



Prospective Passion and Social Capital within DotA 2 Players

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The Dualistic Model of Passion (obsessive and harmonious passion) can explain motivations for videogame play along with associated outcomes, such as the development of social capital; however, existing research exploring passion and social capital in videogaming has been cross-sectional. In the current study we surveyed players of DotA 2 at three time points, over six months (T1 n=462, T2 n=182, T3 n=115), to explore the stability of passion for DotA 2 over time and how such passion may lead to the development or erosion of social capital. Our key findings include that passion for playing DotA 2 is relatively stable over time and that harmonious passion predicts future bridging social capital, while obsessive passion predicts future bonding social capital. Importantly, our findings suggest the absence of a “slippery slope” scenario in which players who have a healthy pattern of engagement development obsessive passion or problematic play. Equally, however, our findings also suggest that those who are obsessive are unlikely to naturally trend towards a more harmonious style of engagement over time. We consider the implications of our findings for health practitioners, players and videogame developers and identify the differences between our longitudinal findings and the existing cross-sectional research.

CCS Concepts: • **Applied computing** → *Computer games*; • **Human-centered computing** → **Empirical studies in collaborative and social computing**; **Empirical studies in HCI**.

Additional Key Words and Phrases: digital gaming, dualistic passion, social capital, wellbeing, problematic gaming, obsessive passion, harmonious passion, DotA, MOBA, gaming disorder

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1 INTRODUCTION

Playing digital games has consistently been shown to provide myriad benefits to wellbeing, such as helping players recover from stress [7, 41, 42, 42], combating loneliness through social connection [11, 36, 38], and improving their emotional state [5]. However, high levels of engagement in gaming

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can also lead to problematic play that can harm wellbeing. The World Health Organization describes problematic gaming as “(...) a pattern of persistent or recurrent gaming behaviour (‘digital gaming’ or ‘video-gaming’), which may be online (i.e., over the internet) or offline, manifested by: 1. impaired control over gaming (e.g., onset, frequency, intensity, duration, termination, context); 2. increasing priority given to gaming to the extent that gaming takes precedence over other life interests and daily activities; and 3. continuation or escalation of gaming despite the occurrence of negative consequences.” [58]. Recently, gaming disorder has been included in the WHO’s ICD-11 diagnostic criteria [58], and as a condition of interest that warrants further clinical research in the DSM-5 [2, 58]. There remains significant disagreement among scientists, game scholars, and clinicians about the appropriateness of describing problematic gaming as a disorder [1, 14, 54], and whether it might better be described as an effective coping mechanism for a different underlying problem [3, 27]. There is, however, general agreement that there are people for whom videogame play can be problematic and others for whom videogame play is simply an enjoyable leisure activity that provides relief and recovery [30, 54]. The question then becomes, how do we figure out which players fall into which category, so that we can help prevent players from developing problematic trajectories while simultaneously supporting high engagement for passionate players.

To better characterize the nature of highly engaged players, researchers have recently turned to the dualistic model of passion [52], which divides passion into harmonious passion (HP)—characterized by a balanced and authentic relationship with the beloved activity, and obsessive passion (OP)—characterized by preoccupation and inflexible persistence toward the loved activity. HP is typically associated with improvements to wellbeing and OP typically with decrements to wellbeing, across a variety of contexts [e.g., 8, 9, 50, 53, 59], including videogame play [e.g., 13, 24, 36, 44]. Because relationships built through games are known to provide social support to players [e.g., 11, 47], researchers have also considered the relationship between dualistic passion and social wellbeing, operationalized using the social capital framework [40] that considers both bridging capital—social ties that broaden the social horizon, but may lack depth—and bonding capital—social ties that provide strong personal connections and emotional support, but may represent less diversity of opinion and background. By modeling passion for gaming using a dualistic model, and associating HP and OP with effects on wellbeing—including on social wellbeing as described through social capital—researchers can begin to provide models [13, 24, 36, 38] that may help differentiate for whom high engagement in games is problematic, and for whom it is simply indicative of a beloved hobby that generates significant attention and investment.

However, the problem is that this limited prior work on how passion for gaming may build social capital in games [36, 38] has only employed cross-sectional data and methods, which limits our understanding of how passion changes over time, and how the development (or waning) of passion for videogame play over time may affect social capital formed through play. Research on the longitudinal nature of passion for gaming is needed for several reasons. First, prior work [13, 24, 36, 39, 44] has suggested that although harmonious passion is associated with benefits to wellbeing, there is the potential that this balanced and authentic passion might morph over time into a persistent and inflexible one that is associated with harm. This ‘slippery slope’ argument suggesting that HP might be a gateway to OP has never been demonstrated in a gaming context but would have implications for how we understand the nature of highly engaging, but non-problematic levels of gaming. Second, there is a possibility that OP might wane over time, naturally helping players correct from a harmful passion orientation into a highly engaged, but more balanced passion; however, no evidence is available to support this ‘natural equilibrium’ argument. Third, by examining whether and how passion orientation builds or erodes social capital over time, researchers are better positioned to propose interventions for problematic play that account for

how social relationships built within games can reinforce both beneficial and harmful patterns of engagement over time.

In the current paper, we focus both on the stability of passion for gaming over time, and how passion for gaming may build social capital through a prospective study. We explore the association between passion and social capital in a study with pre-registered analysis using cross-lagged panel models on data collected at three time points and analyzed in three datasets (cross-sectional: $n_1 = 462$, two-wave: $n_2 = 182$, three-wave: $n_3 = 115$) among passionate players of a popular digital game (*Defense of the Ancients 2: DotA 2*). DotA 2 is a massive online battle arena (MOBA) game that pits players in a 5v5 competition with mechanics influenced by real-time strategy (RTS), first-person shooter (FPS), and role-playing games (RPGs). Two teams fight to control a map, in which they each have a base; players are generally distributed across three lanes (top, middle, and bottom) and fight to destroy their opponents' base, thereby winning the game. Because of the large number of characters available, alongside decisions in team composition, and play choices within the game, each match unfolds in a unique way, making it difficult to employ a singular strategy and requiring skill to adapt as a team. At the time of data collection, DotA 2 had the most number of players per hour on the game platform Steam, as well as the highest number of concurrent players that year [35].

