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Hostility is associated with self-reported cognitive and social benefits across Massively Multiplayer Online Role-Playing Game player-roles

Ciaran M. Smith^a
Paul Rauwolf^a
James Intriligator^b
Robert D Rogers^a

^aSchool of Psychology, Bangor University,
Adeilad Brigantia, Penrallt Road,
Gwynedd LL57 2AS

^b School of Engineering, Tufts University,
200 College Avenue, Medford, MA 02155

Corresponding author: Professor Robert D. Rogers, School of Psychology,
Adeilad Brigantia, Penrallt Road, Gwynedd LL57 2AS

Tel: +44 (1248) 382095

E-mail: r.rogers@bangor.ac.uk

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ABSTRACT

Massively Multiplayer Online Role-Playing Games (MMORPGs) can sometimes be associated with patterns of play that are harmful to health and well-being. Hazardous MMORPG play has been linked to hostility (towards other people). However, little is known about how hostility, as a risk-factor, relates to players' choices within games, or players' experiences of the positive aspects of MMORPGs. Here, we surveyed 5,847 players of Jagex's *RuneScape* to examine how trait hostility relates to player-roles, prioritising skill acquisition/improvement (Skillers), combat (Killers), or narrative challenges (Questers). Killers reported slightly higher levels of trait hostility than Skillers and Questers. The most hostile players reported the strongest importance of in-game relative to offline achievements, possibly indicating hazardous involvement. Critically, hostile players also report the strongest cognitive and social benefits. These include (i) skills acquired through MMORPGs that help players to achieve things in their offline lives and (ii) online relationships that benefit offline relationships. These findings offer a new perspective on the way that a previously reported risk factor for harmful MMORPG play relates to player engagement, possibly by offering a helpful space for hostile individuals to develop problem-solving and social skills. Hence, those individuals who might be vulnerable to developing harmful patterns of MMORPG play may simultaneously experience stronger tangible benefits.

INTRODUCTION

Multiplayer Online Role-Playing Games (MMORPGs), offering role-play and fantasy-themed narratives, now sustain a diverse player-base of over 50m worldwide (11% of US households), generating \$12b annually¹. Individuals are motivated to play MMORPGs through a variety of psychological mechanisms. Drivers include a sense of achievement from progress through game structures, excitement generated by immersive experiences, and a variety of social rewards involving relationships with other players and groups²⁻⁴.

Several individual characteristics have been linked to patterns of MMORPG play that are detrimental to health and well-being, sometimes amounting to 'gaming addiction'ⁱ. These include clinical indicators (e.g. attentional or hyperactive difficulties, elevated anxiety and depressive symptoms¹⁰⁻¹⁴), personality and cognitive factors (e.g. impulsivity and poor coping skills¹⁵⁻¹⁸); and, from a motivational perspective, gaming to cope with stress or over-valuing gaming achievements and immersion^{19,20}. However, some of the most salient aspects of 'gaming addiction' include difficult social experiences: loneliness^{11,21}, introversion^{11,12}, low social self-efficacy²², and, of particular relevance here, hostile attitudes towards others^{16,23-25}.

Hostility has been associated with problematic Internet use²⁶⁻³¹ and hazardous MMORPG play^{24,25} in primarily Asian samples of children²⁵, adolescents²⁴⁻²⁸ and college students²⁹; with effect sizes of medium magnitude ranging between 0.48 to 0.66. Whilst these associations may reflect how the online space offers opportunities to express hostility in some individuals³², they may also indicate how hostile individuals are more likely to play MMORPGs as an escape-avoidance strategy^{24,27}. From this perspective, MMORPG play can operate as a coping mechanism that promotes gaming activities to the point of addiction²³. Alternatively, MMORPG play may offer an accessible and practical way for individuals to

compensate for negative real-world challenges – e.g. lack of social stimulation – that, while producing positive benefits, can also lead to excessive and harmful patterns of play^{9,33}.

Alongside the above observations, MMORPG play can result in knowledge gain³⁴ and the development of leadership³⁵ and social^{36,37} skills, particularly in vulnerable groups such as those with an autism spectrum disorder³⁸. MMORPG play can also facilitate the accumulation of social capital^{39–41, 42}. In this way, MMORPGs may allow players to express themselves in ways that they find uncomfortable in offline settings⁴³. Relatedly, some players report less social anxiety and loneliness in online compared with offline settings⁴⁴. These benefits and the possibility that risk factors for problematic play operate as compensatory mechanisms suggest that player' choices within MMORPGs and their cognitive and social benefits are linked to hostility. Put another way, hostility may be a marker for individuals who gain the most benefits from MMORPGs – through compensatory processes – or act as a block to the social benefits of MMORPGs, in line with the 'rich get richer' model of Internet use⁴⁵. At present, almost nothing is known about how hostility relates to the socio-cognitive benefits of MMORPGs or to players' choices within the games, even though these factors may be critical to understanding the importance of trait hostility in hazardous play.

MMORPGs afford core player activities which can broadly be grouped under three headings: 'Skilling'; 'Killing'; and 'Questing'⁴⁶. 'Skilling' consists of a player/character either collecting or using in-game resources to gain competence in non-combat skills (e.g. woodcutting, mining, smithing). While skilling can involve repetitive activities, it can also offer settings in which players can congregate and socialise in communities⁴⁷. 'Killing' involves engaging in combat against monsters or against other players. Finally, 'Questing' signifies completing narratives or storyline-driven content, often involving combat, puzzles, or search/exploration-

based challenges⁴⁸⁻⁵⁰. Possibly, preferences for combat activities could relate positively to greater hostility, in contrast to the sometimes more social communal skilling activities.

