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Researchers' commercial video game knowledge associated with differences in beliefs about the impact of gaming on human behavior

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ABSTRACT

Over the past thirty years, research situated in many individual sub-domains of psychology has investigated the potential impact of video game play on behavior. Interestingly, although researchers in the various sub-fields are (presumably) versed in the results of the published research, there nonetheless remain significant individual differences in opinion across researchers regarding what exactly the given literatures "say." Previous work has suggested that some individual difference factors, such as prior gaming experience, can account for some of this variance. The current study expands this work by examining several additional individual difference factors including field of study (e.g., whether one primarily studies links between video games and aggression, cognitive skill, or well-being) and video game knowledge.

Both types of individual differences were associated with differences in belief regarding the state of the literature. In particular, video game knowledge was negatively associated with the belief that video games can lead to addiction and cause aggression and violence, and higher knowledge scores were positively associated with a belief that games can model prosocial behavior. Results are presented in a larger discussion of how researchers' primary domains of knowledge influence the study of technology of effects, such as those from video game play.

1. Introduction

Objectivity is central to science [1]. In an ideal scientific process, neither differences in internal convictions nor differences in subjective experiences should influence the pursuit or evaluation of scientific statements. In practice though, scientists as humans are unquestionably subject to biases. As such, there is always the concern that these biases may influence every step of scientific inquiry—from the questions asked, to the hypotheses proposed, to the interpretation of data. Such concerns may be particularly magnified in media psychology, defined partly by Rutledge (2012) as a field focused on the "intersection of human experience and media" (p. 44) [2], given the documented history of concern over new media technologies and their effects [3]. Because bias is arguably an inherent part of the human experience, any domain that has human experience at its core will almost by definition be prone to possible bias. Indeed, Elson and Ferguson (2013) argued that researcher biases in the domain of media psychology can "…substantially influence scientific research, and its results are readily used as confirmation for what has been suspected" (p. 32) [4].

For illustrative purposes, one example of this can be found in the work of Wertham's (1954) *Seduction of the Innocent* [5], which argued that comic books were a corrosive influence on American youth. While this work was consistent with many academic (and popular) views of media at the time, later critics argued that this work presumed rather than demonstrated these effects, lacked scientific rigor and control, and in some cases included fabricated and exaggerated data [6]. Such concerns are not unique to the present technological age; historical concerns regarding the effects of new technology have persisted since the invention of the telegraph [3] and indeed, can be traced back to the invention of writing itself [7]. Accompanying these concerns is often a negatively-connotated perspective that risks both filtering out valuable information that would otherwise more appropriately guide research approaches and engendering a lack of understanding of full effects (positive and negative).

As popular fears regarding the impact of technology commonly motivate research, scholars from domains well-positioned to study the

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aversive and concerning effects of technology shift their focus to nascent technologies as they manifest and evolve. Meier et al.'s computational scoping review [8], which analyzes how interdisciplinary researchers study the relationship between computer-mediated communication (CMC) and mental health, serves as an example as to how one's primary domain can lead to positively or negatively-valenced research orientations associated with technology. The scholars found that the fields of psychology and psychiatry have been the dominant research communities contributing to this work related to CMC and mental health. These disciplines were much more likely to approach research from a psychopathy orientation (suggesting a more problematic or risk-aversion frame), versus a psychological well-being perspective (a more functional or utilitarian frame). Furthermore, these approaches differed in key ways from other domains (such as communication and education) that were also featured in their analysis. With respect to Meier et al., one suggested consequence of the psychological/psychiatric dominance in CMC research is that articles focused on addiction and problematic technology usage have been the most common topic of investigation in leading journals from 1998 to 2018.

One area of debate in media psychology today revolves around the effects that video game play may have on the brain, body, and behavior. Over the past two decades, video games have become one of the most heavily used forms of entertainment in the modern world. According to 2018 estimates, 43% of Americans play video games, and the activity cuts across nearly all demographic categories, with 49% of women aged 18–29 playing video games and 28% of adults older than 50 playing video games [9]. Yet, the popularity of games, along with observations of players engaging in bad behaviors, brought with them assertions that the medium would lead to serious harm [10]. Korucek [11] suggests that as early as the 1970s, popular press coverage of games such as Exidy's *Death Race* encouraged an early framing of video games as technologies prime for stimulating active violence in their players—concerns echoed by Kestenbaum and Weinstein, [12] among others.

For many, the interactive and rewarding nature of video games makes them potentially far more capable of altering the human brain and, thus, human behavior. Consistent with such concerns, the literature on the effects of video games is vast and spans many disparate areas of psychology, from clinical psychology (e.g., addiction), to social psychology (e.g., aggressive or pro-social behavior), to educational psychology (e.g., the development of games to augment or replace classroom instruction), and to cognitive psychology (e.g., perceptual skills). Yet, despite the wealth of data that has been acquired, there remains considerable disagreement in the literature about the behavioral effects of video games in essentially every sub-domain where the effects have been studied—disagreements seen even at the *meta*-analytic level [13]. Beyond standard issues such as variance in study inclusion criteria, others have argued that the failure to reach consensus may reflect, at least in part, differences in internal convictions and/or differences in subjective experiences that serve to color investigators' scientific approaches, inferences, and evaluations of the broader literature. For example, Huesmann [14] suggested that scholars who reject the notion of video games having antisocial effects could be falling victim to cognitive dissonance—scholars who themselves play or enjoy video games may have difficulty reconciling their own behaviors with any data that might suggest that those behaviors are associated with negative outcomes. Other scholars similarly suggest that researchers are simply unwilling to acknowledge media violence effects [15].

Conversely, Przybylski and Weinstein [16] found that negative attitudes about games were most likely to be found among individuals who self-reported very little direct exposure to the medium itself, a study framed through an exposure-attitude perspective [17]. They found that individuals with gaming experience felt less negative about the medium overall. Others have found individual differences influence beliefs about the impact of video games. For example, Ferguson [18] found great variability in clinician and clinical researchers' beliefs about gaming effects; individual difference factors such as age, gender, and attitudes about youths accounted for a significant degree of this variability. These authors further argued that beliefs about video games could result in cognitive dissonance-like effects, not only in terms of conclusions drawn, but at various stages of the scientific process—from patterns of citations (e.g., the authors have argued that while citation bias is evident among studies that observe a relationship between gaming and aggression, such bias is virtually absent among studies with null results [18]) — to data analysis (e.g., taking advantage of various researcher degrees-of-freedom in exploratory analyses [19,20], for discussion see [20]).

Ferguson & Colwell [21] probed scholars' attitudes about video game violence and views about video games generally and found that scholars who held more negative views towards youth also tended to hold more negative views about video games. Combined, these studies might be evidence of confirmation bias [22]. The authors further noted that older scholars endorsed more negative views about video games, although the influence of age was likely conflated with gaming experience (i.e., younger scholars having more experience with video games; also found in Przybylski and Weinstein [16]).

