

Case for Support

Objectives

Video games are extremely popular¹—92% of British people aged 16-24 played in the last year. However, games are not yet scientifically understood^{2,3}. Indeed, the science has largely been led by public concerns; namely, that games must necessarily have a negative effect on players' mental health, potentially impacting the lives of millions of people. Such concerns include video game addiction, depression, and possible links between violence in games and real-world violence. Unfortunately, despite more than three decades of research, the scientific community has yet to properly describe and understand video game play behaviour. We have only a limited understanding of how and why people play video games, and how play might relate to mental health. Despite this limited understanding, policymakers have begun to classify and devise "treatments" for game play, as the WHO did by including "gaming disorder" in the International Classification of Diseases⁴. These decisions have been questioned by the academic community, who have highlighted the lack of reliable evidence for supposed diagnoses and treatments of gaming disorder specifically, as well as the basic lack of knowledge about video game play in general⁴⁻⁷. Addressing this gap is crucial: Health and welfare stakeholders and the global games industry urgently require a comprehensive understanding of video games if they are to regulate gameplay, advise parents and players, and develop games responsibly⁸.

Responding to this need, we will conduct a principled research programme that builds on our team's unique collaboration with games industry partners. Over the course of several years, we have established good working relations with major players in the games industry (e.g., Nintendo, Microsoft, Sony). We were successful in convincing an industry historically reluctant to work with independent scientists to share objective, industry-captured data on player behaviour with us (and the world). Out of this collaboration came a series of nine studies in which we, for the first time ever, combined these behavioural data with self-reports of well-being in thousands of players over time^{9,10}. Contrary to public fears, we found little to no effect of play on well-being and reported these findings in two papers. The historic collaboration and findings sparked academic (over 7,000 paper and 300 data downloads) and policy engagement with talks delivered to the WHO, roundtables with the Department for Digital, Culture, Media & Sport (DCMS), and consultations with the office of the United States Surgeon General. In covering the work, *The Guardian* reported on our aim to "introduce a higher standard of evidence"¹¹.

These successes are promising steps towards fundamentally improving how quantitative social scientists study the influence of video games on mental health. With this proposal, we will develop a research programme that expands our approach and leverages our experience and working relationships with industry partners. We will combine a large, representative sample of 7,000 UK players with data on their real play behaviours, obtained from three major game publishers (Nintendo, Microsoft, Sony) and various third-party publishers (e.g. Electronic Arts). Combining these data sets will allow us to address three academic objectives:

Objective 1: Describe video game play. By combining real-life gaming data with self-reported data from our representative sample of 7,000 adult gamers, we will deliver the first broad understanding of *who plays what games, for how long, and when*. These games will include all titles played on any of the three major consoles (Xbox, PlayStation, Switch).

Objective 2: Predict video game play. We will then test which *demographic, personality, and motivational factors predict specific behavioural patterns*, such as duration, distribution, and intensity of play.

Objective 3: Predict mental health. We will analyse *to what extent and under which conditions video game play predicts mental health* (e.g., conduct problems, depression) and well-being (e.g., affect, life satisfaction).

Meeting these academic objectives will allow a comprehensive understanding of video games. Without such an understanding, there is a real danger that any regulations that not rest on a firm evidence foundation may turn out to restrict basic human needs and open up stakeholders operating without that foundation to severe criticism. Therefore, our proposal has three specific impact objectives:

Objective 4: *Set the standard* for academia-industry collaborations for a more credible, robust, and reliable study of video game play.

Objective 5: *Deliver the first authoritative open data set* on video game play and mental health.

Objective 6: *Engage policymakers* with our findings to demonstrate the need for high-quality evidence and an agenda of gold-standard science that can be relied upon for a truly evidence-based policy regarding video game play and mental health (e.g., on decisions whether to fund treatment for gaming addiction, whether to restrict video game play for certain age groups).

Background

Because video game play research has historically been reactive to public concerns, many important methodological limitations have never been addressed. These include: **Low data quality, unrepresentative samples, and a lack of research transparency**, which have led to a **lack of an incremental principled approach (i.e., description, followed by prediction, followed by causation)**. Without first establishing a solid scientific understanding of the behaviour in question, any insights into its effects on mental health and its component, wellbeing, will be of limited validity.

The first key limiting factor has been **poor data quality**. To date, most game research has not measured actual play behaviour, but has instead asked people to estimate how much they play. Such estimates are biased and inaccurate^{9,12,13}. In contrast, video game companies collect complete and granular play behaviour data from their users to inform their own game development processes, but, given the commercially sensitive nature of these data, they have hitherto been reluctant to collaborate with academic researchers.

