of digital games, where the former are fundamental to the gameplay, such as game mechanics, while the latter are peripheral or even extraneous to the core gameplay, such as information players require that is not clearly discernible or tasks they must undertake in order to support the mechanics prior to or which interrupt play. In Section 2, we argue that the extrinsic elements unnecessarily increase the demands on the player creating burdens which subsequently reduce or break player engagement. Subsequently, in Section 3, we propose a framework that helps to reveal how extrinsic elements may be minimised so that intrinsic gameplay is better supported and stronger degrees of engagement are facilitated. The framework encapsulates and integrates a range of emerging technological approaches reported in the literature and comprises three layers: 'core' (intrinsic gameplay support); 'interaction' (reduces extrinsic player interactions); and 'interface' (reduces extrinsicality at the user interface [UI]). Finally, in Section 4, we draw some conclusions and distinguish the main areas of potential framework usage.

2. Intrinsicality and Extrinsicality in Digital Games

In order to consider burdensome aspects of digital games, we interpret them from a perspective of whether they reduce or break player engagement. We adopt a view of engagement as being progressive, as in the Revised Game Engagement Model (R-GEM), proposed by Procci, Bowers, Jentsch, Sims, and McDaniel (2018). We use this model as it is empirically validated, rooted in over two decades of prior research, and helps to reduce inconsistency in current games research terms while enabling consideration of all key constructs. R-GEM interrelates four key constructs that have proven critical to games research (each construct is substantially explored within their paper and definitions are based on those used within the model): 'immersion' (being enveloped by the games' stimuli and experiences); 'involvement' (motivation to play); 'presence' (feeling physically located within and interacting with the game, requiring a high level of immersion); and 'flow' (optimal experience of intrinsically-motivated and goal-driven enjoyment where temporal perception is distorted, requiring a high level of involvement, which occurs when a careful balance is achieved between task difficulty and player skill). In R-GEM, attention leads to low-level, reciprocal engagement states of 'immersion' and 'involvement,' which must be experienced prior to high-level engagement states of 'presence' and 'flow.' High-level engagement states are less easily attainable than low-level states, and thus the potential for burdensome aspects to affect high-level engagement is much greater. In addition, the more a player's cognitive effort is spent focusing their attention, the fewer cognitive resources remain for them to become further engaged; thus, minimising burdensome aspects also helps the player sustain their attention. The model also reflects the fact that immersion and involvement are reciprocal (e.g., more immersion is likely to lead to the player becoming more invested and thus more involved, while non-immersive games can become immersive through strong player determination to be involved). Thus, while presence and flow are presented as distinct states directly influenced by immersion and involvement respectively, there may also be some indirect influences which are acknowledged by the model. Such overlaps have been extensively discussed in the literature. For example, Csikszentmihalyi (1975, 1990), who first introduced flow, proposed various elements, some of which coincide with notions of immersion, such as concentration and the merging of action and awareness, while others help to distinguish it from presence, such as loss of self-consciousness (not being preoccupied with self). Alternatively, Michailidis, Balaguer-Ballester, and He (2018) have argued that flow is not substantially different from immersion and the terms can be used interchangeably, while Lombard and Ditton (1997) have argued that presence is conceptualised as immersion which makes players feel involved. Calleja (2011) considered involvement to be a precursor to presence or immersion where his notion of incorporation has been shown to align with R-GEM. It is also important to note that R-GEM only presents likely influences leading to progression, rather than conclusive progression (it is not deterministic), due to its focus on subjective player experience.

Using this model, we consider digital game elements from a viewpoint of being primarily either 'intrinsic' or 'extrinsic' to gameplay (while these terms have connotations stemming from psychological disciplines and gamification, we do not use them here in the same way). 'Intrinsic' game elements are fundamental to gameplay and serve to support engagement directly without being burdensome. Effectively, these serve what Salen and Zimmerman (2003) refer to as the internal, intrinsic qualities of games, relating to rules and play. Hence, intrinsic game elements will typically be focused on game mechanics, which contribute to involvement and flow by regulating the levels of challenge in the game, around well-crafted narratives involving in-game characters that players are able to empathise and identify with thus supporting intrinsic motivation and leading to involvement, or around high-sensory aesthetics which assist player control and encourage players towards immersion and presence (Alexiou & Schippers, 2018). Intrinsic game elements necessarily place demands on players and may involve overheads, but these facilitate rather than impair player engagement, e.g., such demands form part of the challenge needed for flow, and therefore do not evolve into burdens. It is therefore important that intrinsic game elements take into account the gaming experience and cognitive skills of the player so that engagement is not prevented (Sherry, 2004), and that choices are embedded into gameplay mechanics so that players are actively able to control and facilitate their in-game flow (Chen, 2006, 2007). However, if engagement is overly facilitated, the player may become engaged excessively, such that the experience of flow or presence does not serve to provide meaningful growth that they value (Salisbury & Tomlinson, 2016), e.g., to the point of addiction (Loton, Borkoles, Lubman, & Polman, 2016) or such that they feel an obligation to achieve (Molesworth & Watkins, 2016). This too, then, would be burdensome. Therefore, we might consider the relationship between player engagement and burdens to be a bell curve, centred around an engagement 'sweet spot,' though further consideration is beyond the scope of this paper.

In contrast, 'extrinsic' game elements are peripheral or even extraneous to gameplay. They unnecessarily increase player overheads and create excessive demands that may be considered burdens, which subsequently reduce or break their engagement. This may include information players require or tasks they must undertake in order to support the game mechanics before they can get on with the matter of just playing the game or which interrupt gameplay, effectively serving as the bureaucracy of the game, and game elements which detract or distract from meaningful gameplay, such as interfaces and controls that are too difficult to master or understand. Such difficulties are not the same as challenges or demands necessary for games, e.g., for facilitating flow, but typically occur as a result of less effective game design. For example, PaRapper the Rapper 2 requires buttons to be pressed in time with the music, which necessitates continued focusing on visual guidance at the top of the screen thereby detracting from the rest of the screen which tends to reduce player engagement, whereas, in contrast, Just Dance 2020 uses on-screen dancers performing the routine in the centre of the screen as core guidance, with only intermittent glances necessary to the pre-emptive dance icons at the bottom, making this less extrinsic. Likewise, the 'viewpoint synchronisation' element in the Assassin's Creed franchise is required for the player to view in-game objectives and get oriented to their current location, which requires consulting a map to locate a viewpoint (typically a tall building or tower), navigating to that viewpoint, and then climbing it, potentially manifesting multiple layers of game bureaucracy. However, the use of climbing and 'leap of faith' mechanics (to drop down on to a haystack) adds a level of challenge to the otherwise extrinsic element which encourages involvement and thus flow, while the inclusion of a 360-degree view of the surrounding area at the top of the viewpoint provides the player with an immersive form of information and new locations, which, coupled with realistic views of historical locations, has a likely influence on presence. There is therefore some overlap between extrinsicality and what Procci et al. (2018) refer to as internal and external distractions, some of which may be reduced through more usable designs and less obtrusive game peripherals that limit external sensory interference.