2. Field of study and video game knowledge as possible correlates

Previous work has examined associations between beliefs about the impact of video games and multiple individual difference measures including age, gender, and *stated experience* with video games and beliefs about the impact of video games. For the current study, we sought to examine two additional individual difference factors. First, it is commonly the case that investigators whose research examines associations between video game play and human behavior tend to focus primarily within a particular sub-domain of human behavior (e.g., pro-social behavior, aggression/violence, cognitive abilities, well-being, etc.) almost by necessity must also be reasonably aware of the work being conducted in other sub-domains. This is true for a variety of reasons including similarities between models of behavioral change [23,24] and ethical considerations (e.g., with respect to intervention studies). However, it may be the case that because they are at an arm's length from the given sub-domains, they may show different patterns of beliefs than those whose work is in the given domains (and thus are more invested in certain hypotheses). For example, a researcher whose primary domain is aggression/violence might be predisposed to approaching their research methodology related to the given sub-domain of video games from a public health standpoint in which threats are identified so that they can be avoided or eliminated. Alternatively, a researcher whose primary domain is in pro-social behaviors and media effects might be predisposed to approaching video games as objects for learning and self-reflection. In both cases, the researchers are only able to confirm or disconfirm a narrow set of predictions about gaming effects that are already rooted in an anti-social (former) or pro-social (latter) perspective; the former would be unable to observe pro-social effects, and the latter would be unable to observe anti-social effects, although see the cited work by researchers who examine the possible impact of games from both perspectives simultaneously [25,26].

Second, while previous work has examined associations between beliefs about the impact of video games and stated previous video game experience, here we sought to examine whether a relation exists between individuals' *measured knowledge* of video games and their beliefs about the impact of video games. We posit that when considering the study of media effects broadly (and video games, specifically), it is possible that some who study the medium might not have deep knowledge of the medium. Rather, scholars engaging video games as a subject of study might have come to the medium purely as a function of their formal research area, rather than because of an interest in the impact of video games per se. For instance, scholars studying problematic gaming (usually a reference to gaming for extensive periods of time, such that gaming becomes an addiction; [27]) address games as a social

concern first—a recent review of games by Petry et al. [28] features six authors with extensive background in drug or gambling addiction, but none with game studies background. Relatedly, scholars that span diverse domains, from gaming studies to public health, have expressed criticism in regard to the World Health Organization's ICD-11 Gaming Disorder proposal, citing that the operationalization of the items were rooted in substance use and gambling symptoms that shared little conceptual overlap with problematic gaming symptoms [29]. Similarly, cognitive psychologists interested in the potential benefits of video games on perceptual or cognitive skills come from a cognitive training background rather than a video game background [30]—their views might celebrate the potential of games in training and development from a perspective that is comparatively uncritical of the unintended negative consequences of gaming [31]. In both cases, the actual video games are less an artifact of study in their own right but more a MacGuffin[2] for which to study some other focal concept. Notably, we do not suggest that those who are experts in these fields are deliberately video game aversive in their research pursuits; however, the lens through which they engage such pursuits may engender partiality nonetheless. The reverse is also as likely—a scholar with primary domain expertise in media studies or game studies might be predisposed towards viewing video games as functional and beneficial entertainment and thus, be less inclined to consider dysfunctional uses of the medium. To these ends, the current study aims to understand the relationship between domain expertise (here, objective knowledge of video games) and assertions about various positive and negative outcomes of video game play.

3. Research questions

Several open questions are of interest. We first consider the degree of video game knowledge shown by researchers who study video games and whether this knowledge tends to differ by scientific sub-domain (e.g., clinical psychology, social psychology, cognitive psychology, etc.); this is done through the creation of a commercial video game knowledge metric designed to assess objective knowledge of video games, such as recognition of game characters, consoles, genres, and popular game titles. We then turn to the question of whether differences in field of study and/or video game knowledge are associated with differences in beliefs about the impact of video games. It is unclear how having high (or low) levels of knowledge about video games may influence researchers' beliefs about the various sub-literatures. Overestimating knowledge can be dangerous, as it can result in a *meta*-ignorance where researchers may not know what they do not know—and such effects have been observed with individuals who are overall quite knowledgeable, but lack knowledge in one particular domain [32]. For example, researchers whose expertise lies in issues of addiction and cognition might not acknowledge (or recognize) they are less informed or knowledgeable about video games themselves; the reverse could be true for researchers whose primary area is in game studies or a related field, but their understanding of possible consequences is relatively lacking. Combined with authentic concerns about the technology's impact that motivate an interest in applying primary domain expertise to gaming in the first place, such conductions might result in research seeking to confirm rather than falsify effects, as suggested by Elson & Ferguson [4]. Thus, we are interested in exploring individual difference factors among researchers to understand whether the implicit biases they might hold in relation to their research domain and/or video game knowledge might be associated with their views on the effects of video games more broadly. Given objectivity is central to science, this study seeks to explore and potentially reveal the impact implicit bias could have on one's views on games. To formalize our research questions, we ask:

RQ1: Is the commercial video game knowledge scale developed for this project a valid metric for objectively assessing knowledge of video games?

RQ2: Does video game knowledge differ across self-identified subdomains of research expertise?

RQ3: Are video game knowledge scores systematically associated with beliefs about the effects of playing video games?

RQ4: Is there an interaction between video game knowledge and self-identified research domain with respect to beliefs about the effects of playing video games?

Given the topics of objectivity and bias as they relate to one's research domain, one's positive/negative view toward gaming, and one's video game knowledge/experience, which are central to this paper, we deem it essential to explicate these individual difference factors as they vary among the authors of the current paper. Game playing experience and knowledge ranges from low (one author) to high (three authors). Research domains/views are quite mixed. One author's lab studies video games from a perceptual and cognitive perspective (positive view), while also placing focus on addiction scholarship (negative view). Another author's lab contributes to research on the functional role of video games (which could be considered positive or negative). A third author has no prior game studies focus and does not play video games either. Thus, the domains of the authors fall broadly into psychology and communication/media studies; however, the narrower domain often depends on the specific study or publication. We believe this variance in individual difference factors contributes significant value to this study, but we also acknowledge that this variability cannot necessarily be equated to complete objectivity.

4. Methods

The goal of this study is to draw conclusions about how individual differences among researchers who study video games as a subdomain might be associated with certain beliefs of the effects of playing video games. A key motivation guiding this research is the importance of becoming aware of implicit bias, particularly when objectivity is central to research. The following sections explain methods used for recruitment, the final sample of participants, and the method used to create the survey.

4.1. Participants

Researchers active in research on commercial video games and their impact on human behavior were recruited using two key means: First via a search of published works on PubMed, and second via academic listservs.