In this research, we first sought to uncover whether existing passion for DotA 2 predicts future passion and how much change there is over time. This design will inform whether HP can facilitate future OP for gaming, leading to a situation in which a balanced passion has potential for future harm, and also test whether OP for gaming might facilitate future HP, implying that people with persistent and inflexible passion can self-correct into a balanced and harmonious one. Second, we wanted to know how passion for a game is associated with future social capital built within that game. Does HP predict future bridging or bonding, suggesting that a balanced and authentic passion may yield future social benefit? And does OP predict future social capital, built in spite of an inflexible and persistent obsession with the game?

We therefore asked two main research questions:

- RQ1: Is dualistic passion for DotA 2 stable over time?
- RQ2: How does passion lead to the development or erosion of social capital in DotA 2?

For this question, we explored the question both prospectively, to consider how passion predicts social capital at a future date (R2a), and cross-sectionally, to compare to previous work with different game titles (R2b) [Destiny: 38][WoW: 36].

Overall, our findings suggest that for our sample, passion for playing DotA 2 is relatively stable over time (RQ1) and that there are no cross-lagged effects (i.e., HP does not predict future OP, nor does OP predict future HP); that harmonious passion predicts future bridging social capital, while obsessive passion predicts future bonding social capital (RQ2a); and finally that harmonious passion for DotA 2 is cross-sectionally associated with bridging and bonding social capital, while obsessive passion is not cross-sectionally associated with either kind of social capital (RQ2b). We situate these findings within previous work on passion and social capital in gaming, and provide a discussion of how our results can inform the design of interventions designed to promote a healthy and harmonious engagement with gaming, while combating the problematic aspects of obsessive play.

2 RELATED LITERATURE

2.1 Passion

As a means of understanding people's desire to engage with specific activities, Vallerand and colleagues [52] defined passion as a strong inclination toward an activity that a person likes, finds

important, and in which they invest energy and time. Importantly, as part of the Dualistic Model of Passion [52], they proposed that passion can emerge as one of two types: harmonious or obsessive [34, 52]. Harmonious passion (HP) can be seen in contexts where a person has autonomously internalised their interest in the activity and freely accepted it as important in the absence of attached contingencies. It can be thought of as a “want” as opposed to a “need” to engage in the activity, in other words, engagement occurs willingly alongside a sense of volition. The activity occupies a significant part of the person’s life but is not overpowering, it is literally “in harmony” with other aspects of their life. In contrast, obsessive passion (OP) can be seen when a controlled internalisation of the activity into identity has occurred. There is intra- or inter-personal pressure because of contingencies attached to the activity ranging from uncontrollable urges to feelings of social acceptance or self-esteem associated with the activity. These contingencies lead to a compulsive “need” to engage in the activity and ultimately the activity fills a disproportionate space in the person’s identity and causes conflicts with other aspects of their life [34, 52].

2.1.1 Passion in Games. A range of studies focussed on videogames have confirmed the utility of the Dualistic Model of Passion for understanding motivations for play as well as various associated outcomes [13, 24, 31, 36, 39, 44]. Przybylski and colleagues [39] in the first study looking specifically at passion for videogame play, explored the ways in which satisfaction of needs leads to the development of passion. They also found that HP was associated with a range of positive outcomes (increased enjoyment and vitality), while OP was associated with negative outcomes (decreased enjoyment and greater tension). Since then, a number of studies have confirmed this broad pattern of HP for videogames being associated with positive outcomes and OP with negative outcomes [e.g., 13, 36, 44]. However, not all studies have found simultaneous support for both relationships. For example, Johnson and colleagues [24] found evidence for OP being associated with negative outcomes, but they did not find any connection between HP and positive outcomes. The inconsistent findings raise questions about the stability of the associations, prompting a turn to longitudinal research.

2.1.2 Longitudinal Passion. Inherent to the notion of passion is the idea that it develops over time, progressing through stages of activity selection, activity valuation and internalisation of the activity in identity [51, Chapter 5]. The majority of work exploring passion for videogames has taken a cross-sectional approach leaving the question of stability of passion in this context largely unanswered (with associated calls for more longitudinal research in the field [51, Chapter 13]). However, looking outside of videogames, there has been greater exploration of passion over time. Much of this work has occurred in educational settings. For example, Horwood and colleagues [17] in a study of burnout among school principals found evidence of stability of both HP and OP for their work over a one year period (correlations between T1 and T2 of approximately $r = .7$). Similarly, looking at workplace attitudes among school teachers, Lavigne and colleagues [32] found that teachers’ passion for their jobs was relatively stable over a 3-month timeframe ($r = .7$). Moving to students’ passion for study, and exploring the question over three timepoints during an academic year, Schellenberg and Bailis [43] found similar levels of passion at T2 ($r = .7$) and sustained but slightly reduced stability at T3 ($r = .6$). Finally, again with a sample of university students, but exploring passion for their preferred activity, Tóth-Király and colleagues [49] confirmed relative stability of both types of passion over four months.

To the best of our knowledge, the only insight regarding stability of passion for videogames is provided in a study focused on the relationship between passion, need frustration, and time spent playing [37]. While not focussed on stability of passion, Mills and colleagues found HP to be relatively stable ($r = .65$) over 75 days, and OP to be somewhat less stable ($r = .33$). Given their focus on other relationships, the authors do not interpret this finding in any detail. It is also

worth noting that their sample consisted of university students whose degree of passion and time available for videogames might be expected to vary over the course of an academic term, that these students were not necessarily passionate gamers, and also that their participants were asked about their passion for videogames in general rather than for a specific game.

2.2 Social Capital in Gaming

One key component of wellbeing that is commonly shown to be influenced by videogame play is social connectedness, with prior work showing that social gaming has the potential to build social capital, which benefits players by satisfying our need for relatedness [e.g., 11], providing offline social support [e.g., 47], and even combating loneliness [11, 36]. The social capital framework describes social networks as resources that, when nurtured, return value to a person in the form of social support and personal information sharing that benefit wellbeing [40]. There are two kinds of relationships described in the social capital framework: bridging ties and bonding ties [40]. Bonding ties are characterized by strong personal connections that provide mutual and substantive emotional and social support [40]. Bridging ties are characterized as indefinite relationships that provide breadth; they broaden an individual's social horizon as they expose us to views and opinions different from our own [40].