Here, we surveyed 5,847 players of the long-established browser-based MMORPG, *RuneScape* (<https://www.jagex.com/>; see Supplemental Materials)^{49,51-53}, to explore relationships between choices of playing-roles, their trait hostility – as 'resentment and suspicion of others'⁵⁴ – and any resultant beneficial outcomes from play. We tested between the preliminary hypotheses that (i) trait hostility can, on the one hand, impede the experience of MMORPGs' cognitive and social benefits versus, on the other hand, that (ii) MMORPG spaces afford valued benefits in hostile individuals. Finally, we tested the supplementary hypotheses that: (iii) player-roles in MMORPGs are associated with differences in hostility and (iv) benefits from play; (v) player-roles moderate the relationship between trait hostility and benefits from play; and (vi) the importance placed by players on in-game achievements relative to offline achievements is moderated by their hostility.

METHOD

The study was approved by the AUTHOR INSTITUTION School of Psychology research ethics committee. At the start of the survey questionnaire, respondents read a brief participant information page and indicated their consent by clicking a single radio-button.

Recruitment and demographic information

By arrangement with Jagex, *RuneScape* players were recruited via a Twitter 'tweet' advertising the survey, a forum post on *RuneScape*'s official forum and a 'mention' in a game update-post. Recruitment was supported by an optional lottery draw for nine one-year subscriptions to the *RuneScape 3* game. Respondents who wished to 'opt-in' and enter the

draw provided their e-mail address on the final page of the survey. To preserve anonymity, survey responses and e-mail addresses (for lottery-draw entrants) were separated before data analysis. To start with, respondents answered questions regarding their gender, age, country of residence, educational attainment, and their current occupation.

Gaming (within *RuneScape*) preferences and self-reported benefits

First, respondents were asked to indicate their main *RuneScape* character role from the following options: 'Skiller'; 'Killer'; 'Quester'; or 'Other' to signal that they participated in several activities in the game and/or that the way that they played *RuneScape* was not properly captured by any of the other three options. The first three options are categorisations that are known and used by *RuneScape* players. If respondents indicated 'Other', they were able to enter a short text description. In the main, these responses indicated a hybrid of two or more player-roles, or that they were 'Maxed' (having reached the top level in all skills, both combat & non-combat) or 'completionists' in the sense that they had completed – or were completing – all game content including skills, combat, and narrative challenges⁵⁵.

Next, respondents rated how much they agreed or disagreed with the following statements: *'The skills I have gained in MMOs have helped me to achieve major things in my life.'* and; *'My online relationships inside MMOs have helped my offline relationships'*, using a 10-point Likert scale with anchor points of 'Strongly disagree' and 'Strongly agree', and the term 'MMOs' indicating any/all Massively Multiplayer Online (MMO) games.

Third, respondents were asked to indicate *'How important do you regard your in-game achievements compared to achievements in other areas of your life?'* by indicating one of the

following (categorical) options: 'Much less important'; 'Slightly less important'; 'No more or less important'; 'Slightly more important'; 'Much more important'.

Psychometric measurement of hostility

Respondents completed a number of self-report, psychometric assessments of socio-cognitive function. Here, we concentrate upon the Hostility subscale of the Buss-Perry Aggression Questionnaire (AQ)⁵⁴. The Hostility subscale of the AQ includes eight statements rated for applicability using a 5-point Likert scale, about resentment and suspicion toward other people, that together load as a measure of trait hostility. The scale has been used in forensic and non-forensic samples to test associations between hostility and social support, interpersonal approach behaviours⁵⁶, self-esteem⁵⁷, and negative automatic thoughts⁵⁸.

Details of our Data Analysis are provided in the Supplementary Materials.

RESULTS

Full details of the data analysis (including respondent exclusions) are described in the Supplementary Materials, alongside information about the length of time respondents had been playing *RuneScape*, and number of active players for each player-role (Table S1).

Of the 5,847 completed questionnaires, 1,738 respondents self-identified as Skillers, 964 as Killers, 1,331 as Questers, and 1,814 identified as Others. There were more male ($N = 4,954$) than female respondents ($N = 893$), $\chi^2(1, N = 5,847) = 2819.155, p < .001$. Self-identified player-roles differed markedly by gender (Table S2) ($\chi^2(3, N = 5847) = 177.819, p < .001$). Skillers were more likely to be females than Killers or Questers (partitioned $\chi^2(2, N = 4033) = 173.764, p < .001$). Player-roles also differed by age (Table S3) ($\chi^2(9, N = 5847) = 301.350,$

$p < .001$), with Skillers tending to be older than the other roles, and more reporting an age of ≥ 30 (partitioned $\chi^2 (1, N = 5847) = 220.254, p < .001$). More Killers reported ages of ≤ 19 years compared with the other roles (partitioned $\chi^2 (1, N = 5,847) = 53.048, p < .001$).

Player-roles differed in their levels of academic attainment (Table S4) ($\chi^2 (12, N = 5,847) = 81.006, p < .001$), with more Skillers reporting completion of undergraduate or postgraduate degrees (partitioned $\chi^2 (1, N = 5,847) = 47.423, p < .001$), but significantly more Killers having completed primary or secondary-level education and fewer having postgraduate degrees (partitioned $\chi^2 (2, N = 5,847) = 19.661, p < .001$). Finally, employment status differed across player-roles ($\chi^2 (9, N = 5,847) = 110.204, p < .001$), with Skillers being more likely to report being employed or retired than other player-roles and less likely to be students than Questers (Table S5) (partitioned $\chi^2 (1, N = 2,577) = 70.745, p < .001$).