4.1.1. PubMed search

To identify researchers who had conducted recent research on commercial video games, we conducted a search on PubMed for the phrase "video games" (separate words) with no quotes or modifiers, with a date range of 1/10/2010 to 11/4/2016. This initial broad search yielded 3068 records. Three research assistants well-versed in the study of video game effects read the abstracts of each paper and determined whether the study sought to evaluate the effects of playing commercial video games on some aspect of human behavior (Cronbach's $\alpha = 0.68$). In cases where at least two of the three coders determined that the paper fit the criteria, we included the paper for consideration. In all, 1616 papers fit our criteria. From these papers, we identified 1640 researchers with valid email addresses.

We then sent a recruitment email to the identified email addresses. The recruitment email stated that the study was intended "to assess video game researchers' attitudes and beliefs about the video game research field and about video games more generally," with an emphasis

[2] In narrative studies, a MacGuffin is an object or some focal device that has no inherent meaning or value in itself but serves to advance the plot. Classic MacGuffins in literature include the ring from *Lord of the Rings*, Private Ryan from *Saving Private Ryan*, and Rosebud from *Citizen Kane*.

on "whether there are consensus beliefs about various empirical results in the field." We offered a drawing for one $100 gift card as an incentive and recruited approximately 148 participants using this method.[3]

4.1.2. Academic listservs

After directly soliciting video game researchers via email, we then sent emails to several academic listservs with scholars focused on this research. The targeted listservs were the following: Games + Learning Society, Entertainment Software and Cognitive Neurotherapeutics Conference, Authors & Digital Games Research Association, Foundations of Digital Games, Association of Internet Researchers, International Communication Association (Game Studies), National Communication Association (Game Studies), and Canadian Game Studies Association (details about each listserv can be found in "Supplemental Materials" at [33]). In our recruitment emails to these listservs, we specified that respondents should have published on the topic of video games and human behavior in the past two years. We also included the same language regarding the purpose of the study as described above as well as the offering of an additional $100 gift card drawing. We recruited approximately 138 participants using this method.

4.1.3. Final sample

Of the 286 participants who began the survey, 48 dropped out at various stages before reaching the video game knowledge scale (which was the final portion of the survey), and 25 dropped out upon reaching the page with the video game knowledge questions without answering any questions. Thus, our final sample consisted of $N = 213$ participants. Within this sample, 22.52% skipped at least one question, but a participant was included if they completed at least 85% of the entire survey. The survey first asked for basic demographic information, including age, gender, and academic title (e.g., graduate student, assistant professor, etc.), as well as reported domain of research with which the individual was most associated (addiction, aggression, cognition, communication, education, game design, game studies, media psychology, social, and well-being). In addition to these options, participants could also choose "other" and type in a research domain. When possible, participants who chose "other" were placed into one of the existing domain categories (for example, "physical therapy" was coded as "well-being"); otherwise, participants remained in the "other" group (for example, "computer science"). In all, 43 out of the 47 individuals who initially selected "other" were categorized as belonging to one of the existing categories, while the final 4 participants remained in the "other" category. Approximately 57% of the sample identified as male, 40% as female, and 3% indicated they preferred not to answer, with an average age $M = 38.9$ ($SD = 10.1$). The data file that includes detailed information is available in the references [33]. Table 1 includes additional demographic information separated by domain of study, along with the distribution of the self-identified study domains in the sample.

4.2. Measures

To draw conclusions about the research questions posed, several measures constitute the survey. First, participants completed a demographics section, which asked them questions about their primary research domain, current position, and research experience. Participants then proceeded to answer questions regarding their beliefs about video games, followed by the commercial video game knowledge scale. These

[3] We note that because participants were not uniquely identified in the survey as coming from either the PubMed search or the individual listservs below, our estimates of the number of participants recruited via the given methods is based upon the dates of responses (there was an approximately two-month gap between the last PubMed emails and the first listserv emails) rather than precise counts.

Table 1
Demographic information and reported study domains of survey respondents.

Group	N	Age (Mean)	Age (SD)	% Male	Academic Status (if listed)
Addiction	24	37.1	9.0	58	Full Professor: 3 Associate Professor: 0 Assistant Professor: 5 Post-doc: 5 Graduate Student: 3 Industry Researcher: 1 Other: 7
Aggression	32	39.9	16.3	81	Full Professor: 14 Associate Professor: 3 Assistant Professor: 6 Post-doc: 4 Graduate Student: 4 Industry Researcher: 0 Other: 1
Cognition	48	41.5	10.9	53	Full Professor: 16 Associate Professor: 10 Assistant Professor: 10 Post-doc: 3 Graduate Student: 3 Industry Researcher: 1 Other: 5
Communication	19	36.0	8.8	61	Full Professor: 2 Associate Professor: 4 Assistant Professor: 4 Post-doc: 1 Graduate Student: 7 Industry Researcher: 0 Other: 1
Education	24	36.7	11.3	63	Full Professor: 3 Associate Professor: 3 Assistant Professor: 6 Post-doc: 1 Graduate Student: 2 Industry Researcher: 3 Other: 6
Game Design	8	31.6	14.2	63	Full Professor: 0 Associate Professor: 2 Assistant Professor: 3 Post-doc: 1 Graduate Student: 1 Industry Researcher: 1 Other: 0
Game Studies	9	32.0	4.6	67	Full Professor: 0 Associate Professor: 0 Assistant Professor: 3 Post-doc: 0 Graduate Student: 4 Industry Researcher: 0 Other: 2
Media Psychology	27	32.0	14.4	60	Full Professor: 2 Associate Professor: 6 Assistant Professor: 9 Post-doc: 1 Graduate Student: 8 Industry Researcher: 0 Other: 1

(continued on next page)

Table 1 (*continued*)

Group	N	Age (Mean)	Age (SD)	% Male	Academic Status (if listed)
Social	22	35.6	8.4	52	Full Professor: 0 Associate Professor: 6 Assistant Professor: 4 Post-doc: 1 Graduate Student: 7 Industry Researcher: 1 Other: 3
Well-being	44	38.3	16.6	47	Full Professor: 10 Associate Professor: 8 Assistant Professor: 10 Post-doc: 5 Graduate Student: 4 Industry Researcher: 2 Other: 5
Other	4	34.3	3.4	50	Full Professor: 0 Associate Professor: 0 Assistant Professor: 3 Post-doc: 0 Graduate Student: 0 Industry Researcher: 0 Other: 1

measures, and the rationale for including specific sub-sections of these measures, are detailed in full below.

4.2.1. Beliefs about video game effects

After the basic demographics section, the next section of the survey focused on probing participants' beliefs about the impact of commercial video games on a broad level on various aspects of human behavior, as well as other items tangential to the present paper including opinions about research funding priorities, industry research, and gaming regulations. For each of the items posed, response options ranged on a 7-point Likert scale, from "Strongly Agree" to "Strongly Disagree" [33]. Participants also had the option to select "Neither Agree or Disagree," which offers a neutral option if they were unsure of their answer or did not believe they could generally agree/disagree with the broad items. The items of primary interest asked participants about their general beliefs regarding the impact of commercial video games in the cognitive, clinical (e.g., addiction), social (e.g., aggression/violence), and educational domains (e.g., perceptual and cognitive abilities). These items were intentionally broad to determine whether participants would present generalized associations with respect to games.