Williams et al. [56] were first to apply the concept of social capital to in-game relationships in the context of World of Warcraft (WoW), which is a massively-multiplayer online role-playing game (MMORPG) in which in-game relationships are vital to the game's mechanics. Games researchers have investigated the quality of in-game relationships using the social capital framework in the context of World of Warcraft [6, 36, 46, 57], Second Life [19], Counter-Strike [22, 23], Destiny [38], and within broader game communities [e.g., 11, 47]. To summarize, early research showed that gaming can generate social capital, but that friendships enacted in-game likely forms bridging ties, which perhaps provide less social and emotional support [12, 19, 45, 46, 57]. However, Trepte et al. [47] found that both bridging and bonding social capital were built within esports clans—a gaming context in which players are arguably more dedicated and consistent than in casual play. In particular, the social capital built during esports was positively associated with offline social support in the form of advice, assistance, and listening. More recently, researchers have also considered the properties of the game and the gamers, with Perry et al. [38] showing that playing with online and physical friends in Destiny built bonding ties, whereas playing with online friends and strangers built bridging ties [38]. Depping et al. [11] further found that interdependent and benevolent gaming communities facilitated both bridging and bonding capital in games, and that both were associated with reductions in loneliness outside of the game.

2.2.1 The Relationship between Social Capital and Passion in Gaming. In considering which aspects of the game, gamer, and gaming community best support the development of social capital, few researchers have considered dualistic passion for gaming, or addressed these relationships in longitudinal research. In Perry et al.'s [38] research in the context of Destiny (a massively-multiplayer online first-person shooter: MMOFPS), the authors used structural equation modeling (SEM) to show that playing with online friends, offline friends, and strangers all led to the building of social capital via greater HP, and not via OP. And in the context of WoW, Mandryk et al. [36] used SEM to show that HP for WoW (an MMORPG) is associated with both bridging and bonding social capital, a reduction in loneliness, and an increase in hedonic wellbeing. They also showed that OP is also associated with both types of social capital, but that these social ties were not indirectly combating loneliness, and rather that OP is directly associated with increased loneliness.

2.3 Summary

While knowledge of passion for videogame play and the development of social capital during play is steadily building, there are still key gaps in our understanding. There is a range of cross-sectional evidence that HP for videogame play is associated with positive outcomes and OP with negative outcomes. However, there are some inconsistencies in these findings across games and contexts and a lack of longitudinal evidence. Outside of videogame play (primarily in the field of education), there is evidence of relative stability of passion over time. In the single study to explore passion for videogames prospectively, there was evidence of greater stability of HP than OP. Turning to social capital, there is a range of evidence across games, genres, and contexts of videogame play facilitating both bridging and bonding social capital. However, to date, very little is known about the development of social capital over time, nor how passion for play influences such social capital development. The present study is designed to begin filling these gaps in the literature.

3 METHODS

We conducted repeated surveys in late 2016 and early 2017. Ethical approval for this study was obtained from the ethics committee at Queensland University of Technology [approval number 1600000558]. A previous publication based on these surveys explored the relationships between sense of identity, game play and toxicity [33]. Neither passion nor social capital were analysed in the previous work.

3.1 Recruitment

Data were gathered via a three-wave longitudinal study, with participant recruitment being conducted online using a snowball sampling method. A recruitment post detailing eligibility criteria, the aims, and purpose of the study together with a link to the initial survey was shared across a range of social media sites and discussion forums dedicated to DotA 2 in September 2016. These sites included subreddit forums such as r/DotA2, online communities such as Dotabuff.com and Dotafire.com, and Facebook groups dedicated to the DotA 2 player population of a major Australian university. Both the text and the survey itself were only available in English. Although collected some time ago, this data remains valid both because the MOBA genre remains popular, but also because DotA 2 continues to maintain a consistent playerbase.¹ Participants were informed that participation was voluntary, that they could withdraw at any time prior to submitting their final responses, and that to be eligible they needed to be 15 years or older and be currently playing DotA 2. Those who consented to participate were directed to the first survey which took 30 to 40 minutes to complete (similar completion times were observed at Times 2 and 3).

Participants who completed the survey at Time 1 were offered the chance to participate in a follow-up survey three months after the close of the six-week period in which the first survey was available, with those completing the second survey invited to participate in a third survey three months after the close of that. Participants were offered the chance to win \$20AUD in game credit for their participation at Time 1, \$50AUD in game credit at Time 2 and \$100AUD in game credit at Time 3. Participants who completed all 3 timepoints were given a code to redeem for a bundle of games from Valve Corporation (developer of DotA 2). Duplicate entries (based on IP address) were not permitted after the participant had submitted their survey. In addition, participants were requested to supply their Steam ID for the purpose of cross-referencing player-provided data.

¹While the all time peak number of concurrent players was approximately 1.29 million in March 2016, a peak of over 800,000 was observed in April 2023 as per <https://steamcharts.com/app/570#All>

3.2 Participants

Overall, 912 participants responded to the request for participation, of which a majority did not complete the survey. We removed participants who failed any of the four attention checks at Time 1, the single attention check at Time 2, or the attention check at Time 3 and participants with incomplete responses to the scales of interest relevant for the analyses at Times 1, 2, and 3. With this, the samples included 462 participants for the cross-sectional analysis (Time 1 only), 182 participants for the two-wave analysis (Times 1 and 2), and 115 participants for the three-wave analysis (Times 1-3). Demographic information² was comparable across samples (see Table 1). We asked participants to estimate the overall number of hours they played DotA 2 ($M = 2505.13$, $SD = 2182.63$) and how many hours per week they played in the last month ($M = 20.04$, $SD = 26.25$).

Table 1. Participant information across the three datasets.

	Cross-sectional (Time 1)	Dataset	Two-wave Dataset (Time 1&2)	Three-wave (Times 1-3)	Dataset
<i>n</i>	462		182	115	
Gender ²	10 female, other, 1 missing	448 male, 3 other,	3 female, 178 male, 1 other	2 female, 113 male	
Age	15 - 41 ($M = 22.76$, $SD = 4.42$, $Mdn = 22.00$)		15 - 41 ($M = 22.88$, $SD = 4.61$, $Mdn = 22.00$)	15 - 33 ($M = 22.74$, $SD = 4.29$, $Mdn = 22.00$)	

3.3 Measures

In addition to demographic information, data were collected concerning players' passion towards DotA 2 and the level of bridging and bonding social capital they experienced with other players.