Cognitive and social benefits of MMOs as related to players' hostility

Respondents with the highest trait hostility scores tended to report the strongest benefits in terms of (cognitive) skills gained in MMOs helping them to achieve major things in their lives (Figure 1A); $M = 5.617, SD = 2.617; F(1, 5845) = 149.307, R^2 = .025, p < .001$).

Similarly, the most hostile respondents reported the strongest agreement that their online relationships inside MMOs had helped their offline relationships (Figure 1B); $M = 5.317, SD = 2.837, F(1, 5845) = 90.249; R^2 = .015, p < .001$).

Hostility across MMO player-roles

Hostility ($M = 21.782, SD = 6.953$) differed significantly across self-identified player-roles (Figure 2) ($F(3, 5843) = 3.614, \eta^2 = .002, p = .013$), though the effect size was very small.

Pair-wise contrasts revealed that Killers reported significantly higher hostility scores than did

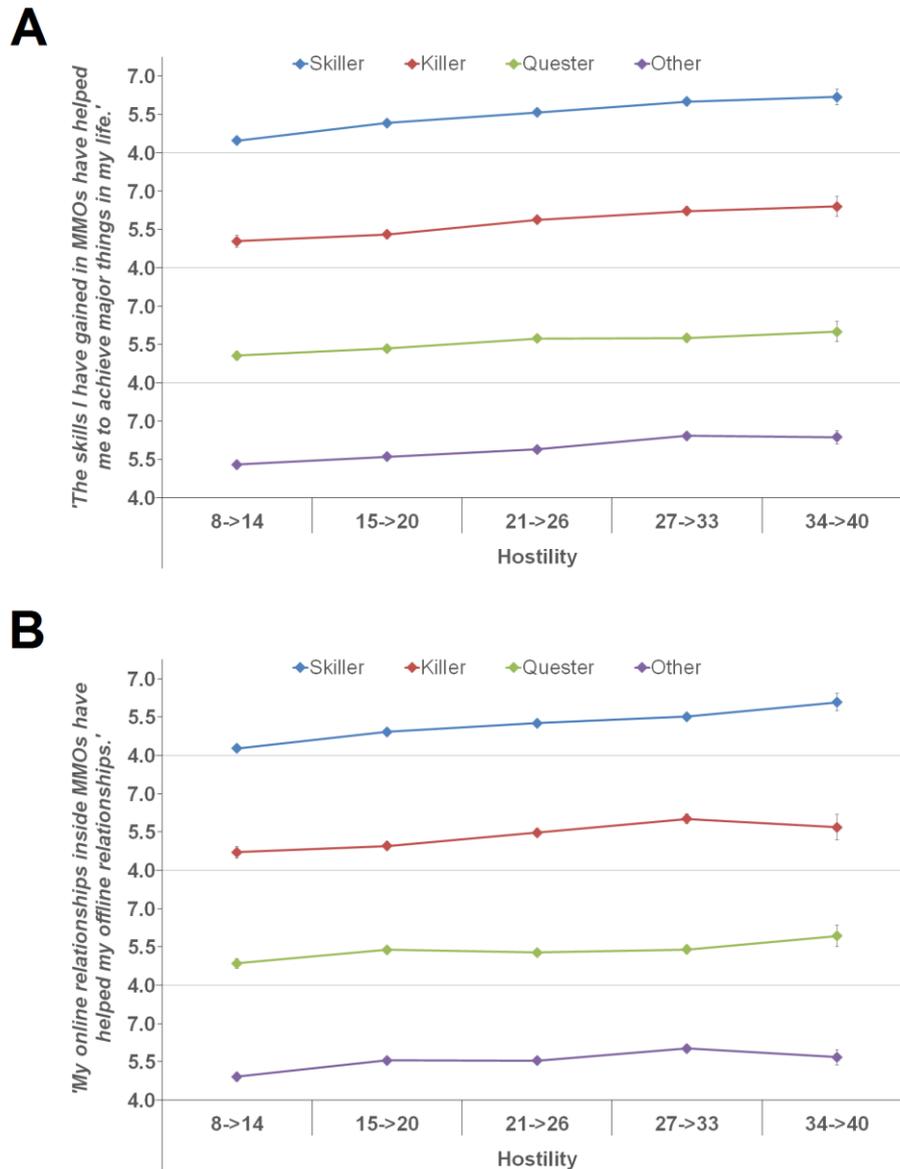


Figure 1. Stacked graphs of cognitive and relationship benefits of MMOs as a function of hostility, separated by player-role. (A) Rated agreement to the statement ‘The skills I have gained in MMOs have helped me to achieve major things in my life’. (B) Rated agreement to the statement ‘My online relationships inside MMOs have helped my offline relationships’. Hostility was measured by the hostility subscale of the Aggression Questionnaire (Buss & Perry, 1992); mean \pm 95% CIs.

Skillers ($p = .031$, 95% CI [0.047, 1.481]) and Questers ($p = .048$, 95% CI [0.005, 1.515]).

No other contrasts showed significant differences (all $ps > .1$).