We separately analyzed questions about beliefs that were largely framed in terms of negative behavioral effects (seven items, $M = 3.75$, $SD = 1.19$, $\alpha = 0.88$) and positive behavioral effects (six items, $M = 4.92$, $SD = 0.82$, $\alpha = 0.58$), and the correlation between responses on both dimensions was $r(155) = 0.43$, $p < .001$. Separate analyses were done for the negative and positive items, and supplemental analyses were done for individual behavioral endorsement items under each of those labels—especially due to the lower internal consistency of the positive beliefs aggregate score, which provides nominal evidence that the positive beliefs analyzed in the current study do not form a unidimensional construct.

4.2.2. Commercial video game knowledge scale

The final section of the survey probed participants' knowledge about commercial video games. When participants came to this section, they were instructed to answer the questions without looking up any answers. The creation and inclusion of this scale is distinct compared to many other studies measuring video game experience because often, other studies assess game experience by quantifying the amount of hours played per day/week. Such a measure does not necessarily speak to the breadth of game knowledge. For example, it is possible for an individual to play a single game heavily, thus resulting in deep knowledge of that particular game rather than video games more generally. Thus, this scale assesses participants' breadth of video game knowledge across myriad gaming properties and experiences.

The video game knowledge scale was divided into four sub-sections focused on popular video games, genres, game characters, and game hardware. The maximum possible score was 41, and observed scores ranged from 11 to 38, $M = 27.18$, $SD = 7.16$, with a median time of completion of 307.23 s (just over five minutes, or about 13 s per question) and an inner-quartile range of 227 to 416 s. Scale validation data (such as internal consistency) is reported in our Results, as our answer to RQ1.

The first section asked about **characters in games**, in which participants were asked to match 10 popular video game characters to their associated video game. Games and characters were selected for this section by using the top results of a poll of IMDb users of their favorite game characters.[4] In addition to these, we also included the franchises *League of Legends*, *World of Warcraft*, *Starcraft*, and *Call of Duty* as markers for popular video game properties; $M = 8.44$, $SD = 2.24$, *Range* = 0–10.

The second section focused on **video game hardware** in which participants were asked to match images of five video game hardware systems with the name of each system (editing the actual system names out of all images); $M = 2.93$, $SD = 1.18$, *Range* = 0–4.

The third section asked about knowledge of **video game genres**, where participants matched games with their best-fitting genre. To generate a list of potential games, we selected the top two games by Metacritic score[5] for the following genres: role-playing games, fighting, first-person shooting, action-adventure, and strategy. We also performed searches for prototypical games of the given genres and included four additional games as a result of this search (*Call of Duty*, *Starcraft*, *Street Fighter*, and *World of Warcraft*). All 14 included games had fairly clear genre classifications, but we did count correct scenarios in which a game could reasonably be included in multiple genres (e.g., identifying *Zelda: Ocarina of Time* as either a role-playing game or action-adventure video game); $M = 9.74$, $SD = 3.51$, *Range* = 0–14.

The final section of the survey asked participants to sort **video games by popularity** by rank-ordering video games within genres based upon the popularity of the game (using metrics such as daily players or units sold depending on the game) as of the time of initial data collection (October 2016). We selected games for the following genres, with the games here listed in the correct rank-order: role-playing games [*Pokémon* (Red, Blue, or Green), *Skyrim*, and *Diablo 3*], real-time strategy (*Starcraft 1*, *Warhammer 40,000: Dawn of War 1*, and *Age of Empires 2*), first-person shooters, (*Call of Duty: Black Ops*, *Battlefield 3*, and *Halo 3*) and multiplayer online battle arena (*League of Legends*, *DOTA 2*, and *Smite*); $M = 5.95$, $SD = 2.12$, *Range* = 1–12.

5. Results

The research questions this study posed were exploratory given the new methodology proposed that would lead to novel results. Given research questions 2–4 are contingent upon research question 1, the next section first discusses the validity of the commercial video game knowledge questionnaire in full. Following this, we discuss knowledge score differences among participants in different research domains. We proceed to explore associations found between knowledge scores and beliefs of effects of video games, both positive and negative. We

[4] IMDb survey results available online at http://www.imdb.com/poll/NpNzzkaA5Lw/results?ref_=po_sr

[5] List of games was generated via http://www.metacritic.com

Table 2
Video game knowledge score regressed against video game experience.

Question	b	*t* statistic	*p* value	VIF
For how many years have you/did you regularly play video games?	0.26	$t(202) = 7.06$	< 0.001	1.56
Currently, how many hours per week do you typically spend playing video games?	0.16	$t(202) = 1.6$	0.10	2.28
In the period of your life where you spent the most time playing video games, approximately how many hours per week did you play?	0.11	$t(202) = 3.00$	0.003	2.47

Note: Regression equation is video game knowledge score = A + b1Years + b2HoursNow + b3HoursMost. Seven participants were removed as high influence points, with Cook's D above 4/(N-P); $F(3, 202) = 65.0$, $p < .001$, adj. $R^2 = 0.48$

conclude by discussing the interactions between knowledge scores, domain, and beliefs.

5.1. RQ1: Is the proposed video game knowledge questionnaire a valid metric?

Our first research question sought to test the validity of the commercial video game knowledge scale that we developed for this project. To test this, we examined the scale's face validity in detail, as well as construct validity (by considering its internal structure) and concurrent validity (by considering its association with relevant variables, such as gaming experience and self-described gamer knowledge).

5.1.1. Face validity

The focus of the scale was to capture general knowledge about the commercial video game space. Consistent with this, the scale contained questions that required knowledge of video game characters, genres, hardware, and popularity. We chose these based upon the belief that individuals who are well-versed in video games should: (1) know who the most popular video game characters are; (2) know the content of popular video games and, as such, the genre to which the games belong; (3) know the hardware systems that people use to play video games; and (4) know which games are the most popular. As such (and as outlined above), questions and answers for each of these sections were drawn from existing lists of the most recognizable characters, highest rated Metacritic games, top-grossing games, and most popular consoles.

5.1.2. Construct validity

As the scale was (a) a summed test in which higher scores represent more knowledge of video games and (b) that all items were dichotomous in nature (one could answer them either correctly or incorrectly), we examined the scale's internal consistency using a Kuder-Richardson (Formula 20) coefficient as a test of homogeneity of the items. This coefficient was 0.88, suggesting a high degree of internal consistency.