It is important to note that the distinction between intrinsic and extrinsic is not the same as internal and external to the gameworld, where the former are firmly contained within the realm of the game while the latter are outside and serve as a form of mediator between the player and the game, such as how players map to game controllers (Liebold, Bowman, & Pietschmann, 2018). While this distinction may similarly be used to understand demands on players, such as the physical demands required by controllers (Bowman, 2018), and thus may overlap somewhat, the perspective of intrinsic and extrinsic does not fully align. For example, consider where the player needs to read a large amount of in-game text with direct relevance to the game, e.g., where some events and characters are not depicted directly on screen. This may be considered internal to the gameworld but requires some imagination and internal processing on the part of the player and thus some overhead. If this text is not carefully presented so that it facilitates player engagement, we may consider it overly demanding, and therefore burdensome and extrinsic. Thus, while text may be intrinsic to the gameworld, it may not be intrinsic to meaningful gameplay. For this reason, a distinction in terms of gameplay rather than gameworld is preferred in this work.

3. Framework for Reducing Extrinsicality

Following from the above, we propose a framework, depicted in Table 1, comprising key emerging technological approaches surveyed from the literature which individually or in combination may serve to minimise extrinsicality (and thereby facilitate intrinsicality) and positively influence low- to high-level player engagement. At the base layer are core technological approaches used to realise digital game elements, which support the layers above and typically focus on intrinsic gameplay support. The middle layer comprises interaction technologies, in conjunction with the core layer below and in support of the higher interface layer, in order to effectively facilitate non-burdensome interaction between player and game. The top, interface layer encapsulates technological approaches that may be used to reduce extrinsicality at the player UI, typically the screen but may also include controllers and any physical interaction spaces, to improve the effectiveness of the UI. Figure 1 illustrates how these layers relate to the digital game elements and player engagement discussed in Section 2. Given that in R-GEM, immersion is a necessary antecedent for presence and involvement is a necessary antecedent for flow, technologies will generally influence progressive engagement pathways (i.e., immersion–presence and/or involvement–flow), rather than individual construct levels within those pathways, and may also influence the reciprocity between immersion and involvement, as was discussed in Section 2. Thus, we denote these influences as: immersion–presence (IP), involvement–flow (NF), and immersion–involvement (IN) in Table 1 and the rest of this section.

3.1. Core

The core layer consists of technologies which support higher level layers in achieving intrinsic gameplay support through minimising extrinsicality. Mostly these are concerned with 'game mechanics,' where game elements challenge and engage cognitively, physically, or emotionally, thereby influencing involvement, and as these progress, influencing the player to transcend into flow (Huang et al., 2018; Procci et al., 2018), supporting the NF engagement pathway. Many games enable the selection of different gameplay modes and difficulty levels, however, game mechanics which are specifically designed to reduce the cognitive load on the player have been shown to increase involvement (Nelson, Bowman, Bowman, & Kim, 2018). 'Dynamic difficulty adaptation' (DDA; a.k.a. scaling) undertakes adjustment of difficulty

Table 1. The proposed framework.

Layer	Example technological approaches generating digital game elements	Engagement pathways influenced*		
		IP	NF	IN
Interface (top)	Fluid UI	X	X	
	Diegetic interfaces	X	X	
	Gamespace awareness	X	X	X
	Playful-consumption experiences	X		
Interaction (middle)	Pacing	X		
	Isomorphic controllers	X		
	Personalisation and player profiling	X	X	X
	Model matching	X	X	
	Incentivisation		X	
	Emergent collaboration		X	
	Believable agents	X	X	X
	Persuasive technologies		X	
Core (base)	Game mechanics		X	
	Dynamic difficulty adaptation (DDA)		X	X
	Procedural content generation (PCG)	X	X	X
	Narrative optimisation	X		

Notes: I = immersion, P = presence, N = involvement, F = flow.

during the game and has been identified as core to facilitating engagement, predominantly involvement and flow (NF). For example, Silva, do Nascimento Silva, and Chaimowicz (2017) use DDA to minimise and avoid frustrations commonly caused by the lower autonomy and higher challenge elements of MOBAs, via a game agent that adapts its behaviour dynamically to player performance as evaluated via a metric based on certain game features (level, death count, and towers destroyed). Similarly, in FlowAI (Cruz & Uresti, 2017), a DDA module is responsible for adapting any tangible gameplay feature that might change the perceived level of difficulty, specifically non-player character (NPC) behaviour, quests or scenarios, and game mechanics. However, FlowAI also includes a specific immersion module, responsible for breaking down barriers that could limit a player from immersing in a game by adapting NPC behaviour, quests or scenarios, and controls, thus DDA may also help to fa-