Second, most research has **relied on small convenience samples** rather than samples representative of the entire population of gamers. Video game behaviour estimated from these samples is therefore unlikely to be representative of “typical” players, and cannot speak to play in general¹⁴. That is, insights from studies of these “atypical” players cannot be used to inform broadly disseminated health advice or regulations aimed at the public in general^{2,14}.

Third, research on video games **lacks transparency**—a problem that has rendered many supposedly foundational results unreliable^{15,16}. So far, little research on video games has publicly shared its data, materials, and analysis code¹⁷. This lack of transparency prevents verification of results and reduces confidence in the field, including the advice given to policymakers and the public. Transparency is especially important when collaborating with industry, given the potential for (perceived) conflicts of interest, or industry capture¹⁸.

These shortcomings have led to a literature that tends to focus on the outcomes of a behaviour (such as the effect of play on mental health) without a clear understanding of that behaviour in the first place. That is, **we lack a principled approach to the study of video games** that follows a cumulative process of description, followed by prediction, with investigations of causality as the final step. Research has tended to skip over the necessary first two steps of that process in favour of examining potential effects of gaming. As a result, the field has produced isolated findings from small-scale experiments in artificial settings that have little to do with how games fit into real people’s actual lives^{14,17}. Being able to statistically predict a behaviour has critical importance to understanding when and under what circumstances it occurs, and is required for examining potential causal relations. Accurate prediction therefore

can inform policymakers where investing resources might have the most impact. We will pursue a principled research programme to overcome these limitations and meet our first three objectives of describing play, predicting play, and predicting mental health by answering three corresponding research questions.

Objective 1: First, we seek to describe the behavioural patterns of play to answer the question: *Who plays what games, when, and for how long?* Working with the video game industry, we will accurately measure, for the first time, the temporal rhythm of video game play. We will recruit a large, representative cohort of gamers, query their mental health, personality, motivations, and demographic information to then combine their self-reports with their play data. The resulting data set will represent a valuable resource to accurately describe and, finally, understand play.

Objective 2: Next, we aim to achieve a more detailed understanding of play by investigating what player characteristics predict play to answer the question: *What motivations, personality traits, and demographics predict video game behaviour?* Specifically, we will study what motivations (e.g. intrinsic or extrinsic motivation), personality traits (e.g., extraversion, neuroticism), and demographics (e.g., age, gender) predict patterns of play (e.g., duration and temporal patterns of play; genre of games played; in-game achievement and performance). Such an approach broadens the scope of the field away from a narrow preoccupation with potentially harmful effects of video game play, and provides a reliable baseline for other studies to build upon.

Objective 3: Finally, we will aim to predict different indicators of subclinical and clinical mental health with different video game play patterns to answer the question: *To what extent, and under what conditions, does video game play predict mental health?* We will investigate whether playing specific kinds of games, at specific times of day, for longer durations, or in specific temporal patterns predicts mental health and well-being. Moreover, we will seek to obtain an understanding of the subgroups and contexts under which reliable prediction occurs. Answering this research question will build the groundwork for identifying risk and resilience features of play—knowledge the field is sorely missing. Description and prediction of video game play will facilitate understanding under what conditions video game play predicts mental health and thus provide the prerequisites for future investigations of game play's causal effects.

Method

Our dataset review indicated that our current understanding of video game play has been limited by inadequate data because video game companies have never before shared their data. Therefore, we propose to collect a large data set. Our team is in a unique position to undertake such work because of our established track-record of working with industry partners across nine collaborations described in two studies^{9,10}. The proposed method for data collection is informed by insights from these two studies, mitigating potential risks we have identified. Moreover, we are currently conducting a pilot that tests the method below with 2,000 UK participants (University of Oxford John Fell Foundation awards #0010468 and #0011260).

Specifically, we will **recruit a nationally representative sample of 7,000 active adult players** in the UK that follows quotas for age, gender, and employment. This approach will counter the risks of participant self-selection and unrepresentativeness that we have identified in our previous work. Our two studies have indicated that 7,000 participants guarantees sufficient representation when we stratify by age, gender, and employment status, to ensure high statistical accuracy. These participants will complete a half-hour **survey on mental health, well-being, motivations, personality, and demographic factors**. We will use well-validated scales to measure psychological states: We query for mental health status with the GAD-7¹⁹, PHQ-9²⁰, WHOQOL-Bref²¹, and Kessler Psychological Distress Scale (K10;²²); well-being with the SPANE and flourishing scales²³; need satisfactions and motivations for play with the PENS²⁴; personality factors with the Big Five Mini-Markers²⁵ and HEXACO Personality Inventory²⁶;

and demographics with a comprehensive (but non-identifying) set of items, including age, gender, and employment status.