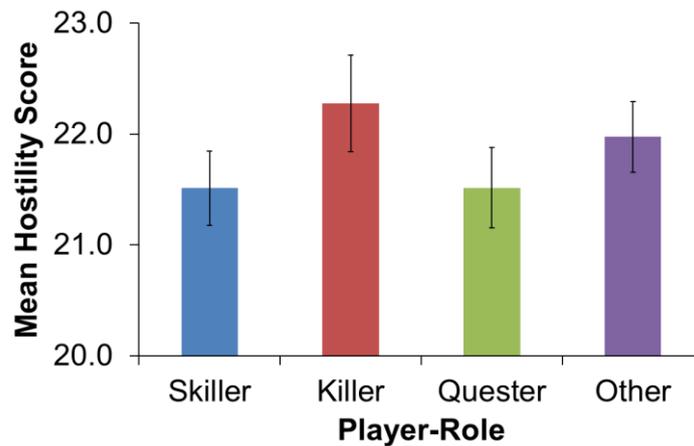


Figure 2. Hostility scores across player-roles of 5,847 players of the browser-based MMORPG, Jagex's RuneScape (<https://www.jagex.com/>). Hostility was measured by the hostility subscale of the Aggression Questionnaire (Buss & Perry, 1992); mean \pm 95% CIs.

Cognitive and social benefits from MMO play across player-roles

Self-reported benefits in skills from playing MMOs varied significantly across player-roles (Figure 3A) ($F(3, 5843) = 10.859, \eta^2 = .006, p < .001$), though – as with hostility – player-role selection explains only a small amount of the variance. Pairwise contrasts showed that respondents who self-identified as Others (engaging in a more diverse mix of game content) reported significantly greater benefits in skills than did Skillers ($p < .001$, 95% CI [0.251, 0.701]) and Questers ($p = .002$, 95% CI [0.089, 0.573]). Killers also reported significantly greater skill benefits than Skillers ($p = .008$, 95% CI [0.065, 0.604]). No other comparisons showed significant differences between player-roles (all $ps > .3$).

The extent to which respondents reported that their online relationships had benefitted their offline relationships also varied across player-roles ($F(3, 5843) = 8.543, \eta^2 = .004, p < .001$), showing almost exactly the same pattern as for skill benefits, and a similarly small effect size. That is, by pair-wise contrasts, respondents who self-identified as Others reported significantly stronger relationship benefits than Skillers ($p < .001$, 95% CI [0.232, 0.721]) and Questers ($p = .046$, 95% CI [0.003, 0.528]). Killers tended to report stronger relationship

benefits than Skillers but not quite significantly so ($p = .052$, 95% CI [-0.002, 0.583]). No other contrasts showed significant differences between player-roles (all $ps > .1$) (Figure 3B).

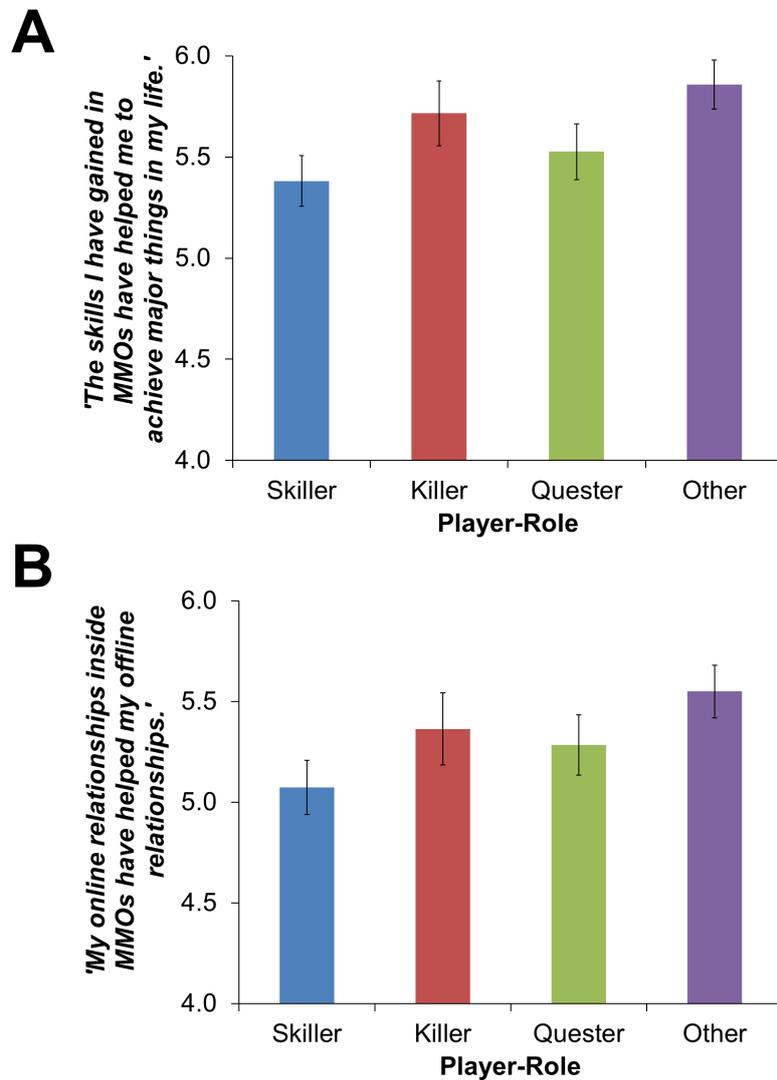


Figure 3. Cognitive and relationship benefits of MMOs as a function of player-roles in 5,847 players of Jagex’s *RuneScape* (<https://www.jagex.com/>). Rated agreement to the statements (A) ‘The skills I have gained in MMOs have helped me to achieve major things in my life’ and (B) ‘My online relationships inside MMOs have helped my offline relationships’; mean \pm 95% CIs.