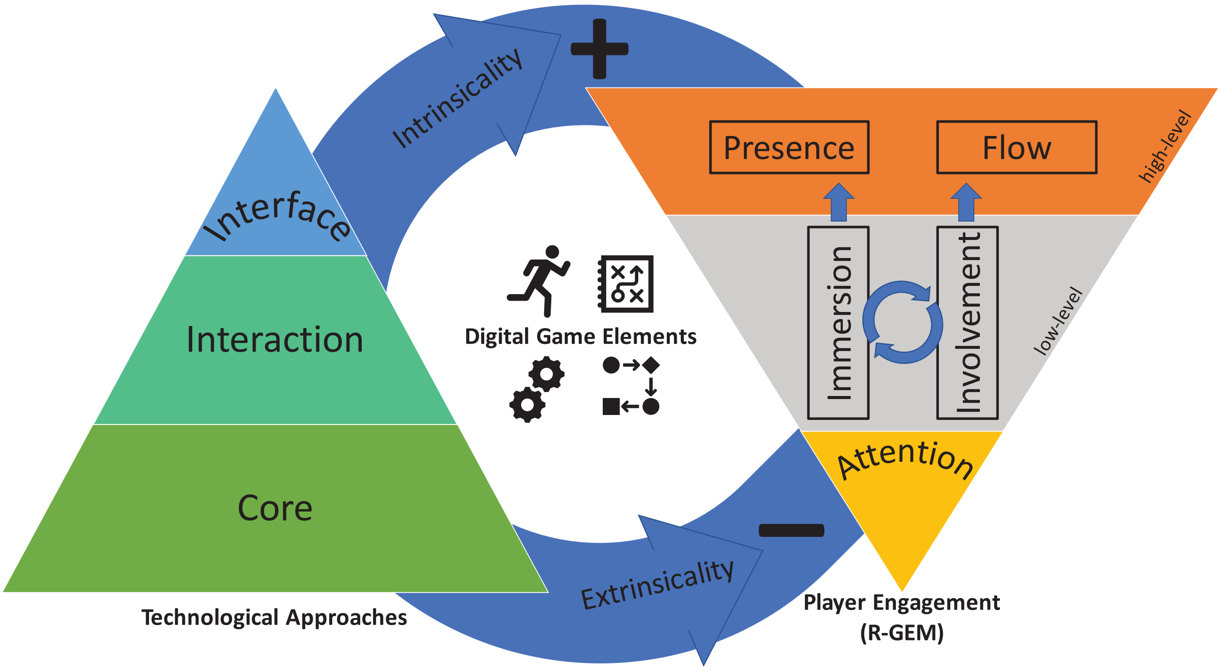

Figure 1. How the framework relates to digital game elements and player engagement. Note: Player engagement model is adapted from Procci et al. (2018).

cilitate immersion–involvement reciprocity (IN). Indeed, even when DDA is not actually present but players are told that the game they are playing will adapt, players actually report feeling more immersed (Denisova & Cairns, 2019). Primarily though, DDA has the potentially to perfectly balance challenges against player skill and increase player confidence (Constant & Levieux, 2019), ensuring players feel more in control and remain in a state of flow (Chen, 2007), and may thus mitigate against other extrinsic elements thereby alleviating extraneous player burdens.

Intrinsic game content is key for facilitating and maintaining player engagement. However, manual content production is costly and not scalable. As games have increased in complexity, developers have turned to ‘procedural content generation’ (PCG) to algorithmically and automatically generate all kinds of game content, including game bits (e.g., textures, fire, sound), gamespaces, game systems, game scenarios, game designs, and derived content (e.g., news, leaderboards), which may be generated using a variety of techniques ranging from pseudo-random number generators, generative grammars and image filtering, through to spatial algorithms, modelling and simulation of complex systems, and artificial intelligence (AI; Hendrikx, Meijer, van der Velden, & Iosup, 2013). Such game content may be generated at runtime during gameplay, during the design stage or prior to gameplay. Studies (e.g., Connor, Greig, & Kruse, 2017) have found that overall there is no statistically-significant difference between manually-generated content and PCG, but that there are particular areas where PCG may not succeed in engaging players as well, indicating that the PCG method should be appropriate and implemented in a way that maximises the ability to generate content facilitating immersion. One means in which PCG may be considered appropriate is by avoiding burdensome extraneous content and focusing on intrinsic game content. For example, generated derived content should not be used in an extrinsic manner such that it interrupts or distracts from the core gameplay, such as interrupting the player with news items to flatter them or generating music (Jordan et al., 2012; Summerville et al., 2018) that distracts and burdens the player. Instead, it should be based on player actions and game state to heighten the experience and further engender immersion. When used intrinsically, PCG avoids repetitiveness and creates the opportunity for games to be experienced repeatedly as being new and engrossing for the player. This influences motivation and thus involvement and flow (NF), while increasingly realistic game content can influence immersion and thus presence (IP). Given the importance of game content to the gameworld and meaningful gameplay, PCG can also reinforce the reciprocity of immersion and involvement (IN).

‘Narrative’ is central to many game genres and compelling and engaging narratives are often what enable games to be particularly meaningful (Oliver et al., 2016). Several narrative properties have been identified as being key to improving immersion (Verbrugge & Zhang, 2010), which would facilitate intrinsicality and the IP engagement pathway, notably logical consistency, continuity of story elements, level of tension or atmosphere, as well as gameplay issues such as ensuring player progress, and adequate coverage of potential player choices. Players are also more likely to immerse in a narrative if they empathise with the characters, even when the characters are morally ambiguous or questionable (Dechering & Bakkes, 2018). Narratives that do not adequately fulfil these properties may potentially create an extraneous cognitive burden for the user leading the narrative towards extrinsicality. This was the case in Frequency 1550 (Admiraal, Huizenga, Akkerman, & Ten Dam, 2011) where players paid attention to the intrinsic procedures and technology of the game but did not take the story seriously and paid little attention to the embedded narrative messages within the game. Similarly, Arjoranta (2017) has studied how the narratological concepts of focalisation (narrative viewpoint), granularity (narrative fineness/coarseness and richness of included elements), and mode of narration (tellers vs. reflectors) can be used as tools for creating cognitive responses from players, which must be carefully balanced to avoid being burdensome. While narrative does not tend to influence player involvement and flow per se, game mechanics which are designed to complement the narrative have been found to do so (Moser & Fang, 2015), and thereby help to avoid the need to introduce extrinsic elements into the game. For example, The Walking Dead utilises the narrative as a progression mechanic, where the player chooses from multiple dialogue options, one of which is frequently to say nothing and even this choice can progress the narrative and game, e.g., in the first instalment, during Chapter 2, Episode II, the player can take Kenny’s or Lilly’s side, stay neutral, or stay silent. Other games such as Assassin’s Creed, Borderlands, Red Dead Redemption and even the campaign modes of Call of Duty, where narrative is bi-directionally complementary to the game mechanics, allows for the narrative to also increase immersion. In such games, players may develop their character based on their own perception of it, through the making of ethical choices or an honour system, and thereby influence the game narrative. When ethically-heavy choices are forced on the player (otherwise the game would not progress), such as to destroy Megaton in Fallout 3 or to execute the sick people of Kefalonia in Assassin’s Creed Odyssey, the choices are demanding, primarily from a moral perspective, but they are not extraneous to the gameplay and thus are intrinsic rather than extrinsic and serve to further engagement rather than be burdensome. Interactive narratives have also been found to influence presence (IP) in direct correlation with the player’s perceived sense of control over their character (Seif El-Nasr, Milam, & Maygoli, 2013), which is further heightened, through cognitive, emotional, and behavioural responses, when players create their own narratives (Riches, Elghany, Garety, Rus-Calafell, & Valmaggia, 2019). This relates to such narratives being core and thus intrinsic to the game.