To link participant survey data with their video game play behaviours, the survey will direct participants to a website linked to **data collection APIs** which the console makers (Microsoft, Nintendo, PlayStation) have already agreed to co-develop with us (see Figure 1). Participants will be able to select all game services they use, and to consent to donate their play data from those services to the study. This consent process prompts the participant to log into all play services they use, which will result in the creation of an anonymous identifier, recorded with the survey data. Through the APIs, our team can query the game companies' databases to obtain and store (de-identified) play data from each console via these anonymous identifiers and link it with survey responses. Through this system, a) we can obtain *all* play, not just that of a specific game; b) we can select which indicators of play we need for our research (e.g., play time, progress within the game, etc.); and c) we can select any timeframe of play (i.e., any time before or after the survey) because behavioural data are not tied to the study period.

The anonymised player data and survey responses will be stored and analysed on University of Oxford servers, following University protocols for research ethics and data management. The **raw, de-identified data** (including all survey responses and behavioural data), **analysis code, and materials will be made publicly available** on the Open Science Framework, under a permissive CC-BY 4.0 license.

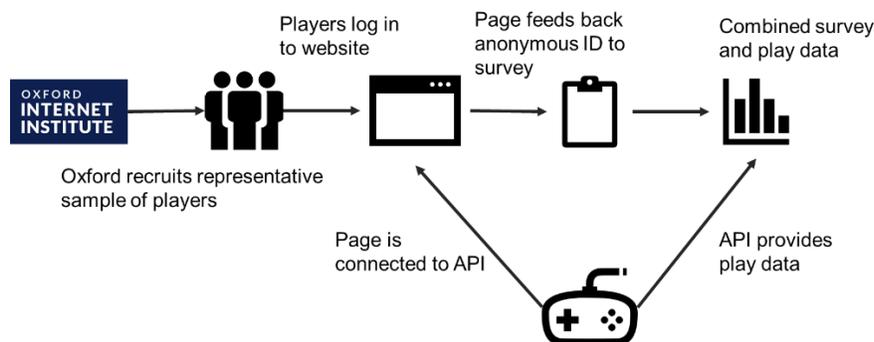


Figure 1. Visualization of our data linking method.

Data Analysis

To meet our first objective, **we will describe participants' play behaviours** to allow inferences to the population of UK video game players. That is, our inferences will be on the group-level, not on the level of individual gamers. Building on an innovative method our team has already applied successfully²⁷, we will specify a richly parameterised *Generalised Additive Mixed Model* (GAMM) of players' video game play time series data. The analysis decomposes the minute-by-minute observations of play into temporal (time of day) and seasonal (day of week, month of year) components, stratified into different genres of games and demographic factors of players. This approach allows us to describe the quantity and distribution of play across the day, week, and year, and how those distributions vary between different games and players, delivering an accurate and generalisable description of *who plays what, when, and how*. Moreover, we will be able to investigate the open question of how play evolves over longer time periods and test whether there are increases or decreases in play; that is, we can examine whether play is a stable or a developmental process and thus inform future time series work.

To meet our second objective, we will **identify factors that accurately predict video game play** with the survey-provided data on players' motivations, personality features, and demographics. This step will move the project from describing video game play to explaining what individual-differences factors explain how people engage with video games. On the broadest level, we will predict the average time of play per day with players' intrinsic and

extrinsic motivations for play and personality features (the Big Five and HEXACO factors). Then, we will expand the GAMM methodology to predict the genre and temporal features of play from players' motivations and personality features. Together, such models will inform us of potential player profiles and deliver a deeper understanding of different play patterns. For example, it is possible that play is common across ages and genders, but it matters more with what motivation players approach gaming.

To meet our third objective, we will **predict players' mental health and well-being with their play behaviours**. Specifically, we will predict various subclinical (i.e., well-being, including affective well-being and life satisfaction) and clinical (e.g., conduct problems and depressive symptoms) mental health indicators with play time. Then, we will use insights from RQ2 on potential control variables and interactions: For example, those with high enjoyment of video games might play more and also feel better. In such a case, we need to control for enjoyment to avoid confounding the relation between playing and mental health. Alternatively, there might be a negative relation between the time of day a player plays and depression, but only if a player perceives little choice in their play (i.e., compulsion).

The size of the data sets will require high computational power. Therefore, analyses will be undertaken using Oxford's High-Performance Computing (HPC) resources.