Cognitive and social benefits of MMOs, hostility across player-roles

Respondents' self-reported player-role tended to moderate the associations between trait hostility and self-reported benefits to only a very limited extent (see Figure 1A and 1B).

Thus, the two-way interaction between hostility and player-role was not quite significant for

skill benefits ($F(3, 5839) = 2.412, p = .065$) and was only just significant for relationship benefits ($F(3, 5839) = 2.654, p = .047$). Inspection of the regression models of the skill and relationship benefits against hostility scores for each player-role separately show that the Questers showed the marginally weakest associations of the player-roles (Tables S6 and S7).

Relative importance of in-game achievements as related to players' hostility

Finally, respondents with higher levels of hostility were more likely than players with lower levels to rate their in-game achievements as at least as important as, or more important than other life achievements (see Figure 4). This association was comparable across all player-roles, with no improvement in the model fit arising from the addition of the interaction term between hostility and player-role ($\chi^2(3, 5389) = 2.500, p > .4$) (see Table S8).

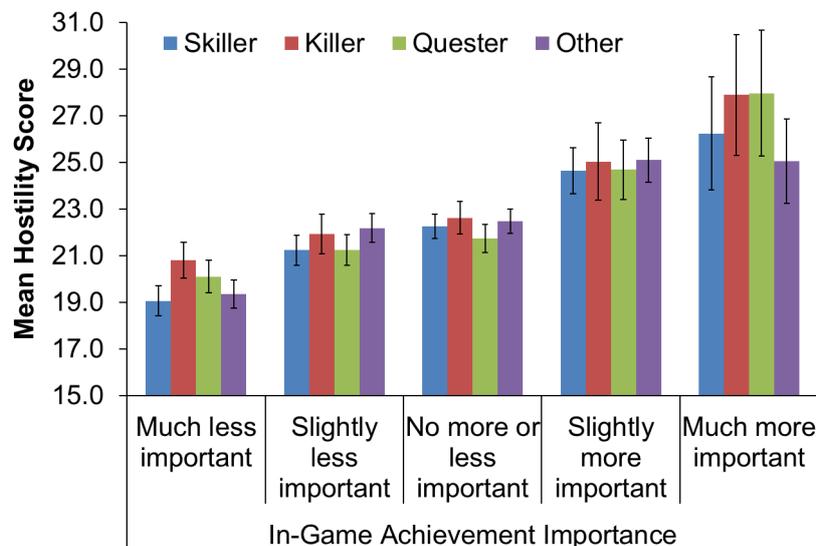


Figure 4. Relative importance of in-game achievements across player-roles in 5,847 players of the browser-based MMORPG, Jagex’s *RuneScape* (<https://www.jagex.com/>). Ratings to the question ‘How important do you regard your in-game achievements compared to achievements in other areas of your life?’. Hostility was measured by the hostility subscale of the Aggression Questionnaire (Buss & Perry, 1992); mean \pm 95% CIs.

DISCUSSION

Here, we surveyed players of an MMORPG, *RuneScape*, to test the conjecture that hostility is related to choices of player-roles and the self-reported cognitive/skill and social/relationship benefits of MMO play. Our study has several strengths. First, we secured a high completion rate ($\approx 80\%$) that provided 5,847 completed questionnaires. Most of our respondents were currently active (*RuneScape*) players (88% to 94% across the player-roles) but exhibited largely expected differences in demographic characteristics. Self-identified Skillers were more likely to be female than the other roles, tended to be older, more likely to report higher educational attainments and more likely to be in full-time employment. Killers tended to include the youngest respondents and, probably, for that reason, reported lower educational attainments and, like the Questers, were more likely to be students. Slightly fewer Questers were active players, probably reflecting preferences for narrative content that can be engaged only episodically in contrast to repeatable activities of skilling or combat. These observations provide reassurance that our sample match those of previous reports of MMORPGs⁵⁹⁻⁶¹.

To summarise our findings, we found that the most hostile respondents consistently reported the most positive outcomes of MMO play, both in terms of skills gained enabling them to achieve major things in their lives and positive benefits of online for offline relationships. We also found that self-identified player-roles differed in terms of their trait hostility, though only to a very limited degree. Killers reported the highest levels of hostility, and at a comparable level to Others. Skillers and Questers, by contrast, report the lowest hostility. These observations indicate that individuals' choices within MMORPGs can to some extent reflect adverse attitudes to others – in this instance, hostility in the sense of resentment and suspicion⁵⁴ – with implications for which players find which aspects of MMORPG play the most rewarding. Players choosing to engage in the widest variety of in-game activities –

Others – reported the greatest cognitive and social benefits than did, in particular, Questers and Skillers. Interestingly, despite the opportunity for socialisation during skilling activities, these players reported weaker relationship benefits than Others and, to a degree that approached significance, Killers. It should be noted, though, that player-role was only responsible for a small amount of variation in self-reported cognitive and social benefits from play. Finally, players with the most hostile attitudes reported placing greater value on in-game achievements than those with the least hostile attitudes. This association was evident across all player-roles.