5.1.3. Concurrent validity

We would expect that video game knowledge should be associated with actual experience playing video games.[6] To examine this, reported gaming experience (years spent playing, average hours of weekly play, and peak hours of weekly play) was regressed against video game knowledge score (see Table 2). The overall regression equation was significant, $F(3, 202) = 65.0$, $p < .001$, *adj.* $R^2 = 0.48$, with years playing ($b = 0.26$, $p < .001$) and current hours per week ($b = 0.16$, $p = .003$) both emerging as significant positive indicators of video game knowledge scores. In addition, a simple regression analysis of video game knowledge scores on self-reported knowledge scores was also significant, $t(205) = 29.33$, $p < .001$, $b = 6.50$.[7]

As an additional concurrent validity test, we similarly examined the relation between age and knowledge scale score. Although industry estimates place the average age of video game players at 34 years of age [30], data generally suggests that younger individuals are more likely to be avid gamers [31]. Simple regression analysis likewise confirmed that younger participants in our sample had significantly higher video game knowledge scores, $b = -0.38$, Welch's $t(205) = -8.12$, $p < .001$, *adj.* $R^2 = 0.24$, see Fig. 1.

Finally, although tests of RQ2 involve comparisons of video game knowledge scores by self-defined research domain, one comparison that serves as an additional test of concurrent validity is to compare knowledge scores for individuals fundamentally focused on aspects of video games to individuals who are not. We thus combined individuals

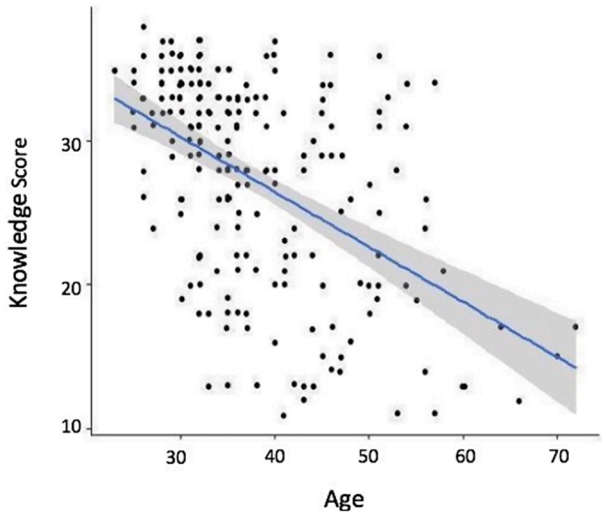

Fig. 1. Video game knowledge scores, as a function of age. *Note: b = -0.38, Welch's t(205) = -8.12, p < .001, adj. $R^2 = 0.24$.*

[6] It is of course possible for individuals who play no video games to be knowledgeable about video games, the expectation is still that direct experience with the games should be associated with increased knowledge of games.

[7] Notably, 25 participants quit the survey immediately upon coming to the knowledge section. It is unclear why these individuals quit at this point—this could have been due to lack of knowledge, lack of interest in taking this part of the survey, or some other reason. However, there was a significant difference in stated "total years spent playing video games"(which was highly predictive of scores on the knowledge section) between those who quit right at the start of the knowledge section ($M = 4.16$, $SD = 12.06$) and those who completed the knowledge section ($M = 15.38$, $SD = 9.38$; $t(34.01) = 5.46$, $p < .001$), Cohen's $d = 0.95$. Inclusion/exclusion of those who did not complete the knowledge section did not meaningfully affect the results reported above, and supplemental analyses with those individuals included are available via our OSF link.

from the domains of "game studies" and "game design" (n = 14 total participants) into a single group and compared the game knowledge scale score of this group with a group composed of all other participants (n = 199). A significant difference in the expected direction was observed: Game studies/design: M = 32.93 (SD = 3.08); non-game studies/design: M = 26.65 (SD = 7.37); Welch's $t(25.37) = 8.64$, $p < .001$, Cohen's d = -0.87—an effect that might be underestimated due to the high variability in the non-game studies/design group. Notably, the game studies and game design groups did not differ significantly from each other—game studies M = 33.75, (SD = 2.60); game design M = 31.83, (SD = 3.54), Welch's $t(8.84) = 1.11$, $p = 0.29$, although a moderate Cohen's d = 0.63 should be interpreted with caution given the small sizes of comparison groups for this analysis (see Table 1).

Taken together, the above results suggest that the scale itself exhibits face validity and construct validity, and its concurrent validity aligns as expected.

5.2. RQ2: Does video game knowledge differ across self-identified subdomains of research expertise?

Beyond the clear differences expected in video game knowledge between game scholars and others (discussed above), we also assessed whether there were any other differences in average video game knowledge across participants from the various domains.

Visual inspection of the bar charts in Fig. 2 above shows both cognition and well-being scholars to have the overall lowest video game knowledge scores, with all other groups having moderate but overlapping knowledge scores. As reported previously, game studies scholars had the overall highest video game knowledge scores, significantly higher than all other groups except for game design scholars. For robustness, a follow-up one-way analysis of variance (ANOVA) comparing all 11 groups confirmed the existence of significant between-group differences, $F(11, 201) = 7.72$, $p < .001$, partial $\eta^2 = 0.30$, with Scheffe post hoc analysis revealing the following subgroup differences: social researchers (M = 31.26, SD = 4.27) scoring higher than cognition scholars (M = 23.12, SD = 6.70, p = .036) and well-being scholars (M = 21.65, SD = 6.59, p = .006). Other groups that also out-scored well-being scholars (the lowest-scoring group with respect to video game knowledge) were education scholars (M = 30.45, SD = 7.08, p = .012) and media psychologists (M = 29.59, SD = 5.88, p = .047). Together, these results suggest that there are significant differences in video game knowledge in the various fields that study video games.

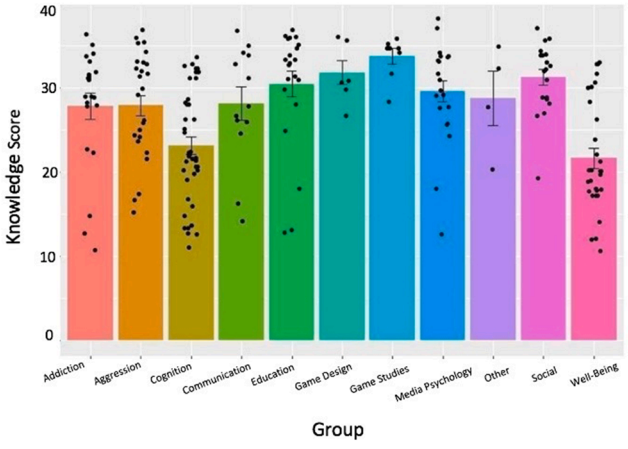

Fig. 2. Video game knowledge scores, by self-reported research domain. *Note: $F(11, 201) = 7.72$, $p < .001$, partial $\eta^2 = 0.30$.*

5.3. RQ3: Are video game knowledge scores systematically associated with beliefs about the effects of playing video games?