Players' passion toward DotA 2 was assessed using a 10-item version of the Vallerand et al. [52] Passion scale. Participants were asked to complete the scale's items with regard to their experiences in DotA 2. Two 5-item subscales were used to assess harmonious and obsessive passion (sample item for harmonious passion: "This game is in harmony with the other activities in my life"; $\alpha_1 = .746$, $\alpha_2 = .728$, $\alpha_3 = .705$ ³; sample item for obsessive passion: "The urge is so strong, I cannot help myself from playing this game"; $\alpha_1 = .890$, $\alpha_2 = .887$, $\alpha_3 = .893$). This scale was completed on a 7-point Likert scale ranging from "1 - Do not agree at all" to "7 - Very strongly agree."

The extent to which involvement in the DotA 2 community affected players' social capital was assessed using a 10-item version of the Internet Social Capital Scale [56], which was designed to measure the type of relationships individuals have with their online communities along two dimensions, "bridging" and "bonding". This 10-item version consisted of two five-item subscales, derived from the complete ISCS, which evaluated the extent to which involvement in the DotA 2 community promoted these two types of social capital on the same 7-point Likert scale as the Vallerand measure (sample item for bridging: "Interacting with people in DotA 2 makes me feel like part of a larger community", $\alpha_1 = .847$, $\alpha_2 = .873$, $\alpha_3 = .855$; sample item for bonding: "When I feel lonely, there are several people I play with in DotA 2 I can talk to.", $\alpha_1 = .838$, $\alpha_2 = .853$, $\alpha_3 = .851$).

²These data were gathered in 2016 and 2017, at which time we assessed gender in the way described. Currently, best practices inform that gender should be gathered by allowing participants to self-describe. As such, we do not employ gender (as gathered) in subsequent analyses, but are simply reporting it here to characterise our sample.

³ α_n denotes Cronbach's alpha reliability for subscale of responses at Time n for all participants who were included in the respective dataset.

3.4 Data Analyses

The analysis for this paper was pre-registered at <https://osf.io/ay4jn>, which we complemented with one additional cross-sectional analysis.

As per the pre-registration, we conducted two main analyses and an exploratory analysis using cross-lagged panel models. For all our analyses, we used the calculated scores as observed variables for the constructs harmonious and obsessive passion, and bonding and bridging social capital as described above. We used robust models specified in lavaan syntax and evaluated them in JASP 0.16. Effects were evaluated based on standardized regression coefficients (β) and reported as significant if $p < .05$. Additionally, we evaluated explained variance using R^2 .

The first main analysis with the two-wave data (Times 1 and 2) used a model with two constructs (harmonious and obsessive passion) measured at Times 1 and 2, aiming to evaluate the stability of passion and directional relationships across the period of three months (RQ1). Additionally, we specified an exploratory three-wave model with obsessive and harmonious passion for Time 1, Time 2, and Time 3 with the same modeling approach but extended to three time points (building on RQ1) using the three-wave dataset (Times 1-3). In this model, we used harmonious and obsessive passion at Times 1, 2, and 3 with direct effects of all variables from Time 1 to Time 2 and Time 2 to Time 3. This model examines the stability of passion and directional relationships across the period of 6 months.

Then, for the second main analysis and using the two-wave dataset, we specified a model with four constructs (harmonious and obsessive passion, and bonding and bridging social capital) measured at Time 1 and Time 2, aiming to investigate the stability of the constructs across a period of three months, and the directional relationships between the passion and social capital constructs (RQ2a). In this model, we used harmonious and obsessive passion, and bonding and bridging social capital at Time 1 and Time 2 with direct effects of all Time 1 constructs on all Time 2 constructs. We allowed all constructs at a time point to covary.

For all these models, the effects provide information about stability effects (e.g., T1_HP \rightarrow T2_HP), cross-lagged effects (e.g., T1_HP \rightarrow T2_OP), and cross-sectional effects (e.g., T1_HP \leftrightarrow T1_OP).

Finally and complementary to the pre-registration, we conducted a cross-sectional analysis using the cross-sectional data from all respondents to Time 1, comprising the largest dataset with the largest statistical power. In this model, we modeled direct effects of harmonious and obsessive passion on bonding and bridging social capital, while also allowing both passion and social capital constructs to covary (RQ2b).

3.4.1 Primer on Fit Indices. As described, we employ path analysis and structural equation modeling in our analyses. In such approaches, fit indices give an indication for how well a theoretical model fits the data to which it is applied [10, 18, 28, 29]. Absolute fit indices presume the best fitting model has a fit of zero and the measure provides an indication of how far the model is from perfect fit. Comparative fit indices compare two different models. The Root Mean Square Error of Approximation (RMSEA) is an absolute measure of fit based on the non-centrality parameter, it represents the average of the covariance residuals (i.e., the differences between corresponding elements of the observed and predicted covariance matrix). The Standardized Root Mean Square Residual (SRMR) is an absolute measure of fit in the form of the standardised difference between the observed correlation and the predicted correlation. The Comparative Fit Index (CFI) is a comparative fit index that compares the fit of the target model to the fit of an independent model (i.e., a model in which the variables are assumed to be uncorrelated). The Incremental Fit Index (IFI) is an incremental fit index that allows for sample size and degrees of freedom. Rules of thumb are used to interpret these indices and evaluate model fit [18, 20]. Prior work has suggested different rules of thumb to guide the identification of models that have good fit: SRMR below 0.8, RMSEA below 0.6,

CFI over 0.95 and IFI over 0.9. However, prior work has also suggested that such rules of thumb need to be considered cautiously, e.g., in cases where the rule of thumb for a single index is not met, the model should not be assumed to be invalid [10]. Instead of overly relying on fit indices, a theoretical foundation for a model is essential [20], especially as some indices have known shortcomings e.g., RMSEA has been found to over-reject true models for small N 's (< 250) [20]. Importantly, it should be noted that where a model is 'just identified' (i.e., there are no degrees of freedom as the number of free parameters equals the number of known values), then such measures of fit are not available [10].

4 RESULTS

Tables 2, 5, and 8 show descriptive statistics and correlations across the samples.