Trait hostility is associated with an increased vulnerability to psychological and physical ill-health in a number of populations including adolescents and young adults^{58,62–66}. Hostility in adolescence is linked to mood disorders and substance misuse^{67,68}, and to 'gaming addiction'^{23–25}. One possible interpretation of the relationship between hostility and hazardous play is that it is complex, such that hostility increases problematic Internet behaviours in vulnerable individuals as an avoidance/escape-based coping strategy^{24,27}, while promoting patterns of Internet use that complicate cognitive and social adjustment to engender further hostility as an externalising response²⁴. In this context, our findings present a striking paradox by demonstrating, in a very large sample of players, that a risk factor for 'gaming addiction' is also strongly associated with self-reported transfer of online skills to offline achievements and the positive effects of players' online relationships to offline relationships.

Players with the highest hostility scores – here defined as representing 'resentment and suspicion' towards others⁵⁴ – reported that the skills gained in MMOs had helped them to achieve valued goals in their own lives, and that their online relationships had helped their offline relationships. Thus, a risk factor for 'gaming addiction' – hostility – is also a marker

for individuals who report cognitive and social relationship benefits of MMOs. Hostility is associated with avoidant coping styles that contribute to elevated risks of social isolation and health problems^{58,65}. Possibly, reflecting a compensatory mechanism^{9,33}, MMORPGs offer vulnerable individuals a space in which to improve problem-solving skills – in combat and/or questing roles^{69,70} – and social skills through membership of structured 'clans' or unstructured partnerships with other players^{36,38}.

MMORPGs can also be helpful in building a form of online social capital and competence that can transfer to offline settings³⁹⁻⁴², possibly highlighting more general benefits that accrue to players with high levels of hostility. This interpretation would be in line with the somewhat weaker association between social benefits and hostility in players identifying as Questers. This is because questing is arguably the most solitary core activity within MMORPGs, thus perhaps providing fewer opportunities to socialise through the players' preferred core in-game activity. However, at the same time, other features of the MMORPG environment may promote over-involvement in hostile individuals, generating hazardous play that gets picked up in studies of 'gaming addiction'²⁴. This interpretation of compensatory involvement is perhaps supported in our observation that players engaging in the widest selection of in-game content, often attempting to 'max' their skills, or attain 'completion', also report the highest cognitive and social benefits from play. Clarification of the mechanisms that mediate these associations will require careful (qualitative) study of the experiences of hostile individuals in the online space and of what it is about MMORPGs that facilitate positive effects (in terms of the development of skills and relationships), particularly given the limited contribution of player-role.

We also find that hostility is linked to player-roles involving combat with game monsters or other players, though player-role selection only explains a very small percentage of the variance in hostility. It is possible to view this observation as suggesting that MMORPGs (and other online activities involving social interactions) may offer vulnerable individuals a conduit for the expression of hostility that is unavailable, or subject to censor, in offline settings²⁴. We make no claims as to the proportion of our sample who might have been experiencing harms from MMORPG play or their Internet use generally. However, the observation that hostility in our sample was strongly associated with players' reports that in-game achievements were more important than their achievements in other areas of life is indicative of potentially hazardous play or, equally, may simply capture the particular (momentary) recreational value of an enjoyed leisure activity or hobby. Possibly, it could also reflect some respondents' wish to represent their MMO involvement in a favourable fashion as a learning opportunity, rather than purely a fun activity.

Given the limited contribution of player-role to levels of hostility and perceived benefits from play they are, however, overall unlikely to be useful in understanding how hostility is associated with developing cognitive and social skills through play. From these findings, future work can consider the positive link between MMO play, hostility and offline benefits as generally true regardless of the type of in-game content players focus on.

There are inherent limitations in studies of the kind reported here, and inevitable areas of uncertainty. First, as with any self-report survey of a self-selected sample, we have to trust the information provided by our respondents. Our main protection from idiosyncratic responding lies in the large sample size and high rate of completions. However, we

acknowledge that bias in one or more of the self-identified player-roles cannot be ruled out, nor bias in the characteristics of the players who completed the survey in the first place.

Secondly, our survey involved only one MMORPG - the long-established, browser-based game, *RuneScape* – so that the characteristics of our respondents reflect those for whom this game is the most appealing in a highly competitive marketplace. Therefore, we cannot rule out the possibility that our findings do not generalise to other MMORPGs. Finally, we are unable to provide any corroborating evidence about the skill transfer or offline relationship benefits of MMO play from players' social partners or family, although independent study involving players' family and friends could address this directly.

Notwithstanding the above uncertainties, our findings provide a new slant upon the choices players make within MMORPGs and the benefits that players believe they derive from these choices including both positive skill transfer to players' offline lives and, perhaps more strikingly, positive transfer from online to offline relationships. Critically, our research provides evidence that those vulnerable to patterns of play that might damage health and well-being appear to gain the most tangible benefits from these games.

AUTHOR DISCLOSURE STATEMENT

No competing financial interests exist.

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SUPPLEMENTARY MATERIALS

'RuneScape'

RuneScape is a long-established browser-based MMORPG developed and offered by Jagex (<https://www.jagex.com/>)^{1,2} with over 260m accounts. Research with the game has been limited and focused upon comparisons between virtual and material world economies³, whether 'mini-games' constitute gambling⁴, and child identity formation in online worlds⁵. Little is known of the player-base beyond what Jagex has publicly released⁶.

Data analysis

Five respondents were removed because of possibly unreliable survey responses (e.g. single-value or stereo-typed patterns of responding across questionnaire items). Four more were removed for duplicated submissions attached to the same e-mail address. In these cases, the original responses were retained and the duplicate responses deleted. Their inclusion (or exclusion) makes no difference to the patterns of data or statistics reported here.