3.2. Interaction

The interaction layer consists of technological approaches that exploit core layer technologies and work in conjunction with interface layer technologies to deliver a reduction in extrinsic player interactions. Immersion here is often supported by technological provision of immersive cues, such as realistic interactivity and input mechanisms, and the stronger these are, the easier it is to reach the higher-level engagement state of presence (Procci et al., 2018). However, the 'pacing' of interaction has been found to cause players to experience significantly different levels of state anxiety and negative affect (Jennett et al., 2008), suggesting that pacing should be adapted appropriately to facilitate immersion (IP) and to avoid interaction becoming burdensome. 'Isomorphic controllers' may help to improve the pacing of interaction. The manipulation and mapping interface layers in the Historical-Analytical Comparative System (HACS; Therrien, 2017) correspond closely with the interaction layer of our framework. The manipulation interface layer provides a broad typology of symbolic to isomorphic controllers, ranging from screen-augmented (visually encoded props) to corporeal (detection of body movements). Greater isomorphism has the potential to facilitate immersion (IP), e.g., mouse-based manipulation of windows, icons and pointers tends to create overhead that frustrates gameplay and therefore engagement. The mapping interface layer also extends from symbolic to isomorphic and associates primitive manipulations with represented or virtual actions, ranging from punctual (automation of virtual actions) to symbiotic (equivalence). Greater isomorphism and symbiosis here, made possible by controllers such as Leap Motion and Oculus Touch, similarly facilitates immersion (IP) by limiting the need for complicated motor activations, such as wiggling joysticks.

However, perhaps the most predominant technological approach at the interaction layer is 'personalisation,' which enables tailoring of gameplay information and social and group dynamics, often using AI, so that players and teams are not overburdened. Frequently this involves the use of 'player profiling' (a.k.a. player modelling), which groups players into common cognitive and emotional archetypes, and recent evidence shows that this can improve immersion (Denisova & Cairns, 2019), thereby facilitating the IP engagement pathway. Systematic Multiple Level Observation of Groups (SYMLOG) has been used in a non-intrusive manner to build collaborative profiles of a group of players in an online game working together towards a common goal (Berdun, Armentano, Berdun, & Cincunegui, 2019), which avoids extrinsic means for gathering profile data from players such as questionnaires. In FlowAI (Cruz & Uresti, 2017), discussed above, the DDA module responsible for adapting gameplay features relies on a player profile to create a personalised gaming experience that is reactive to players and thus can ensure that only necessary, intrinsic interactive demands are placed on the player and extrinsic game interactions are reduced or avoided completely. When used in this way, personalisation and player profiles can directly affect goal and challenge elements thereby influencing involvement and flow (NF). When combined with approaches that capture player interactions across multiple game environments (Scoular, Care, & Awwal, 2017), much richer profiles may be built that allow for inferencing of indicative player knowledge, skills, behaviour, and performance, which can be exploited for effectively managing extrinsicality, and facilitating the reciprocity of immersion and involvement (IN). 'Model matching theory' is related to this and helps to predict player outcomes linked to gameplay by focusing on the interrelationship among game mechanics, external situations, and players' mental models. Alignment increases mental model transfer and influences a range of outcomes, notably immersion, involvement, and flow (IP, NF), but also in-game performance, learning, and game transfer phenomena (McGloin, Wasserman, & Boyan, 2018), and can help to reduce extrinsic game elements and extraneous burdens.

'Incentivisation' has been used to identify and dynamically reward different classes of players based on personalised, relative assessments of performance. This helps provide a satisfactory game experience for both experienced and inexperienced players, and incentives that enhance players' engagement in the game could be used in combination with player predictions to prevent a player's choice to quit the session, or frustration that may drive them to quit the game (Sapienza et al., 2018), thereby maintaining interaction and thus involvement and influencing flow (NF), potentially mitigating negative consequences of extrinsic game elements. Many mobile games, such as Candy Crush Saga and Crossy Road, use various devices such as daily gifts or timer-based boosts which last for specific durations and may increase with continued daily participation. However, while they often successfully increase involvement initially, such devices typically serve as extrinsic game elements that are designed to feed extrinsic motivations. They are therefore burdensome to players as they detract from gameplay and do not sufficiently sustain motivation or engagement in the long-term (Pink, 2009); at best they can merely mitigate other extrinsic game elements, e.g., having to wait for some time to gain a new life or having to send help requests to friends.

Many games require players to collaborate. However, game mechanisms to support player collaboration are not always used (Zagal, 2006), which is typically a consequence of them being extrinsic to gameplay. Designing collaborative mechanics which are intrinsic results in 'emergent collaboration' among players because it is embedded into the gameplay. Such mechanics include complementary actions (players' individual tasks need to be synchronised with each other in a timely manner to perform a joint task), indirect actions (some players are given information or a task that requires other players to act), and encrypted information (players have individual, unique information needed in task solving; Hämäläinen, Niilo-Rämä, Lainema, & Oksanen, 2018). To perform complementary actions, players need to collaborate to share knowledge; to perform indirect actions, players need to collaborate to exchange information in order to form a joint understanding on what should be done and how; and to use encrypted information, players need to collaborate to share their knowledge with each other so as to form a shared understanding built on each other's thoughts. Thus, emergent collaboration tends to influence involvement and, where the collaboration is absorbing, flow (NF).

Repeated studies (e.g., Mateas, 1999; Pacheco, Tokarchuk, & Pérez-Liébana, 2018) have demonstrated that 'believable agents' within a game greatly impact on feelings of presence and flow, and thus immersion and involvement antecedently, including the positive reciprocity between the two (IP, NF, IN). Different aspects of such agents would have various impacts on the quality of intrinsic and extrinsic game elements. Gomes, Paiva, Martinho, and Jhala (2013) define nine dimensions to believability according to the agent's awareness, behaviour understandability, personality, visual impact, predictability, behaviour coherence, change with experience, social behaviour, and emotional expressiveness. Believability increases immersion and therefore presence (IP) if the players consider them more human, increasing empathy and supporting the suspension of disbelief. Believability would also affect involvement and flow (NF) since the more believable the agents, the easier they will be to interact with at a suitable pace and the less burdensome the interaction with them will be. Reduction in believability would increase the bureaucracy of the game and thus extrinsicality as the player will need to learn how to interact with these agents in order to progress. For example, various bots (agents) in Counter-Strike try to mimic human behaviour using strategies such as rushing at the opponent team, ambushing and holding the base. However, as a team member they do not coordinate well together, requiring the player to learn their behaviour as a team member in order to play with them effectively. Believable agents also affect the interface layer, primarily through visual impact, although this ultimately affects interaction, e.g., how the agent is visually perceived will influence how they are interacted with.