Table 2. Descriptives and Pearson r correlations for constructs in the two-wave dataset. * $p < .05$, ** $p < .01$, *** $p < .001$

	<i>M</i>	<i>SD</i>	T1_HP	T1_OP	T2_HP	T2_OP	T1_Bonding	T1_Bridging	T2_Bonding	T2_Bridging
T1_HP	4.647	1.215	–							
T1_OP	2.579	1.500	0.223**	–						
T2_HP	4.713	1.177	0.720***	0.169*	–					
T2_OP	2.393	1.386	0.221**	0.718***	0.236**	–				
T1_Bonding	4.376	1.643	0.357***	0.076	0.388***	0.067	–			
T1_Bridging	4.567	1.414	0.543***	0.114	0.582***	0.181*	0.411***	–		
T2_Bonding	4.060	1.220	0.397***	0.220**	0.390***	0.281***	0.634***	0.420***	–	
T2_Bridging	4.608	1.436	0.530***	0.212**	0.576***	0.256***	0.412***	0.715***	0.581***	–

In light of participant attrition across time points we were interested in whether those who dropped out of the study differed from those who stayed. With this in mind, we compared the passion for DotA 2 among those who dropped out of the study after Time 1 with those who provided data at Time 2. As per Table 3, those who remained in the study at Time 2 had slightly higher HP and slightly lower OP than those who dropped out; however, these differences did not reach statistical significance (see Table 3). We discuss this further in the discussion limitations section (Section 5.7).

Table 3. Means (and standard deviations) for passion at Time 1 for participants who also completed the Time 2 survey vs those who dropped out for Time 2. The Mann Whitney U test compares the groups.

	<i>n</i>	T1_HP	T1_OP
Completed Time 2	182	4.647 (1.215)	2.579 (1.500)
Dropped out for Time 2	280	4.438 (1.340)	2.688 (1.578)
Mann Whitney U test		$U = 22799.00, p = .056, r = -.105$	$U = 26124.00, p = .645, r = .025$

4.1 Stability of Passion: Two-wave Passion Model (RQ1)

The first model was a cross-lagged panel model with harmonious and obsessive passion at Time 1 and Time 2.

Both HP and OP were stable across a period of three months: Effects from Time 1 to Time 2 were significant for HP ($\beta = 0.718, p < .001$) and OP ($\beta = 0.704, p < .001$). In contrast, neither of the cross-lagged effects reached significance. Time 1 HP did not significantly predict Time 2 OP ($\beta = 0.064, p = .292$). Similarly, Time 1 OP did not significantly predict Time 2 HP ($\beta = 0.009, p = .885$).

Table 4. Results for the two-wave dataset with harmonious and obsessive passion.

Predictor	Outcome	B	se B	z	p	b 95% CI	β
T1_HP	T2_HP	0.695	0.046	15.183	<.001	0.605 0.785	0.718
T1_OP	T2_OP	0.651	0.069	9.392	<.001	0.515 0.786	0.704
T1_HP	T2_OP	0.073	0.069	1.054	0.292	-0.063 0.209	0.064
T1_OP	T2_HP	0.007	0.049	0.145	0.885	-0.090 0.104	0.009

The model explained 51.9% of the variance in Time 2 HP ($R^2 = .519$) and 52.0% of the variance in Time 2 OP ($R^2 = .520$). Table 4 shows all results.

4.1.1 Explorative Model: Three-wave Passion. Table 5 shows descriptive data and correlations between harmonious and obsessive passion measured at Time 1, Time 2, and Time 3, for which we only included those participants with complete responses for all times ($n = 115$).

Table 5. Descriptives and Pearson r correlations for constructs in the three-wave dataset. * $p < .05$, ** $p < .01$, *** $p < .001$

	M	SD	T1_HP	T2_HP	T3_HP	T1_OP	T2_OP	T3_OP
T1_HP	4.741	1.257	—					
T2_HP	2.591	1.558	0.723***	—				
T3_HP	4.812	1.218	0.707***	0.737***	—			
T1_OP	2.365	1.422	0.318***	0.194*	0.237*	—		
T2_OP	4.889	1.103	0.290**	0.270**	0.294**	0.706***	—	
T3_OP	2.458	1.437	0.304***	0.186*	0.254**	0.693***	0.810***	—

The exploratory model was a cross-lagged panel model with passion at three time points. Fit measures for this model were satisfactory (CFI = 0.93940, IFI = 0.9412, SRMR = 0.043), aside from the RMSEA, which was unsatisfactory (RMSEA = 0.2334) [4, 18, 28]. However, the specified model had low degrees of freedom and comparably low sample size, factors that have been suggested as potentially inflating RMSEA [28]. Therefore, we note that these results should be considered with caution, but report them, considering they fit adequately for this exploratory analysis.

Table 6. Results for the exploratory three-wave dataset with harmonious and obsessive passion.

Predictor	Outcome	B	se B	z	p	b 95% CI	β
T1_HP	T2_HP	0.713	0.062	11.454	<.001	0.591 0.835	0.735
T2_HP	T3_HP	0.643	0.061	10.519	<.001	0.523 0.762	0.709
T1_OP	T2_OP	0.623	0.094	6.632	<.001	0.439 0.807	0.682
T2_OP	T3_OP	0.828	0.059	14.039	<.001	0.712 0.943	0.819
T1_HP	T2_OP	0.083	0.078	1.065	0.287	-0.069 0.235	0.073
T2_HP	T3_OP	-0.041	0.074	-0.559	0.576	-0.186 0.104	-0.035
T1_OP	T2_HP	-0.031	0.067	-0.458	0.647	-0.163 0.101	-0.039
T2_OP	T3_HP	0.080	0.045	1.796	0.072	-0.007 0.168	0.103

Table 6 shows the results for the exploratory three-wave model. Again, all stability effects were significant and positive. There were positive relationships for harmonious passion from Time 1

to Time 2 ($\beta = 0.735, p < .001$) and Time 2 to Time 3 ($\beta = 0.709, p < .001$), and for obsessive passion from Time 1 to Time 2 ($\beta = 0.682, p < .001$) and Time 2 to Time 3 ($\beta = 0.819, p < .001$). No cross-lagged effect was significant. The model explained substantial variance in Time 2 HP ($R^2 = .524$), Time 2 OP ($R^2 = .503$), Time 3 HP ($R^2 = .553$), and Time 3 OP ($R^2 = .657$).

Table 7. Results for the two-wave dataset with harmonious and obsessive passion as well as bonding and bridging social capital.