We next examined the extent to which degree of video game knowledge was associated with differences in beliefs about the impact of video games on human behavior. On one hand, we might expect that more knowledge would be associated with generally more positive views of games (e.g., those who know the most about video games are more likely to be avid video game players who might be expected to defend their hobby). At the same time, it is plausible that having more knowledge about video games would make one more sensitive to their potential to behavioral effects broadly (both prosocial and antisocial effects).

5.3.1. Video game knowledge and positive behavioral impacts of games

We first analyzed the relationship between video game knowledge and the aggregated "positive" literature questions. We found no significant relationship between a general belief in the positive effects of video games and video game knowledge, $F(1,154) \sim 0.00$, $p = 1.00$, partial $\eta^2 \sim 0.00$ (6 outliers removed, see Fig. 3a).

5.3.2. Video game knowledge and negative behavioral impacts of games

We next analyzed the relationship between video game knowledge and the aggregated "negative" literature questions. We found no significant relationship between a general belief in the negative effects of video games and video game knowledge, $F(1,173) = 3.07$, $p = .08$, partial $\eta^2 = 0.02$ (7 outliers removed, see Fig. 3b).

To offer some granularity to the above analyses, we next looked at how knowledge scores are associated with each of the individual literature questions in a series of simple regressions (See Table 3).

While not all analyses reported statistically significant results (or reported meaningful effect sizes), four associations did emerge in the expected direction: increased video game knowledge was negatively associated with beliefs that games can lead to addictive (R^2 = 0.06), aggressive (R^2 = 0.02), or violent (R^2 = 0.06) behaviors, whereas gaming knowledge was positively associated with a belief that games can successfully model prosocial behavior (R^2 = 0.03). For all other analyses, we note that observed effect sizes are small, but not nominal.

5.4. RQ4: Is there an interaction between video game knowledge and self-identified research domain with respect to beliefs about the effects of playing video games?

Given evidence that (a) video game knowledge can have some impact on endorsements of different video game effects from the literature and (b) scholars from different academic disciplines differ in their video game knowledge, our final set of analyses probe whether knowledge and being a researcher "in" or "outside" of a given domain interact in predicting beliefs in the various domains. Thus, for each domain, we first separated the "in" group, which is the group that is in the given field, from the "out" group, which comprises all other participants. For example, the "in" group for aggression beliefs (e.g., violence) would be self-identified aggression scholars, compared to all other respondents. As our literature questions can be clustered into five categories, five such analyses were conducted (two for negative effects, and three for positive effects); addiction, violence, prosocial behaviors, cognitive abilities, and educational tools. These categories were chosen because they address dominant themes commonly found in video game effects research.

5.4.1. Addiction

For the question "video games can cause addictive behaviors," we ran a multiple regression on ingroup/outgroup membership and score. The overall regression model was significant, $F(3, 184) = 3.02$, p = .03, adj. R^2 = 0.03, two high influence points were removed (see Fig. 4a), although there was no significant effect of area group: b = 2.30, $t(184) = 0.96$, p = .34, no significant effect of knowledge score: b = 0.10, t

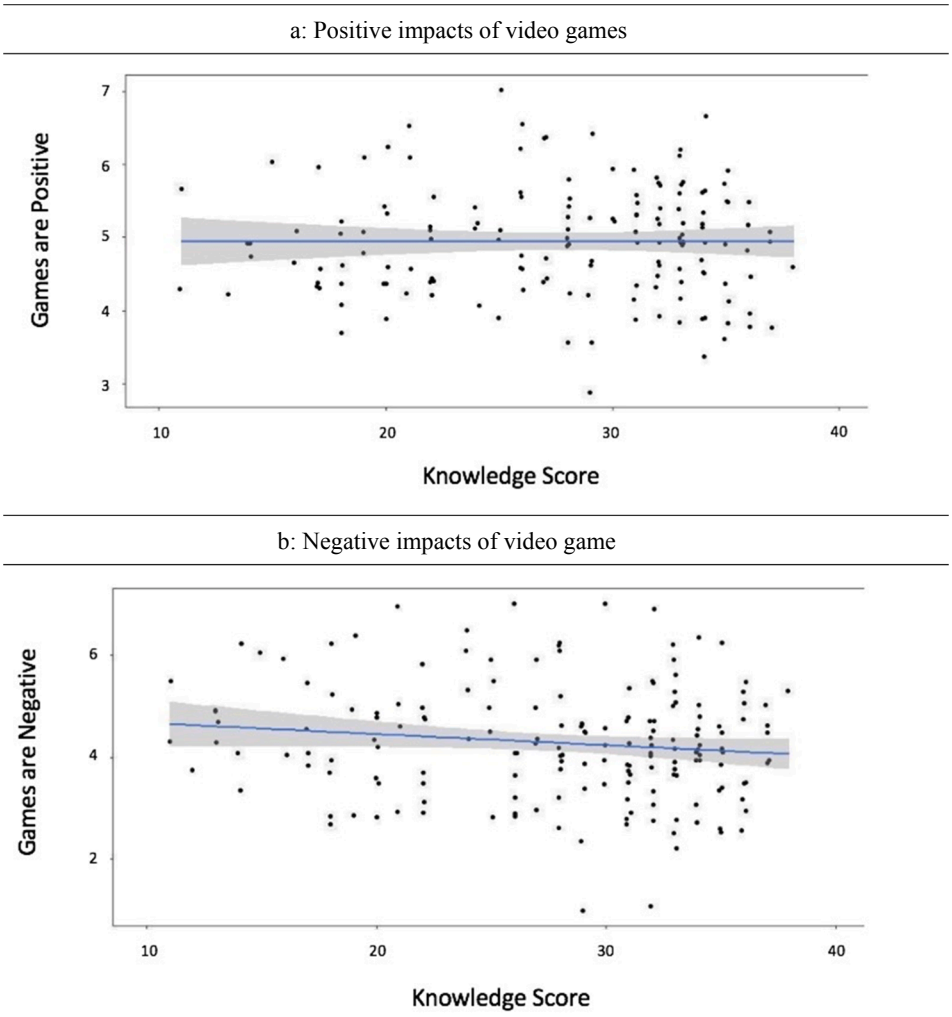

Fig. 3. Influence of video game knowledge on beliefs about the positive and negative impact of video games.

(184) = 1.36, $p = .19$, and no significant effect of their interaction: b = -0.06, $t(184) = -0.76$, $p = .45$.

5.4.2. Violence

For the question "violent video games can cause violent behavior," there was a significant multiple regression model, $F(3,188) = 6.81$, $p < .001$, *adj.* $R^2 = 0.08$, six high influence points were removed (see Fig. 4b). There was a significant effect of area group: $b = 5.65$, $t(188) = 2.5$, $p = .01$, there was a significant effect of knowledge score: $b = 0.24$, $t(188) = 3.05$, $p = .003$, and a significant interaction effect: $b = -0.19$, $t(188) = -2.34$, $p = .02$. The interaction effect was such that ingroup members with lower video game knowledge scores were most likely to endorse claims that video games cause violent behaviors.