'Persuasive technologies' can also be used to reduce extrinsicality through enhanced involvement (NF). Using persuasion, digital games may provide compelling experiences that convey specific messages by allowing players to explore cause-effect relationships, motivating them through vicarious experiences, or helping them rehearse a behaviour. They may also persuade players by making activities easier or more efficient to do, or by applying the same persuasion principles that humans use to influence others (de la Hera Conde-Pumpido, 2018), e.g., through believable agents that engage with and encourage, discourage or coerce the player. Persuasion may also use benevolent deception to enhance the player's experience as long as the player is not aware of it, e.g., where games seek to manipulate players for behaviour change and educational purposes (Denisova & Cairns, 2019). Such approaches rely on other technologies, such as player profiling at the interaction layer, and DDA at the core layer, to adapt the interaction to the individual player.

3.3. Interface

The interface layer consists of technological approaches which work in conjunction with the base core and middle interaction layers to reduce extrinsic burdens at the player UI. Here, immersion and presence are influenced by the extent to which immersive cues are provided, such as higher sensory resolution and increased number of senses provided by the game (Procci et al., 2018), e.g., many games enable adjustment of graphical fidelity and detail to improve the experience, according to the capabilities of the available technical resources such as graphics cards. When used in conjunction with personalisation from the interaction layer, the UI may not only be customised for the player, such as in World of Warcraft and Diablo III which allow the player to customise the abilities tree in-game, but may also achieve the notion of a 'fluid UI' (Dyck, Pinelle, Brown, & Gutwin, 2003) to communicate information to players in ways that do not demand their attention and do not interrupt gameplay, thereby reducing extrinsicality and facilitating immersion (IP). Methods that may be commonly used include calm messaging (unobtrusive messages via the use of sound, speech, transient text, or animation that do not require dismissal, acknowledgement or addressal by the player), attention-aware interface elements (automatically modify themselves based on the amount of attention users are paying to them, to reduce visual clutter and increase size of useable gamespace), and context-aware view behaviours (such as automatically zooming, panning and rotating gamespace views to best suit the task at hand, reducing player effort to navigate and adjust, and filtering information to only that which is currently relevant, to avoid overwhelming the player). Being distracted by navigational problems has been shown to be an extrinsic burden, affecting flow and thus involvement (NF), and decreasing game performance (Admiraal et al., 2011).

Although many expert players tend to focus on the HUD, some (Bowman, Elmqvist, & Jankun-Kelly, 2012; Pears, 2016) have commented on how HUDs can often add an additional unnecessary layer that distances players from the gameplay when not carefully implemented. Guidelines to ensure HUDs are accessible and facilitate intrinsic gameplay have been proposed, some of which emphasise the use of 'diegetic interface' components (may be viewed by the player-character, i.e., in-game) instead where possible (Edwards, 2018) or the design of HUDs for peripheral vision to improve game performance (Tilford, 2019). Some studies (Peacocke, Teather, Carette, & MacKenzie, 2015) are starting to reveal a player preference for diegetic interfaces that tend to improve player performance, thus influencing involvement and flow (NF), while other studies (Iacovides, Cox, Kennedy, Cairns, & Jennett, 2015) have found that the removal of non-diegetic interface components (those viewed only by the player and not the player-character) such as HUDs altogether can improve immersion in expert players (IP). However, the feedback interface layer in HACS (Therrien, 2017), which ranges from signaletic (non-diegetic) to diegetic, reveals that signaletic informational elements, notably progression/failure markers and score, cannot be part of the diegesis.

The notion of 'gamespace awareness' (Antunes, Herskovic, Ochoa, & Pino, 2014; Teruel, Navarro, González, López-Jaquero, & Montero, 2016) can facilitate the player's understanding of time (present, past, future) and social and group dynamics, predominantly via the presentation of information at the player UI, within individual, co-operative and collaborative games. For example, in MMORPGs, players must be aware of other players' roles and locations in order to make player-to-player interaction more frequent so that they can successfully undertake game tasks. This results in a large number of design categories that games may utilise such as availability, communication, mobility, navigation, spatiality, virtuality, and sensemaking, and a large number of resultant game elements such as presence, identity, authorship, task, and location to support time-based concerns, and exposed information, role, group goal, and inner/outer communication to support social and group dynamics. The broad nature of such game elements means that those broadly supporting the undertaking of tasks may influence involvement and thus flow (NF), while those that provide heightened stimuli and experience may influence immersion and thus presence (IP). The extensive inter-relationships between the elements also means that the inter-relationship between immersion and involvement (IN) may also be supported. Such influences will be positive where the game elements are implemented in a manner that does not burden the player but supports them in their intrinsic tasks.

Recently (Abbasi, Ting, Hlavacs, Costa, & Veloso, 2019), it has been proposed that the notion of consumption from the field of marketing may be applied to digital games, yielding a 'playful-consumption experience' approach. This focuses on creating intrinsically, motivating, active, and self-based gameplaying behaviour for players' own sake and pleasure, leading to playful hedonic experiences. Using this approach, it is possible to predict game engagement (cognitive, affective, and behavioural) as it arises from imaginal, emotional, and sensory playful-consumption experiences. Sensory experiences are predominantly provided by the interface layer, thus enhanced sensory technological approaches which appeal to a greater number of senses and allow the player to physically 'feel' the game may enhance intrinsic game content and heighten immersion and thus presence (IP). However, any physical impediments, such as cybersickness and awareness of devices, controllers and head-mounted displays would diminish agency and interaction and lead to reduced immersion and presence (Riches et al., 2019), thereby causing them to become highly burdensome.