Predictor	Outcome	B	se B	z	p	b 95% CI		β
T1_HP	T2_HP	0.536	0.064	8.321	<.001	0.409	0.662	0.553
T1_OP	T2_OP	0.651	0.067	9.742	<.001	0.520	0.782	0.705
T1_Bonding	T2_Bonding	0.396	0.048	8.253	<.001	0.302	0.490	0.534
T1_Bridging	T2_Bridging	0.581	0.063	9.258	<.001	0.458	0.704	0.572
T1_HP	T2_OP	0.023	0.113	0.203	0.839	-0.199	0.245	0.020
T1_HP	T2_Bonding	0.106	0.070	1.511	0.131	-0.032	0.244	0.106
T1_HP	T2_Bridging	0.184	0.084	2.182	0.029	0.019	0.35	0.156
T1_OP	T2_HP	0.009	0.043	0.203	0.839	-0.076	0.093	0.011
T1_OP	T2_Bonding	0.115	0.045	2.535	0.011	0.026	0.204	0.141
T1_OP	T2_Bridging	0.099	0.051	1.931	0.054	-0.002	0.199	0.103
T1_Bonding	T2_HP	0.064	0.040	1.589	0.112	-0.015	0.143	0.089
T1_Bonding	T2_OP	-0.031	0.047	-0.651	0.515	-0.123	0.062	-0.036
T1_Bonding	T2_Bridging	0.099	0.052	1.918	0.055	-0.002	0.201	0.113
T1_Bridging	T2_OP	0.102	0.094	1.090	0.276	-0.082	0.286	0.104
T1_Bridging	T2_HP	0.203	0.059	3.440	<.001	0.087	0.318	0.243
T1_Bridging	T2_Bonding	0.110	0.060	1.817	0.069	-0.009	0.228	0.127

4.2 Two-wave Passion and Social Capital Model (RQ2a)

The second analysis evaluated a cross-lagged model with harmonious and obsessive passion, and bonding and bridging social capital at Times 1 and 2. Again, the model was just identified without any information on fit. This analysis used the same two-wave dataset as in RQ1. Thus, the descriptives are the same and can be found in Table 2.

All constructs had significant stability effects across a period of three months: Effects from Time 1 to Time 2 were significant for HP ($\beta = 0.553, p < .001$), OP ($\beta = 0.705, p < .001$), Bonding ($\beta = 0.534, p < .001$), and Bridging ($\beta = 0.572, p < .001$). There were significant and positive cross-lagged effects between Time 1 OP and Time 2 Bonding ($\beta = 0.141, p = .011$), Time 1 HP and Time 2 Bridging ($\beta = 0.156, p = .029$), and Time 1 Bridging and Time 2 HP ($\beta = 0.243, p < .001$). The remaining cross-lagged paths did not reach significance (see Table 7). The model explained substantial variance in Time 2 HP ($R^2 = .577$), Time 2 OP ($R^2 = .527$), Time 2 Bonding ($R^2 = .465$), and Time 2 Bridging ($R^2 = .561$).

4.3 Cross-sectional Passion and Social Capital Model (RQ2b)

The final analysis was a cross-sectional model testing the effects of passion on social capital. Table 8 shows the descriptives, Table 9 shows the results.

The effects showed that harmonious passion was significantly, positively, and strongly associated with bonding and bridging social capital. On the other hand, obsessive passion was not significantly

Table 8. Descriptives and Pearson r correlations for constructs in the cross-sectional dataset. * $p < .05$, ** $p < .01$, *** $p < .001$

	<i>M</i>	<i>SD</i>	T1_HP	T1_OP	T1_Bonding	T1_Bridging
T1_HP	4.521	1.295	–			
T1_OP	2.645	1.547	0.362***	–		
T1_Bonding	4.204	1.713	0.233***	0.062	–	
T1_Bridging	4.401	1.517	0.526***	0.235***	0.424***	–

associated with bonding or bridging social capital. The model explained only 5.5% of the variance in bonding capital ($R^2 = .055$) but 27.9% of the variance in bridging social capital ($R^2 = .279$).

Table 9. Results for the cross-sectional dataset with harmonious and obsessive passion as well as bonding and bridging social capital.

<i>Predictor</i>	<i>Outcome</i>	<i>B</i>	<i>se B</i>	<i>z</i>	<i>p</i>	<i>b 95% CI</i>		β
T1_HP	T1_Bonding	0.321	0.064	4.994	<.001	0.195	0.446	0.242
T1_OP	T1_Bonding	−0.028	0.054	−0.522	0.602	−0.133	0.077	−0.025
T1_HP	T1_Bridging	0.594	0.050	11.967	<.001	0.497	0.692	0.507
T1_OP	T1_Bridging	0.050	0.042	1.207	0.227	−0.031	0.132	0.051

5 DISCUSSION

5.1 Discussion of Findings

Overall, our findings suggest that passion for playing DotA 2 is relatively stable over time (RQ1); that harmonious passion predicts future bridging social capital, while obsessive passion predicts future bonding social capital (RQ2a); and finally that harmonious passion for DotA 2 is cross-sectionally associated with bridging and bonding social capital, while obsessive passion is cross-sectionally associated with neither kinds of social capital (RQ2b). Additionally, our analyses revealed that bridging social capital can lead to harmonious passion. We explore these findings in more detail below.

5.2 Stability of Passion (RQ1)

Both the two-wave and the explorative three-wave model are consistent in showing statistically significant positive stability effects and a lack of significant cross-lagged effects. In other words, people largely tend to maintain the same type of passion for playing DotA 2 (over the timeframe we surveyed them, i.e., 3–6 months). It should be noted our sample were relatively experienced, as at the time of the survey the game was already approximately 3 years old [see also, 33]. In this sense, the present research samples participants who are past any period of initial passion development; sampling longitudinally from the launch of a new game would be an exciting direction of future research. In practical terms, our findings suggest that for those with harmonious passion, there is an absence of a “slippery slope” pattern in which people who initially have a healthy pattern of engagement develop a problematic style of engagement. In addition, our findings also suggest that those who are obsessive are unlikely to naturally trend towards a more harmonious engagement with the game: no “natural equilibrium” is likely to occur. More broadly the stability of passion shown for DotA is consistent with findings in non-videogame domains including teachers’ and

school principals' passion for their work [17, 32], and students' passion for their favourite activity [49]. Our findings partially contradict those of Mills [37] in that we found OP to be relatively stable, while they did not. This is most likely related to our use of an experienced sample with a specific game while their study sampled university students and focussed on passion for videogames, in general.