5.4.3. Prosocial behaviors

For the question "video games that model pro-social behavior are associated with pro-social behavior," multiple regression revealed no significant effects, $F(3,187) = 1.5$, $p = 0.21$, *adj.* $R^2 = 0.007$, two high influence points were removed (see Fig. 4c). There was no significant effect of area group (p = .67), score (p = .89), or their interaction (p = .80).

5.4.4. Cognitive abilities

For the question "action video games can cause increases in perceptual and cognitive abilities," multiple regression revealed no significant effects, $F(3, 182) = 1.84$, $p = .14$, *adj.* $R^2 = 0.01$, seven high influence points removed (see Fig. 4d). There was no significant effect of area group ($p = .25$), score ($p = .77$), or their interaction ($p = .57$).

5.4.5. Educational tools

Finally, for the question "Video games are effective educational tools," multiple regression revealed no significant effects, $F(3, 198) = 1.96$, $p = .12$, *adj.* $R^2 = 0.01$, five high influence points removed (see Fig. 4e). There was no significant effect of area group ($p = .78$), score ($p = .77$), or their interaction ($p = .55$).

6. Discussion

This work builds on previous studies demonstrating that gaming experience is associated with beliefs about video game effects by including a new metric for assessing video game knowledge and asking researchers to make decisions regarding the positive and negative effects of video games at a broad level. Thus, key findings showed that video game knowledge was negatively associated with the belief that video games can lead to addiction and cause aggression and violence, and higher knowledge scores were positively associated with a belief that games can model prosocial behavior.

A contribution this study makes to research that centers on media is the inclusion of the commercial video game knowledge scale, which is a novel approach to measuring gaming experience that assesses objective knowledge rather than asking participants to self-report gaming hours. Further, this scale assesses breadth of video game knowledge in contrast

Table 3
Simple regressions for beliefs in video game effects by knowledge score.

Literature Question	b	*t* statistic	*p*-value	r^2	Outliers
Some individuals may become pathologically addicted to playing video games.	-0.006	t(201) = -0.41	0.68	-0.005	4
It is possible to design video games in such a way that it is more likely that individuals will become pathologically addicted to them.	0.01	t(192) = 0.76	0.45	-0.002	7
Video games can cause addictive behaviors.	**-0.06**	**t(192) = -3.5**	**< 0.001**	**0.06**	**3**
Video games that model pro-social behavior are associated with pro-social behavior.	**0.03**	**t(187) = 2.68**	**0.008**	**0.03**	**4**
Video games that model pro-social behavior can cause pro-social behavior.	0.01	t(180) = 0.87	0.39	-0.001	5
Violent video games are associated with aggressive behaviors.	-0.009	t(195) = -0.55	0.58	-0.004	3
Violent video games can cause aggressive behaviors.	**-0.044**	**t(196) = -2.41**	**0.02**	**0.02**	**3**
Violent video games are associated with violent behaviors.	-0.03	t(188) = -1.73	0.09	0.01	7
Violent video games can cause violent behaviors.	**-0.06**	**t(193) = -3.78**	**< 0.001**	**0.06**	**3**
Action video games are associated with increased perceptual and cognitive abilities	0.002	t(189) = 0.23	0.82	-0.005	5
Action video games can cause increases in perceptual and cognitive abilities.	0.004	t(190) = 0.30	0.77	-0.005	1
Video games are effective educational tools.	-0.009	t(203) = -0.84	0.40	-0.001	2
Inserting video games in the classroom is more effective than traditional teaching methods.	0.009	t(179) = 0.63	0.53	-0.003	6

Note: Significant simple regression models bolded.

to depth, which is an aspect of experience that video game playing time does not capture. As with any new metric, this scale should be subjected to more systematic validation and will likely need to be updated as the commercial gaming properties shift and change. However, the scale's concept—the assessment of objective knowledge about games—is more critical than the specific items used to assess it. The metric is rather long (41 items) and thus, there are likely more efficient or direct ways to assess knowledge. Our opening effort was intentionally comprehensive to over- rather than under-specify gamer knowledge, and to allow individuals a wide range of concepts that demonstrated their knowledge, but future work might consider a smaller item pool. Moreover, observed effects sizes with respect to endorsing beliefs about gaming effects were overall rather weak, suggesting that future work might consider adjacent concepts, such as more granular understandings of experience and exposure to games and other aspects of being part of "gamer culture" might interact to influence research beliefs. As specified earlier, our scale did favor broad knowledge of the medium, but this could be combined with other indicators of experience, such as past and current gaming experience (e.g., hours spent playing), preference for certain games, or self-perception as a gamer.

Taken together, results from this study suggest that there are significant differences in video game knowledge in the various fields that study video games. In particular, scholars within the domains of game studies, game design, and education scored the highest, whereas scholars within the well-being and cognition domains scored the lowest. Further, we found that a lack of direct gaming experience tends to be positively associated with both (a) a greater likelihood to believe that games have negative behavioral consequences [18,16] and (b) having a less accurate understanding of gaming effects [16]. Results were consistent with this general idea, as decreased objective knowledge of video games was associated with a greater belief that video games could lead to more aggression, violence, and be addictive. In particular, "in-group" violence scholars who also had lower video game knowledge scores were most likely to endorse claims that video games cause violent behaviors. Although we caution that the observed effect sizes are rather small (in the range of 3 to 8% of variance explained), they suggest confirmation bias at play not on behalf of scholars with gaming knowledge but rather, on behalf of scholars without a deep knowledge of the medium. Conversely, those with more knowledge of games were slightly more likely to believe that games could model prosocial behavior, although no other effects were found of gamer knowledge on antisocial or prosocial beliefs about gaming.

Notably, a limitation of this study is that the data was collected in 2016 and further analyzed in 2018. While this paper is not presenting recent data, we feel the methodological approach in creating the commercial video game knowledge scale in conjunction with the topic of objectivity and bias in research, deem it important for the broader community to consider. It is plausible that a replication of this methodology would capture a different subset of researchers, particularly game studies scholars. Thus, it is possible trends would follow. For example if the average age of a game player in the United States is 35–44 [34], participants in a replication study might have slightly more gaming knowledge or experience, which could lead to informative results.

Finally, a consideration that is important to highlight, given the discussion of bias that has been presented, is that we cannot conclude that the sampling frame is representative of the full population of researchers in the observed domains and thus, this work can best be viewed as signal detection work subject to systematic replication and extension. This critique is especially meaningful given that sampling from published academics conflates their inclusion in our sample with known publication biases in various fields of scholarship [35].