4. Conclusions

As gaming technology advances and games become more complex, it is important for maintaining engagement that extraneous burdens on players are minimised and core gameplay is preserved. Having reviewed a range of technological approaches within the framework, it can be seen that it may serve as an initial guide for how such reductions in extrinsicality may potentially be achieved: as a lens by which to view emerging digital game technologies, in terms of how they enhance or hinder levels of engagement and subsequently whether they serve to enable intrinsic or extrinsic game elements, or as a lens for considering particular games at each layer of technological approach and engagement. The proposed framework may also be used to guide game design itself to avoid or reduce extrinsic burdens. For example, in designing an improved version of the multiplayer Beer Game (Daylamani-Zad, Agius, & Angelides, 2018), which traditionally does not support communication or collaboration between players, we targeted the interaction layer by introducing multiple reflective intelligent agents in conjunction with personalisation and player profiling and emergent collaboration to facilitate collaboration without creating burdens, thus improving player and team performance and engagement. Similarly, in creating a World of Warcraft add-on (Daylamani-Zad, Angelides, & Agius, 2012), we targeted the interaction and interface layers, using personalisation and player profiling, model matching, gamespace awareness, and fluid UI to reduce extrinsicality when making choices about weapons, armours, quest paths, and character development, and to identify complementary players for co-op raids and suitable players for PvP arena battles. The framework may also potentially be integrated into game analysis and evaluation tools, such as into assessments of player experience (Johnson, Gardner, & Perry, 2018) so that measurement can be related specifically to technologies, game elements, or precise engagement pathways.

Conflict of Interests

The authors declare no conflict of interests.

References

Abbasi, A. Z., Ting, D. H., Hlavacs, H., Costa, L. V., & Veloso, A. I. (2019). An empirical validation of consumer video game engagement: A playful-consumption experience approach. *Entertainment Computing*, *29*, 43–55. https://doi.org/10.1016/j.entcom.2018.12.002

Abdi, E., Burdet, E., Bouri, M., Himidan, S., & Bleuler, H. (2016). In a demanding task, three-handed manipulation is preferred to two-handed manipulation. *Scientific Reports*, *6*. https://doi.org/10.1038/srep21758

Admiraal, W., Huizenga, J., Akkerman, S., & Ten Dam, G. (2011). The concept of flow in collaborative game-based learning. *Computers in Human Behavior*, *27*(3), 1185–1194. https://doi.org/10.1016/j.chb.2010.12.013

Alexiou, A., & Schippers, M. C. (2018). Digital game elements, user experience and learning: A conceptual framework. *Education and Information Technologies*, *23*(6), 2545–2567. https://doi.org/10.1007/s10639-018-9730-6

Antunes, P., Herskovic, V., Ochoa, S. F., & Pino, J. A. (2014). Reviewing the quality of awareness support in collaborative applications. *Journal of Systems and Software*, *89*, 146–169. https://doi.org/10.1016/j.jss.2013.11.1078

Arjoranta, J. (2017). Narrative tools for games: Focalization, granularity, and the mode of narration in games. *Games and Culture*, *12*(7/8), 696–717. https://doi.org/10.1177/1555412015596271

Berdun, F. D., Armentano, M. G., Berdun, L. S., & Cincunegui, M. (2019). Building SYMLOG profiles with an online collaborative game. *International Journal of Human-Computer Studies*, *127*, 25–37. https://doi.org/10.1016/j.ijhcs.2018.07.002

Bouchard, M. (2015). Playing with progression, immersion, and sociality: Developing a framework for studying meaning in APPMMAGs, a case study. *Journal of Comparative Research in Anthropology and Sociology*, *17*(1), 3–25.

Bowman, B., Elmqvist, N., & Jankun-Kelly, T. J. (2012). Toward visualization for games: Theory, design space, and patterns. *IEEE Transactions on Visualization and Computer Graphics*, *18*(11), 1956–1968. https://doi.org/10.1109/TVCG.2012.77

Bowman, N. D. (2018). The demanding nature of video game play. In N. D. Bowman (Ed.), *Video games: A medium that demands our attention* (pp. 1–24). New York, NY: Routledge. https://doi.org/10.4324/9781351235266-1

Calleja, G. (2011). *In-game: From immersion to incorporation*. Cambridge, MA: MIT Press.

Chen, J. (2006). *Flow in games* (Master of Fine Arts Thesis). School of Cinematic Arts, University of Southern California, California, USA. Retrieved from http://www.jenovachen.com/flowingames/Flow_in_games_final.pdf

Chen, J. (2007). Flow in games (and everything else). *Communications of the ACM*, *50*(4), 31–34.

Connor, A. M., Greig, T. J., & Kruse, J. (2017). Evaluating the impact of procedurally generated content on game immersion. *The Computer Games Journal*, *6*(4), 209–225. https://doi.org/10.1007/s40869-017-0043-6

Constant, T., & Levieux, G. (2019). Dynamic difficulty adjustment impact on players' confidence. In *Proceedings of the 2019 CHI conference on human factors in computing systems* (pp. 1–12). New York, NY: ACM. https://doi.org/10.1145/3290605.3300693

Cruz, C. A., & Uresti, J. A. R. (2017). Player-centered game AI from a flow perspective: Towards a better understanding of past trends and future directions. *Entertainment Computing*, *20*, 11–24. https://doi.org/10.1016/j.entcom.2017.02.003

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. San Francisco, CA: Jossey-Bass Publishers.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper Perennial.

Cutting, J., Gundry, D., & Cairns, P. (2019). Busy doing nothing? What do players do in idle games? *International Journal of Human-Computer Studies*, *122*, 133–144. https://doi.org/10.1016/J.IJHCS.2018.09.006

Daylamani-Zad, D., Agius, H., & Angelides, M. C. (2018). Reflective agents for personalisation in collaborative games. *Artificial Intelligence Review*, *2018*, 1–46. https://doi.org/10.1007/s10462-018-9665-8

Daylamani-Zad, D., Angelides, M. C., & Agius, H. (2012). Personalise your massively multiplayer online game (MMOG) with Artemis. *Multimedia Systems*, *18*(1), 69–94. https://doi.org/10.1007/s00530-011-0237-x

Dechering, A., & Bakkes, S. (2018). Moral engagement in interactive narrative games. In *Proceedings of the 13th international conference on the foundations of digital games: FDG '18* (pp. 1–10). New York, NY: ACM. https://doi.org/10.1145/3235765.3235779

de la Hera Conde-Pumpido, T. (2018). The persuasive roles of digital games: The case of cancer games. *Media and Communication*, *6*(2), 103-111. https://doi.org/10.17645/mac.v6i2.1336

Denisova, A., & Cairns, P. (2019). Player experience and deceptive expectations of difficulty adaptation in digital games. *Entertainment Computing*, *29*, 56–68. https://doi.org/10.1016/J.ENTCOM.2018.12.001

Dyck, J., Pinelle, D., Brown, B., & Gutwin, C. (2003). Learning from games: HCI design innovations in entertainment software. In *Proceedings of Graphics Interface 2003* (pp. 237–246). Ontario: Canadian Information Processing Society. https://doi.org/10.20380/GI2003.28

Edwards, R. (2018). HUD (head-up display). *Accessible Video Game Design*. Retrieved from http://accessiblegamedesign.com/guidelines/HUD.html

Fizek, S. (2018). Interpassivity and the joy of delegated play in idle games. *Transactions of the Digital Games Research Association*, *3*(3), 137–163. https://doi.org/10.26503/todigra.v3i3.81

Gomes, P., Paiva, A., Martinho, C., & Jhala, A. (2013). Metrics for character believability in interactive narrative. In H. Koenitz, T. I. Sezen, G. Ferri, M. Haahr, D. Sezen, & G. Çatak (Eds.), *International conference on interactive digital storytelling* (pp. 223–228). Cham: Springer. https://doi.org/10.1007/978-3-319-02756-2_27

Gray, K., & Huang, W. (2015). More than addiction: Examining the role of anonymity, endless narrative, and socialization in prolonged gaming and instant messaging practices. *Journal of Comparative Research in Anthropology and Sociology*, *17*(1), 133–147.