5.3 Prediction of Social Capital from Passion (R2a)

Players of DotA 2 who reported harmonious passion for play at Time 1 tended to show higher levels of bridging social capital at Time 2. This finding is somewhat surprising, in that cross-sectional work (including that in the current study) suggests HP is often associated with bonding social capital [36, 38]. However, looking prospectively at players of DotA 2, this pattern does not hold. The null association of HP with bonding social capital, and the positive association of OP with bonding social capital, both call into question past research, and for this reason, an important direction of future research would be to seek to replicate the findings in game and non-game contexts.

Taking the results at face value, one interpretation of the findings is that the association of HP and OP with social capital is in part a function of the way more experienced players connect when playing DotA 2. As they play for longer periods, players may tend to engage in ranked play, which means they are often playing with people they don't know [16, 48]. In this context, a healthy passion for play may be more likely to lead to bridging social capital through connection to strangers. However, this does not explain why players of DotA 2 with obsessive passion for play at Time 1 tended to show higher levels of bonding social capital at Time 2. This pattern aligns with the one that was found cross-sectionally with WoW players [36], however. From a theoretical perspective, understanding the mechanisms at play is an important direction for future research. For example, directly surveying participants on their engagement and the means by which they are developing bridging or bonding relationships could be used to explore the moderators and mediators of the effects.

On an applied level, the results are encouraging: it seems that, for players of DotA 2, even an unhealthy passion for play can lead to small benefits over time in forming supportive relationships (building bonding capital). Furthermore, while the theorising of obsessive passion by Vallerand and colleagues [52] suggests that, in some contexts that are more psychologically addicting, shared relationships can foster increasing obsessive passion, there was no evidence of this finding over the time frame sampled in our data. There was also no finding (as noted above) that new, strong relationships would undermine obsessive passion. In this sense, the findings suggest that obsessive passion can deliver a social benefit in some contexts, regardless of obsessive passion remaining stable. Again, it might be desirable in future research directly to inquire as to whether the friendships formed exert any pressure to sustain obsessive gameplay, or encourage harmonious passion, as these would perhaps moderate the longitudinal effects.

5.4 Concurrent Associations Between Passion and Social Capital (R2b)

Given the discrepancies between our own longitudinal findings and that of past cross-sectional research, we conducted additional exploratory analyses which examined the cross-sectional patterns in our data. Our findings show that harmonious passion is associated with both bonding and bridging social capital at Time 1. No concurrent relationships were found between obsessive passion and either type of social capital. The cross-sectional findings suggest that those with a healthy passion for DotA are benefiting in terms of the experience of social capital while playing, while those with obsessive passion are not experiencing this concurrent benefit to wellbeing. The pattern of results aligns with previous research on the game *Destiny* ([38]; where HP was similarly associated with both kinds of social capital and more strongly with bridging social capital), but partly contradicts

previous research on World of Warcraft (WoW; where a similar pattern was found for HP, but in contrast, evidence was also found for OP being related to both kinds of social capital, albeit more weakly than HP, [36]). As noted above, it seems likely that the different games being studied offer potential moderators of the effects. All three games involve regular play with others and hence healthy engagement goes hand in hand with the experience of social capital. However, for some reason, obsessive passion for WoW was still associated with social capital. It may be that WoW offers a more involved form of collaboration in multiplayer (including larger teams) such that even those with somewhat unhealthy engagement can still experience limited benefits. Alternatively, this finding may also reflect the commonality of guilds in WoW—many players (regardless of type of passion) may be reliably connecting with existing and new members of their guild. However, the type of relationships and capital being built may depend upon factors such as opportunities to interact pro-socially and repeatedly (e.g., in clans, or by playing with friends), which will build bonding capital; the likelihood of interacting with new players or strangers, which could build bridging capital; and the presence of toxicity and social norms, which have the potential to undermine or strengthen relationships formed. These factors are promising directions for future research.

5.5 Additional Insights

Beyond our specific research questions, some additional insights can be made from our results. Comparing the model that included social capital to that which only included passion across timepoints, it can be seen that the model with social capital increased explained variance in HP by 5.8% (R^2 from .519 to .577) and in OP by 0.7% (R^2 from .520 to .527). One point is that stability effects in passion already account for a majority of the variance in reported passion: as noted above, exploring the development of passion for new games is a direction of future research. However, the data also highlight that even in the context of more experienced players, a specific form of social capital, bridging capital, may help explain how to foster HP. In other words, social capital is a construct that is useful for contextualizing how players develop and/or maintain HP for play. Understanding the mechanisms by which this occurs is a significant direction of future research.

Additionally, our models also revealed that each type of social capital tends to lead to more of that type of social capital in the future. This is encouraging in the sense that the benefits of social capital through videogame play can largely be assumed to be sustained (at least for DotA 2 play with the current sample). Again, it does not seem reasonable to assume that social capital persists indefinitely: one problem with interpreting the findings is that the Time 3 sample by definition includes only players who persisted in play over at least 6 months. Presumably, some players ceased playing the game and lost many of their relationships and their social capital during this time period. In this sense, future scholars may seek to create a design which more explicitly sought to include game dropouts to be able to examine the trajectories of declining passion and social capital loss.

5.6 Contributions and Implications

This study is important on three levels. First, it contributes to a very limited pool of research on the longitudinal nature of passion, and the findings of relative stability at face value disconfirm two important, opposite, and comparatively untested theories: that harmonious passion can slide into obsessive passion, and that obsessive passion can self-stabilise over time. Neither of these assumptions were borne out in our data. Second, the research provides the first longitudinal test of the relationship of passion for gaming to social capital built within game play, and shows not only the expected contribution of harmonious passion to building future bridging social capital, but two novel findings: a lack of contribution (a null relationship) between harmonious passion and

future bonding social capital, and a positive contribution of obsessive passion to bonding social capital. The novel findings speak to the potential weakness of harmonious passion in building close and intense relationships, and to the social benefits of shared obsessive passion (at least in the context of DotA 2, and perhaps in other MOBAs). These findings open a new direction for wellbeing research and for potential interventions with people who identify as problematic gamers. For example, future interventions can proceed in two directions: on the one hand, the closer relationships that obsessive gamers form can be understood as a psychological resource for wellbeing; however, the contingent acceptance and belonging attached to relationships with other obsessive gamers can pose a potential barrier to escaping what some gamers identify as a problematic behaviour. Additionally, our analyses revealed novel evidence that bridging social capital can lead to harmonious passion. This may reflect a process through which play with a diverse range of other players informs a more healthy attitude towards play. Third and finally, the contrast between the results from cross-sectional and longitudinal analyses highlights the importance of longitudinal research. In particular, the null relationship of obsessive passion and social capital in cross-sectional results may result in under-estimation of the possibility for obsessive passion to play a role in building capital over time.