Demographic variables were grouped into categories for convenience. Age was categorised on the basis of the intervals: ' ≤ 19 '; '20-29'; '30-49'; ' ≥ 50 '. For completed levels of education, categories were as follows: 'Primary/secondary education'; 'Partial 6th Form/University'; 'Completed 6th Form'; 'Undergraduate degree'; and 'Postgraduate degree'. Because our sample was drawn internationally, each education option included a parenthetical age guide to help non-UK respondents to use the terminology appropriately: e.g. age less than 16yr for 'Secondary school', 18yr for '6th Form', 21yr for 'Undergraduate degree'. Occupational categories included: 'Employed'; 'Student'; 'Unemployed'; 'Retired/Voluntarily unemployed'.

Differences in demographic categories across player-roles were tested with omnibus (with Yates correction) and nested (partitioned) χ^2 tests⁷. Associations between respondents' ratings of the transfer of MMO skills to real-life achievements and the benefits of online for offline relationships (on the one hand) against trait hostility scores (on the other hand) were tested using linear regression models. Differences in hostility scores, and cognitive and social benefits, between player-roles were tested using one-way Analysis of Variance (ANOVA) and post-hoc pairwise Tukey-Kramer (Honest Significant Difference) tests.

Testing whether player-role moderated the strength of association between (skill and relationship) benefits of MMORPG play and hostility was completed with multivariate regressions. A first model included hostility and categorical dummy-coded player-role variables as predictors, and a second model added the two-way interaction term between hostility and player-role variables. Model-fit was then compared using an F-change likelihood-ratio test. Relative importance of in-game achievements was recoded as a binary variable of less important versus at least as important and, as above, tested using binary logistic regression models with and without the two-way interaction terms between hostility and player-role variables. Model-fit was then compared using χ^2 likelihood-ratio tests. For illustrative purposes, we provide simple linear (and binary logistic) regressions for both skill and relationship benefits, as well as importance of in-game achievements, against hostility for each player-role separately (see Tables S6, S7 and S8 below).

In all regression models, respondent was included as a random effect in the intercept and the threshold for statistical significance was set at the 5% ($p < .05$) level throughout.

Additional explanatory analyses included tests of hostility against categorical variables of age and how long players had played RuneScape using one ANOVA, supported by post-hoc Tukey-Kramer tests. The results of these tests are set out below.

***RuneScape* activity characteristics of Skillers, Killers, Questers, and Others**

5,847 completed surveys were analysed. The majority of respondents (across all player-roles) had played *RuneScape* for at least seven years (see Table S1) ($\chi^2 (18, N = 5,837) = 35.635, p = .008$), although Killers were less likely to report having played for >10 years (partitioned $\chi^2 (1, N = 5,837) = 10.459, p = .001$). Almost all respondents were currently active, playing the game: the Skillers (93.82%), Killers (93.19%) and Others (92.47%), $\chi^2 (3, N = 5,784) = 32.444, p = .001$. However, the proportion of Questers (88.49%) currently playing was slightly lower than the other player-roles (partitioned $\chi^2 (1, N = 5,784) = 30.228, p < .001$).

Demographic characteristics of Skillers, Killers, Questers, and Others

	Skillers (N= 1736)	Killers (N= 963)	Questers (N= 1331)	Others (N= 1807)
< 1 year	18 (1.04)	4 (0.42)	9 (0.68)	6 (0.33)
1-2 years	25 (1.44)	14 (1.45)	13 (0.98)	25 (1.38)
3-4 years	84 (4.84)	53 (5.50)	56 (4.21)	77 (4.26)
5-6 years	209 (12.04)	134 (13.91)	191 (14.35)	221 (12.23)
7-8 years	507 (29.21)	297 (30.84)	395 (29.68)	500 (27.67)
9-10 years	428 (24.65)	260 (27.00)	361 (27.12)	491 (27.17)
> 10 years	465 (26.79)	201 (20.87)	306 (22.99)	487 (26.95)

Table S1. Number of years for which 5,837 players, recruited through a web-based survey, had played the browser-based Massively Multiplayer Online Role-playing Game (MMORPG), Jagex's *RuneScape* (<https://www.jagex.com/>); %s in brackets. (Due to a technical error, the data of 10 respondents were missing for this item.)

	Skillers (N= 1738)	Killers (N= 964)	Questers (N= 1331)	Others (N= 1814)
Male	1318 (75.83)	892 (92.53)	1194 (89.71)	1550 (85.45)
Female	420 (24.17)	72 (7.47)	137 (10.29)	264 (14.55)

Table S2. Genders of 5,847 players, recruited through a web-based survey, across the four player-roles in the browser-based Massively Multiplayer Online Role-playing Game (MMORPG), Jagex's *RuneScape* (<https://www.jagex.com/>); %s in brackets.

	Skillers (N= 1738)	Killers (N= 964)	Questers (N= 1331)	Others (N= 1814)
≤19	505 (29.06)	448 (46.47)	539 (40.50)	623 (34.34)
20-29	865 (49.77)	474 (49.17)	703 (52.82)	1011 (55.73)
30-49	193 (11.10)	28 (2.90)	63 (4.73)	119 (6.56)
≥50	175 (10.07)	14 (1.45)	26 (1.95)	61 (3.36)

Table S3. Ages of 5,847 players, recruited through a web-based survey, across the four player-roles in the browser-based Massively Multiplayer Online Role-playing Game (MMORPG), Jagex's *RuneScape* (<https://www.jagex.com/>); %s in brackets.