7. Conclusion

A core intention of the current study was to explore how subjectivity and individual difference factors of researchers might permeate the scientific approach to their work in which objectivity is central. A key finding garnered from the study is that objective knowledge about video games differs substantially across individuals who study video game effects, and knowledge is associated with differences in beliefs about the impact of video games on some aspects of human behavior. The former is important, as the impact of video games is known to depend on the content of the games—there is no such thing as video game effects at a broad level, given that certain types of video games produce certain types of effects (cf. action video games and cognitive skill; [36]). Without sufficient knowledge of games, researchers may not pose questions in an optimal way (e.g., by combining games across genres that differ in important ways). The latter contributes to a large existing body of research showing that while ideally, one's assessment of the findings in a scientific domain would depend solely on the results in the literature, in practice certain individual differences can potentially color how results are viewed.

To unpack the importance of this further, a lack of understanding related to differences between gaming genres can be associated with "genre confusion" that ignores underlying cognitive mechanisms associated with certain genres (action first person shooter games versus adventure games). Additionally, research reveals there are potential issues with misclassifying games and gamers [37]. On a theoretical level, researchers propose broader ideas of how to categorize games for certain domains (such as cognitive), which would not be the appropriate way to categorize games for social or clinical domains [36]. Treating all games

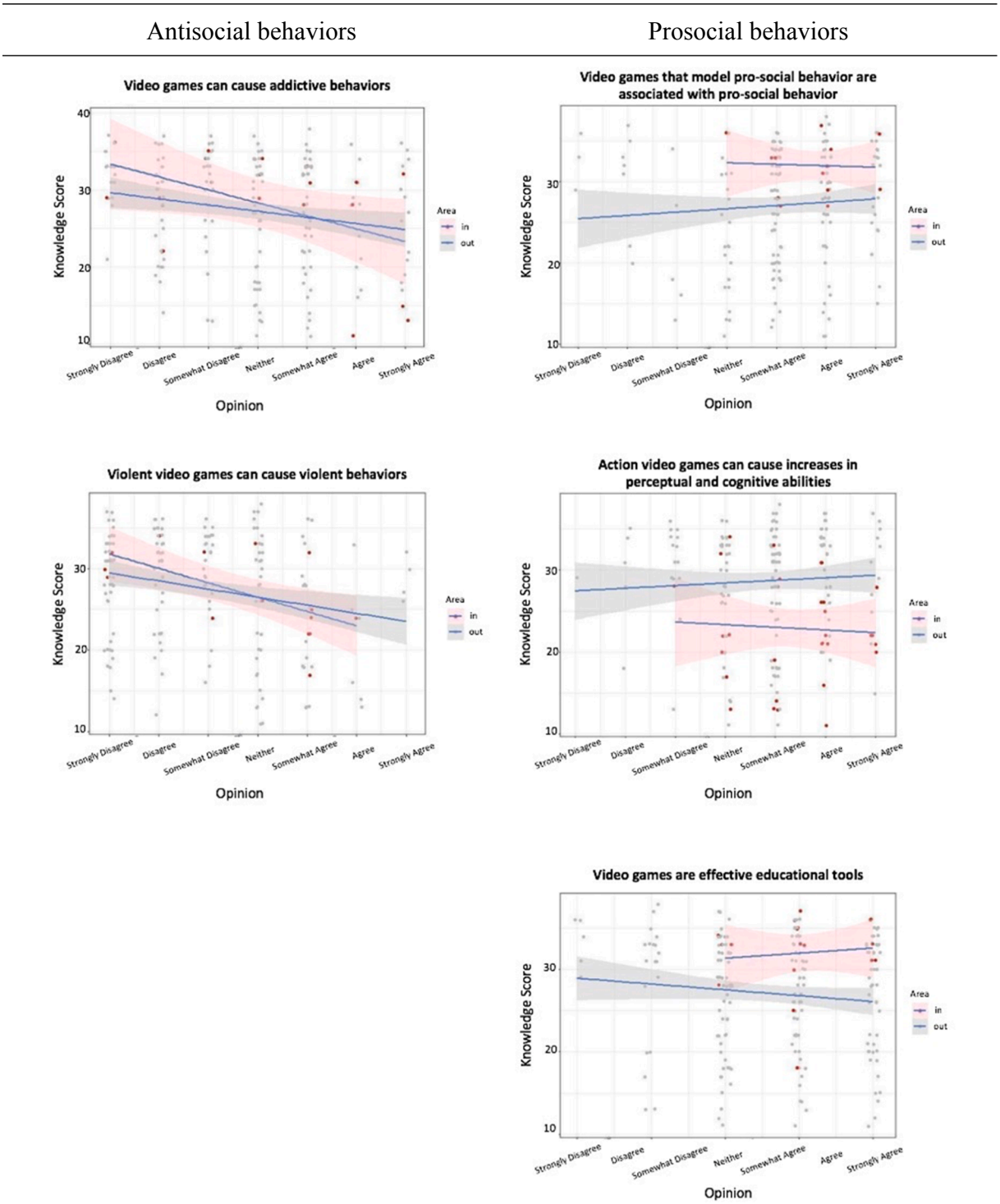

Fig. 4. Influence of video game knowledge on beliefs about video game literature counter-clockwise, a-e from the top-left.

as a single entity is problematic because it leads to the wrong conclusions [23,25]. For example, addiction is strongly associated with certain game types, but not for others. Thus, one could argue that in order to study the effects of this medium in a way that accounts for game/genre complexity, having sufficient knowledge of video games could be critical.

This study contributes to the larger discussion on objectivity and implicit bias that is necessary to have when considering approaches to research. While the focus was on video games and researchers who study video games in various ways, the methodological approach could be adapted and replicated to other sub-domains, particularly other interactive media. For example, virtual reality is a medium that has not received much attention when considering the perspective of media effects. In considering this, we feel that exploring individual difference factors among researchers who study virtual reality as a sub-domain could offer important conclusions regarding how they approach research. The impact of the current study and its examination of objectivity could have impact across research domains and subdomains when considering human behavior and new media. Becoming aware of how one's gaming expertise might influence their research is

imperative. To do so, we encourage researchers to engage in interdisciplinary discussions with communities falling outside of one's primary domain of expertise. For example, an addiction researcher could collaborate with gaming researchers and gaming communities to more broadly consider video game effects. This targeted outreach could alleviate the risk of confirmation bias because it could necessitate the consideration of negative and positive effects of video games, and challenge researchers to reassess the questions being posed. Additionally, research that focuses on video game effects from perspectives beyond psychology could lead to informative conclusions regarding how gamers are impacted. Scholars in game studies and design can contribute their gaming perspectives to projects led by researchers who might not have this knowledge. Lacking direct game playing experience does not have to be considered a limitation if interdisciplinary experts are included in research processes. Further, the converse is true for gaming researchers who might be predisposed to study games through an uncritical lens. The human experience can color researchers' perspectives, which is problematic when objectivity is the core of science. Thus, perhaps interdisciplinary collaboration that integrates expert perspectives is the key that can allow us to come as close to the ideal of objective research as is feasible.

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Declaration of Competing Interest

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

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.entcom.2021.100406.

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