Our findings have implications for game developers seeking to build games that have a positive impact on players. Given the relationship found between bridging social capital and harmonious passion for play, developers could usefully design games that encourage players to engage with a diverse range of other players. For parents, players and health practitioners, our findings have a number of key implications. Firstly, players with harmonious passion for play can largely be expected to maintain this healthy mode of engagement, without the need for concern. In turn, this mode of engagement can be expected to result in wellbeing benefits resulting from increased bridging social capital. Secondly, players with more obsessive passion for play are unlikely to naturally shift to a more healthy mode of engagement and intervention (of one type or another) may be needed. However, somewhat reassuringly, those with obsessive passion are still likely to be benefiting from some positive impacts on wellbeing in the form of bonding social capital. Our finding that even those with obsessive passion can benefit from videogame play—considered in tandem with research showing the protective role videogames can play during stressful life events [13, 21, 25]—highlights the importance of considering all relevant context of the person, their context, and the game itself [26] when assessing the wellbeing impacts of videogame play for a particular individual, and whether intervention is warranted.

5.7 Limitations and Future Work

We analyzed the longitudinal relationships using cross-lagged panel modeling. Recent work has suggested that these models cannot separate between-person from within-person effects, potentially resulting in elevated error rates. For our data, we could not use recommended alternatives like random-intercept cross-lagged panel models, which are not identified for two-wave data, as it adds additional latent variables to the already saturated model [15]. This suggests that the reported effects require confirmation in future studies with more samples that allow for models which can separate within-subjects and between-subjects effects. For example, it will be of interest to examine within-person trajectories of passion and social capital, in which players lose or gain enthusiasm and friends over time, for example after game updates, in comparison to between-person individual differences, in which some players show different levels of passion and social capital than others.

We explored longitudinal associations between passion and social capital with the two-wave model. Only four of the cross-lagged paths reached significance with only one (from Time 1 Bridging to Time 2 HP) being highly significant ($p < .001$). As such, these paths suggest that the found effects for directional relationships between passion and social capital require confirmation in

future work. Similarly, future work could usefully seek to confirm the trends we observed between each type of social capital at Time 1 and the other type of social capital at Time 2. Additionally, the novel evidence we found of bridging social capital predicting harmonious passion could usefully be explored in future research and, if confirmed, understanding which types of diversity most reliably lead to the development of healthy attitudes to play. It may be that group norms and degrees of toxicity are factors informing the potential relationship between bridging social capital and harmonious passion. More broadly, our work had a sample biased towards participants who identify as male. While this aligns with the population with which we sampled, we cannot be sure whether the patterns we observed would be shown with other genders. In relation to our sample, while our analysis comparing those who dropped out before Time 2 with those who provided data at Time 2 did not find any statistical difference in passion for play at Time 1, it could be argued there is a trend indicating that those with lower HP and higher OP were more likely to drop out. With this in mind, future work could usefully seek to both minimise attrition and explore in more depth any differences between the two groups.

It is important to note that the majority of existing work (including the current study) focuses on passion for a specific game in contrast to passion for gaming in general or passion across a variety of game titles (i.e., participants' current favourite game cf. [37]). Future research could usefully consider passion for videogames in general, as well as how passion might develop for games that are designed to be played for shorter time frames (existing research largely focusing on multiplayer games designed to be played over a long timeframe). A multi-game or multi-life domain frame for a study could examine harmonious and obsessive passion in relation to multiple games as changing over time, in order to explore the extent to which players manifest (or do not manifest) a sequence of obsessive or harmonious passions, and how passions and capital in one area or game translate into stability or changed trajectories in others. Additionally, given existing cross-sectional research showing the relevance of who one is playing with [e.g., friends vs. strangers 38] as well as the experience of toxic behaviour [55], future research should explore the influence of these factors over time. Finally, our data was collected in 2016 and 2017; however, given the consistent popularity of DotA 2, our findings remain current. Moreover, our conclusions regarding the stability of passion and the associated relationship to social capital would remain valid regardless of any more recent changes in overall popularity of the game.

6 CONCLUSION

To our knowledge, our study presents the first prospective analysis of passion for videogame play and its relation to social capital. Our findings suggest that passion is relatively stable over time, which is reassuring for those who experience harmonious passion, but conversely suggests that those who develop obsessive passion are unlikely to organically shift towards a more healthy approach. The findings highlight the potential role of interventions designed to help players move to a more balanced and healthy mode of play: in particular, it seems to be the case that developing more bridging social capital may be an avenue to developing more harmonious passion within the game context. With respect to social capital, our findings show that for passionate players of DotA 2, social capital benefits are possible regardless of passion orientation. Obsessive passion was associated prospectively with bonding social capital, i.e., the formation of close relationships. While the finding should not be over-interpreted in the absence of replication, this pattern could indicate a potential wellbeing benefit of obsessive passion for at least some videogame contexts that allow for intimacy to develop. If so, identifying the contexts in which obsessive passion can promote thriving is an important direction for game designers, as well as for scholars. Regardless, developing interventions that preserve the social relationship built through obsessive play is warranted. Finally, our findings suggest that accruing social capital through videogames may have ongoing benefits

in terms of leading to further social capital benefits over time. Future research should seek to confirm these findings in the context of passion for other games and with different groups (e.g., less experienced, diverse genders) groups of players.

Problematic play is not characterised as simply playing ‘too much’, but involves patterns of impaired control, prioritising gaming in harmful ways, and continuing to engage despite negative consequences. Conversely, healthy highly passionate engagement with games can provide myriad benefits to players, including to their social, cognitive, and emotional wellbeing. In this paper, we demonstrate how highly passionate engagement that is either harmonious or obsessive develops over time, and how passion for DotA 2 relates to social capital over time—a necessary step that will help researchers and practitioners design effective interventions that combat obsessive and problematic play while simultaneously promoting high levels of balanced, harmonious, and passionate engagement with gaming.

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