	Skillers (N= 1738)	Killers (N= 964)	Questers (N= 1331)	Others (N= 1814)
Primary/Secondary	454 (26.12)	317 (32.88)	377 (28.32)	521 (28.72)
Partial 6th Form/University	377 (21.69)	245 (25.41)	361 (27.12)	484 (26.68)
6th Form	459 (26.41)	250 (25.93)	348 (26.15)	472 (26.02)
Undergraduate degree	322 (18.53)	129 (13.38)	201 (15.10)	269 (14.83)
Postgraduate degree	126 (7.25)	23 (2.39)	44 (3.31)	68 (3.75)

Table S4. Educational attainment of 5,847 players, recruited through a web-based survey, across the four player-roles in the browser-based Massively Multiplayer Online Role-playing Game (MMORPG), Jagex's *RuneScape* (<https://www.jagex.com/>); %s in brackets.

	Skillers (N= 1738)	Killers (N= 964)	Questers (N= 1331)	Others (N= 1814)
Employed	721 (41.48)	335 (34.75)	423 (31.78)	645 (35.56)
Student	591 (34.00)	422 (43.78)	619 (46.51)	695 (38.31)
Unemployed	255 (14.67)	160 (16.60)	237 (17.81)	338 (18.63)
Retired/Voluntarily Unemployed	171 (9.84)	47 (4.88)	52 (3.91)	136 (7.50)

Table S5. Employment status of 5,847 players, recruited through a web-based survey, across the four player-roles in the browser-based Massively Multiplayer Online Role-playing Game (MMORPG), Jagex's *RuneScape* (<https://www.jagex.com/>); %s in brackets.

Player-role moderation of hostility on cognitive and social benefits of MMOs

	(Intercept)	Hostility B Coefficient	SE	R²	AdjR²	F (df)	p
Skillers	3.789	0.074	0.09	.039	.038	70.329 (1, 1736)	< .001***
Killers	4.281	0.064	0.012	.030	.029	30.195 (1, 962)	< .001***
Questers	4.690	0.039	0.010	.011	.010	14.103 (1, 1329)	< .001***
Others	4.676	0.054	0.009	.020	.020	37.459 (1, 1812)	< .001***

Table S6. Regression models for each player-role of the predictor hostility on rated agreement to the statement '*The skills I have gained in MMOs have helped me to achieve major things in my life*'. Hostility was measured by the hostility subscale of the Aggression Questionnaire (Buss & Perry, 1992).

	(Intercept)	Hostility B Coefficient	SE	R²	AdjR²	F (df)	p
Skillers	3.716	0.063	0.010	.025	.024	43.837 (1, 1736)	< .001***
Killers	3.881	0.067	0.013	.026	.025	25.872 (1, 962)	< .001***
Questers	4.690	0.028	0.011	.004	.004	5.992 (1, 1329)	.014*
Others	4.614	0.043	0.010	.011	.010	19.897 (1, 1812)	< .001***

Table S7. Regression models for each player-role of the predictor hostility on rated agreement to the statement '*My online relationships inside MMOs have helped my offline relationships*'. Hostility was measured by the hostility subscale of the Aggression Questionnaire (Buss & Perry, 1992).

Moderation of hostility on relative importance of in-game achievements

	High Importance Group (%)	Hostility B Coefficient	Exp(B)	Nagelkerke R^2	Wald χ^2 (df)	P(> χ^2)
Skillers	49.60	0.058	1.059	.052	66.218 (1)	< .001***
Killers	46.37	0.045	1.046	.031	22.090 (1)	< .001***
Questers	44.33	0.042	1.043	.026	25.500 (1)	< .001***
Others	50.22	0.054	1.055	.044	58.199 (1)	< .001***

Table S8. Membership of the ‘High Importance Group’ (viewing in-game achievements as at least as important as achievements in other areas of life) and binary logistic regression models of each player-role of the predictor hostility on relative importance placed on in-game achievements. Hostility was measured by the hostility subscale of the Aggression Questionnaire (Buss & Perry, 1992).

Hostility by age and duration of *RuneScape* play

Levels of trait hostility varied by age ($F(3, 5809) = 20.758, \eta_p^2 = .011, p < .001$), but not by how long they had played *RuneScape* ($F(6, 5809) = 0.210, \eta_p^2 < .001, p > .9$). There was no interaction between the two independent variables ($F(18, 5809) = 0.886, \eta_p^2 = .003, p > .5$). Players ≤ 19 year olds reported the highest hostility ($M = 22.811, SD = 6.690$), followed by 20-29 year olds ($M = 21.967, SD = 6.865$), 30-49 year olds ($M = 19.305, SD = 6.971$), and players ≥ 50 ($M = 15.467, SD = 5.594$), all $ps < .001$.

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ⁱ 'Internet Gaming Disorder' (for further study) and 'Gaming Disorder' have been included in the DSM 5 and in the ICD-11, respectively. However, there remain concerns about specificity⁵ in the case of the DSM 5 and about measurement criteria^{6,7} in the case of the ICD-11. More generally, there are concerns as to whether high-engagement gaming is best seen through the prism of pathology^{8,9}. Reflecting this lack of consensus, we refer to risk factors for hazardous, rather than 'addictive' (in this clinical sense), MMORPG play.