Hämäläinen, R. H., Niilo-Rämä, M., Lainema, T., & Oksanen, K. (2018). How to raise different game collaboration activities: The association between game mechanics, players' roles and collaboration processes. *Simulation & Gaming*, *49*(1), 50–71. https://doi.org/10.1177/1046878117752470

Hendrikx, M., Meijer, S., van der Velden, J., & Iosup, A. (2013). Procedural content generation for games. *ACM Transactions on Multimedia Computing, Communications, and Applications*, *9*(1), 1–22. https://doi.org/10.1145/2422956.2422957

Huang, H. C., Pham, T. T. L., Wong, M. K., Chiu, H. Y., Yang, Y. H., & Teng, C. I. (2018). How to create flow experience in exergames? Perspective of flow theory. *Telematics and Informatics*, *35*(5), 1288–1296. https://doi.org/10.1016/j.tele.2018.03.001

Iacovides, I., Cox, A., Kennedy, R., Cairns, P., & Jennett, C. (2015). Removing the HUD: The impact of non-diegetic game elements and expertise on player involvement. *CHI PLAY 2015: Proceedings of the 2015 annual symposium on computer–human interaction in play* (pp. 13–22). Ney York, NY: ACM. https://doi.org/10.1145/2793107.2793120

Jennett, C., Cox, A. L., Cairns, P., Dhoparee, S., Epps, A., Tijs, T., & Walton, A. (2008). Measuring and defining the experience of immersion in games. *International Journal of Human–Computer Studies*, *66*(9), 641–661. https://doi.org/10.1016/j.ijhcs.2008.04.004

Johnson, D., Gardner, M. J., & Perry, R. (2018). Validation of two game experience scales: The player experience of need satisfaction (PENS) and game experience questionnaire (GEQ). *International Journal of Human-Computer Studies*, *118*, 38–46. https://doi.org/10.1016/j.ijhcs.2018.05.003

Jordan, A., Scheftelowitsch, D., Lahni, J., Hartwecker, J., Kuchem, M., Walter-Huber, M., . . . Vatolkin, I. (2012). Beatthebeat music-based procedural content generation in a mobile game. In *2012 IEEE conference on computational intelligence and games (CIG)* (pp. 320–327). Piscataway, NJ: IEEE.

Jørgensen, K. (2013). *Gameworld interfaces*. Cambridge, MA: The MIT Press.

Jørgensen, K. (2016). The positive discomfort of spec ops: The line. *Game Studies*, *16*(2). Retrieved from http://gamestudies.org/1602/articles/jorgensenkristine

Juul, J. (2010). *A casual revolution: Reinventing video games and their players*. Cambridge, MA: MIT Press.

Kokkinakis, A. V., Cowling, P. I., Drachen, A., & Wade, A. R. (2017). Exploring the relationship between video game expertise and fluid intelligence. *PLoS ONE*, *12*(11), e0186621. https://doi.org/10.1371/journal.pone.0186621

Kultima, A. (2009). Casual game design values. In *Proceedings of the 13th international mindtrek conference: Everyday Life in the ubiquitous era on—MindTrek '09*, (pp. 58–65). New York, NY: ACM. https://doi.org/10.1145/1621841.1621854

Liebold, B., Bowman, N. D., & Pietschmann, D. (2018). Natural in the eyes of the (be)holder: A survey on novelty and learning effects in the enjoyment of naturally mapped video game controllers. *Psychology of Popular Media Culture*. Advance online publication. https://doi.org/10.1037/ppm0000215

Limelight Networks. (2019). The state of online gaming—2019: Market research. *Limelight Networks*. Retrieved from https://www.limelight.com/resources/white-paper/state-of-online-gaming-2019

Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of Computer-Mediated Communication*, *3*(2), JCMC321. https://doi.org/10.1111/j.1083-6101.1997.tb00072.x

Loton, D., Borkoles, E., Lubman, D., & Polman, R. (2016). Video game addiction, engagement and symptoms of stress, depression and anxiety: The mediating role of coping. *International Journal of Mental Health and Addiction*, *14*(4), 565–578. https://doi.org/10.1007/s11469-015-9578-6

Martončik, M. (2015). e-Sports: Playing just for fun or playing to satisfy life goals? *Computers in Human Behavior*, *48*, 208–211. https://doi.org/10.1016/J.CHB.2015.01.056

Mateas, M. (1999). An Oz-centric review of interactive drama and believable agents. In M. J. Wooldridge & M. Veloso (Eds.), *Artificial intelligence today* (pp. 297–328). Berlin: Springer. https://doi.org/10.1007/3-540-48317-9_12

McGloin, R., Wasserman, J. A., & Boyan, A. (2018). Model matching theory: A framework for examining the alignment between game mechanics and mental models. *Media and Communication*, *6*(2), 126–136. https://doi.org/10.17645/mac.v6i2.1326

Merikivi, J., Tuunainen, V., & Nguyen, D. (2017). What makes continued mobile gaming enjoyable? *Computers in Human Behavior*, *68*, 411–421. https://doi.org/10.1016/j.chb.2016.11.070

Michailidis, L., Balaguer-Ballester, E., & He, X. (2018). Flow and immersion in video games: The aftermath of a conceptual challenge. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.01682

Molesworth, M., & Watkins, R. D. (2016). Adult videogame consumption as individualised, episodic progress. *Journal of Consumer Culture*, *16*(2), 510–530. https://doi.org/10.1177/1469540514528195

Mora-Cantallops, M., & Sicilia, M.-Á. (2018). MOBA games: A literature review. *Entertainment Com-*

puting, *26*, 128–138. https://doi.org/10.1016/J.ENTCOM.2018.02.005

Moser, C., & Fang, X. (2015). Narrative structure and player experience in role-playing games. *International Journal of Human-Computer Interaction*, *31*(2), 146–156. https://doi.org/10.1080/10447318.2014.986639

Nelson, B., Bowman, C., Bowman, J., & Kim, Y. (2018). The impact of game-based design on visitor engagement with a science museum app. In *European conference on games based learning* (pp. 479–486). Sonning Common: Academic Conferences International.