Outputs and Beneficiaries

To achieve maximum, lasting impact across all six of our academic and policy objectives, we will deliver the following outputs:

Academic Outputs and Engagement

We will publish four open access journal articles meant to frame and advance how quantitative social scientists understand, study, and draw inferences about mental health and video game play behaviour.

1. The first will review the current state of the research on video games and mental health through a causal lens. It will set a proactive agenda for the science of video game play by mapping important open questions and providing a context for identifying methodological improvements. It will be submitted to *Perspectives on Psychological Science*, a widely read flagship journal in our field.
2. The second will focus on the patterns of objective play behaviours in different subgroups we uncover (Objective 1), and will introduce the data set to the community as a public good. It will be submitted to *Psychological Science*, the most widely read empirical journal in Psychology.
3. The third will deliver our rigorous analysis of the predictors of video game play (Objective 2). We will submit this paper to *Plos One* or *Royal Society Open Science*. Both journals have a broader readership, which will help in starting a new discourse on the methods, promises, and limits of prediction in video game research across disciplines (e.g., communication science, human computer interaction, computer science).
4. The fourth will meticulously examine the risk and resilience factors behind links between objectively measured game play and mental health in a representative sample (Objective 3). We will submit this paper to *Nature Human Behaviour* or *Nature Communications*, whose broad readership across the social sciences guarantees that our results are communicated to all researchers who study video games.

We will extend the impact of these papers by directly engaging with our academic networks at the annual meetings of the *Association for Psychological Science* and the *International Communication Association*. Both venues are leading societies that have video games research at their core, and which will guarantee broad impact in our academic world: The former is US-based, whereas the latter is international, with a heavy presence in the UK and EU. We will also

present a workshop at the *Society for the Improvement of Psychological Science* on how to collaborate with games companies, and how to curate large scale data sets for public use. It will aim to unlock the potential of industry data by discussing ways of working towards more open sharing of data and workflows in video games research, and how to link existing cohort studies (e.g., the UK's Millennium Cohort Study) with people's video game play.

Individually, these outputs will represent a step change for video game research across the quantitative social sciences. Through papers and direct engagement, the project will advance our field beyond low measurement and data quality; deliver accurate, generalizable insights that go beyond a given convenience sample; display maximum methodological transparency; and showcase a principled way forward for the study of video games. We hope that these outputs will set a new standard for the field, for innovative, transparent, and ethical projects that make good use of public funds to build useful resources for both academia and other stakeholders.

Dataset

The data we collect will take its place next to other ESRC-funded data sets, such as the Millennium Cohort Study, as a public resource. Researchers in the field can use the public data set and our codebooks to conduct original research through secondary data analysis. Because data like these have never been collected, many novel research questions outside the scope of our specific RQs will be testable for the first time; for example, an analysis of gaming disorder criteria in terms of objective game behaviours—a comparison lacking from three decades of literature. At the same time, collaboration with such prominent industry partners will pave the way to start conversations with other technology companies on data sharing, significantly broadening the portfolio of the ESRC. Our project will show that data sharing can only happen with full transparency and responsibility that supports social data science for the public good.

Policy Engagement

Complementing the projects' high value for the scientific community, we will directly engage non-academic stakeholders in the regulatory, health policy, and industry sectors.

1. Our project provides a worked example in response to the DCMS's call for technology industry partners to collaborate with independent scientists²⁸. We will present our work to DCMS, introduce them to our method for such collaborations, and believe it will be well-received by the DCMS Chief Scientific Adviser who will be convening workshops with UKRI over the course of this project.
2. The project will inform our ongoing engagement with the WHO European Office for Prevention and Control of Noncommunicable Diseases. This unit is keenly interested in our work on the health dynamics of play. We will also communicate our findings to the central WHO office in Geneva (focused on Gaming Disorder). Both parts of the WHO will become familiar with what the practice of open science on games looks like.
3. A wider international network of international charities, health authorities, and non-profits including UNICEF, Childhood.Org, and the office of the US Surgeon General will be updated on our progress, practices, and findings. This is critical because these groups are currently weighing evidence on whether potential restrictions to video game play violates the right of the child to play and regulations concerning data sharing.
4. Last, we will host a two-day evidence and policy conference in Oxford. Here, we will use the results from this project to hold series of workshops and roundtables among academics, industry (i.e., UKIE, UK games companies), and policymakers (i.e., DCMS, Ofcom, UNICEF, Chief Medical Officers' office). The goal of this summit is to create an agenda for future collaborations and research that all parties commit to. We hope such a commitment represents the first step for a truly collaborative science of video games and mental health.