Oliver, M. B., Bowman, N. D., Woolley, J. K., Rogers, R., Sherrick, B. I., & Chung, M.-Y. (2016). Video games as meaningful entertainment experiences. *Psychology of Popular Media Culture*, *5*(4), 390–405. https://doi.org/10.1037/ppm0000066

Pacheco, C., Tokarchuk, L., & Pérez-Liébana, D. (2018). Studying believability assessment in racing games. In *Proceedings of the 13th international conference on the foundations of digital games* (p. 20). New York, NY: ACM.

Peacocke, M., Teather, R. J., Carette, J., & MacKenzie, I. S. (2015). Evaluating the effectiveness of HUDs and diegetic ammo displays in first-person shooter games. *2015 IEEE games entertainment media conference, GEM 2015* (pp. 138–145). Piscataway, NJ: IEEE. https://doi.org/10.1109/GEM.2015.7377211

Pears, M. (2016). HUD: Barrier for immersion hide the numbers. *Gamasutra*. Retrieved from https://www.gamasutra.com/blogs/MaxPears/20160627/275816/HUD_Barrier_for_Immersion_Hide_the_Numbers.php

Pink, D. (2009). *Drive: The surprising truth about what motivates us*. New York, NY: Riverhead Books.

Pirker, J., Rattinger, A., Drachen, A., & Sifa, R. (2018). Analyzing player networks in Destiny. *Entertainment Computing*, *25*, 71–83. https://doi.org/10.1016/J.ENTCOM.2017.12.001

Porter, A. M., & Goolkasian, P. (2019). Video games and stress: How stress appraisals and game content affect cardiovascular and emotion outcomes. *Frontiers in Psychology*, *10*(967). https://doi.org/10.3389/fpsyg.2019.00967

Procci, K., Bowers, C. A., Jentsch, F., Sims, V. K., & McDaniel, R. (2018). The revised game engagement model: Capturing the subjective gameplay experience. *Entertainment Computing*, *27*, 157–169. https://doi.org/10.1016/j.entcom.2018.06.001

Reid, G. (2012). Motivation in video games: A literature review. *The Computer Games Journal*, *1*(2), 70–81. https://doi.org/10.1007/BF03395967

Riches, S., Elghany, S., Garety, P., Rus-Calafell, M., & Valmaggia, L. (2019). Factors affecting sense of presence in a virtual reality social envirnment: A qualitative study. *Cyberpsychology, Behavior, and Social Networking*, *22*(4), 288–292. https://doi.org/10.1089/cyber.2018.0128

Salen, K., & Zimmerman, E. (2003). *Rules of play: Game design fundamentals*. Cambridge, MA: MIT Press.

Salisbury, J. H., & Tomlinson, P. (2016). Reconciling Csikszentmihalyi's broader flow theory: With meaning and value in digital games. *Transactions of the Digital Games Research Association*, *2*(2), 55–77. https://doi.org/10.26503/todigra.v2i2.34

Sapienza, A., Zeng, Y., Bessi, A., Lerman, K., & Ferrara, E. (2018). Individual performance in team-based online games. *Royal Society Open Science*, *5*(180329). https://doi.org/10.1098/rsos.180329

Scoular, C., Care, E., & Awwal, N. (2017). An approach to scoring collaboration in online game environments. *The Electronic Journal of E-Learning*, *15*(4), 335–342.

Seif El-Nasr, M., Milam, D., & Maygoli, T. (2013). Experiencing interactive narrative: A qualitative analysis of Façade. *Entertainment Computing*, *4*(1), 39–52. https://doi.org/10.1016/J.ENTCOM.2012.09.004

Sherry, J. L. (2004). Flow and media enjoyment. *Communication Theory*, *14*(4), 328–347. https://doi.org/10.1111/j.1468-2885.2004.tb00318.x

Silva, M. P., do Nascimento Silva, V., & Chaimowicz, L. (2017). Dynamic difficulty adjustment on MOBA games. *Entertainment Computing*, *18*, 103–123. https://doi.org/10.1016/j.entcom.2016.10.002

Suits, B. (1978). *The grasshopper: Games, life and utopia*. Toronto: University of Toronto Press.

Summerville, A., Snodgrass, S., Guzdial, M., Holmgård, C., Hoover, A. K., Isaksen, A., . . . Togelius, J. (2018). Procedural content generation via machine learning (pcgml). *IEEE Transactions on Games*, *10*(3), 257–270.

Teruel, M. A., Navarro, E., González, P., López-Jaquero, V., & Montero, F. (2016). Applying thematic analysis to define an awareness interpretation for collaborative computer games. *Information and Software Technology*, *74*, 17–44. https://doi.org/10.1016/j.infsof.2016.01.009

Therrien, C. (2017). From video games to virtual reality (and back): Introducing HACS (Historical-Analytical Comparative System) for the documentation of experiential configurations in gaming history. In *DiGRA'17: Proceedings of the 2017 DiGRA international conference* (pp. 1–18). Melbourne: DiGRA. Retrieved from http://www.digra.org/wp-content/uploads/digital-library/57_DIGRA2017_FP_Therrien_HACS.pdf

Tilford, B. (2019). Perceiving without looking: Designing HUDs for peripheral vision. *Player Research*. Retrieved from https://www.playerresearch.com/learn/perceiving-without-looking-designing-huds-for-peripheral-vision-copy

Verbrugge, C., & Zhang, P. (2010). Analyzing computer game narratives. In *Entertainment Computing: ICEC 2010* (pp. 224–231). Berlin: Springer. https://doi.org/10.1007/978-3-642-15399-0_21

Vorderer, P., Hartmann, T., & Klimmt, C. (2003). Explaining the enjoyment of playing video games: The role of competition. In *ICEC '03 Proceedings of the second in-*

ternational conference on entertainment computing (pp. 1–9). Pittsburgh, PA: Carnegie Mellon University.

Zagal, J. P. (2006). Collaborative games: Lessons learned from board games. *Simulation & Gaming*, *37*(1), 24–40. https://doi.org/10.1177/1046878105282279

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