Investigating the Moderating Effect of Massively Multiplayer Online (MMO) Games on the Correlation Between Flow and Game Addiction: A Meta-Analysis

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Abstract

The flow theory of addiction suggests that the psychological flow state and addiction are positively correlated. However, based on 23 empirical studies involving 6,772 subjects, our meta-analysis shows that this relationship is significantly weakened in massively multiplayer online (MMO) games. Our results suggest that game genre, which is often overlooked in existing theories, warrants more attention in future research on game addiction. For game developers, our results suggest that it is particularly important for non-MMO games to provide a good match between game challenge and player skill level, which is essential to the flow experience. As MMO games have been reported to be more addictive than non-MMO games, future research should also investigate the unique characteristics of MMO games that cause addiction in this game genre.

Keywords: Game addiction, flow, immersion, social interaction, massively multiplayer online games.

1   Introduction

Game addiction has become a serious social problem in many modern societies and has recently been recognized as a mental disorder by the WHO (2018). A recent systematic review and meta-analysis suggests that 3.3% of gamers worldwide suffer from game addiction (Kim et al., 2022). During the COVID-19 pandemic, gaming hours increased among children and adolescents lacking parental support, as they turned to gaming as a means to cope with social isolation (Han et al., 2022). Governments around the globe have adopted various policy measures to tackle the problem, including the establishment of dedicated counselling and treatment centres (Király et al., 2018), the implementation of curfews to ban young children from playing games during certain hours of the day (BBC, 2019), and the introduction of regulations requiring game developers to include in-game anti-addiction features (Zhan & Chan, 2012).

Within the academic community, researchers from psychology (e.g., Hilgard et al., 2013) and healthcare (e.g. Kim et al., 2016) have endeavoured to address the problem via continual research efforts aimed at understanding the psychological and cognitive mechanisms that lead to addictive behaviours. IS researchers (e.g., Khang et al., 2013; Snodgrass et al., 2013; Lee et al., 2020) tend to focus on games as hedonic systems, and seek to identify antecedents of addiction in these systems. Understanding the factors underlying game addiction is critical for

promoting public health and can inform the development of effective interventions and treatments for individuals who are struggling with game addiction.

While various authors have summarized the important factors that contribute to game addiction (Juthamanee & Gunawan, 2021; Karmakar, 2020; Kuss & Griffiths, 2012), the lack of coordinated research efforts from diverse disciplines has made it difficult to integrate the knowledge accumulated thus far. In particular, the contextual factors that could support or reject existing theories represent a research gap that needs attention. For example, Na et al. (2017) identify game genre as an underresearched factor and show that the statistical significance of the same factors differs significantly across game genres, implying a need for dedicated research efforts for different game genres.

The objective of this study is to highlight the need to consider game genre in game addiction theory development. As we shall explain in the literature review section, the role of game genre is often overlooked in the literature on game addiction. However, understanding the motivational factors behind game addiction requires the consideration of a host of factors, including the game genre concerned (Hilgard et al 2013). Using a meta-analysis, we show that studies focusing on MMO games tend to report a weaker correlation between flow and game addiction than studies on other game types. This weakened correlation suggests that the flow theory of addiction may be more effective in explaining game addiction in non-MMO games than in MMO games. Therefore, a general theory of game addiction should incorporate game genre into its development.

This study highlights the complex nature of game addiction and suggests that there may be important differences in the factors that contribute to addiction across different game genres. For instance, the motivational factor "achievement" may have a smaller effect in MMO games than in other game types. This finding implies that a "one-size-fits-all" approach to game addiction treatment may not be effective, as different game genres may require different approaches. Understanding the differences in the formation of game addiction in different game genres can help game developers design game features that are engaging while avoiding elements that encourage excessive play. With this study as a foundation, we hope to inspire further research into the pivotal role that game genres play in the development of game addiction.

In the field of IS, flow theory is found to be particularly useful for decisions involving the voluntary choice (Bölen, et al., 2021). It has been applied in many different contexts including technology acceptance and use (Kunz & Santomier, 2019; Naglis & Bhatiasevi, 2019; Lin, et al., 2020), online consumer behavior (Kaur, et. al., 2016) and gamification (Behl & Pereira, 2021; Krath, et al., 2021). However, as pointed out by Valinatajbahnamiri & Siahtiri (2020), the identification of distractors and inhibitors of flow remains a research gap in the existing literature of IS, marketing and psychology; the authors have suggested individual characteristics to be a potential inhibitor. We contribute to this conversation in IS research by suggesting that the computer-mediated environment itself (e.g., game genre) can be a potential inhibitor.

The remainder of this paper is organized as follows. Section 2 critically reviews the relevant literature. Section 3 describes our search process, inclusion and exclusion criteria, and the final data set. Section 4 describes the processes of moderator detection and confirmation. Section 5 discusses the theoretical and practical implications of our findings. Finally, Section 6 summarizes our findings and identifies a few research directions.

2   Literature Review

2.1   Game Addiction

The WHO (2018) defines game addiction as a pattern of (i) gaming behaviour (digital or video gaming behaviour) characterized by impaired control over gaming, (ii) increasing priority given to gaming over other activities to the extent that gaming takes precedence over other interests and daily activities, and (iii) continuation or escalation of gaming despite the occurrence of negative consequences. Other terms that have been used to refer to game addiction include excessive use of online games (Kim & Kim, 2010; Lemmens et al., 2009; Wan & Chiou, 2006; Wei et al., 2012) and problematic play behaviour (Seay & Kraut, 2007; Snodgrass et al., 2013). In this paper, we use the WHO's definition of game addiction because it is a commonly used definition and it is applicable to either online or offline games; this helps us ensure that we can include a sufficient number of publications for our meta-analysis to detect a moderating effect.

Negative impacts of game addiction include decreased academic performance in children (Chiu et al., 2004), decreased work efficiency in adults (Liu, 2011; Wu, 2013), psychological distress (Kim et al., 2016; King & Delfabbro, 2016; Son et al., 2013), depression (Brunborg et al., 2014; Han et al., 2010; Young & Rogers, 1998), social anxiety (Van Rooij et al., 2011; Wang et al., 2019), and a higher likelihood of general health problems (Mentzoni et al., 2011; Yen et al., 2017). Hence, understanding the factors that contribute to game addiction has important practical implications.

2.2   Explaining Game Addiction

Flow is one of the most frequently discussed factors contributing to game addiction (e.g., Chou and Ting, 2003; Hull, et al., 2013; Khang, et al., 2013). It is defined as people's overall feeling when they are completely involved in activities and is considered the optimal psychological state (Csikszentmihalyi, 1996, 2013; Csikszentmihalyi, et al., 2005). Hence, flow is often associated with an engaging and enjoyable experience.

Applying Csikszentmihalyi's theory in the context of games, there are three phases during game progress: *anxiety*, *flow*, and *boredom*. The transition between these phases depends on the player's skills and the game challenge. People feel anxious when their skills are not good enough with respect to the game challenge. As they spend more time playing the game, their skill level increases, and they can reach the state of flow in which they feel a deep sense of achievement and joy. However, as their skill level increases, they may find that the game becomes too easy and feel bored, which leads them to look for more challenges to maintain the state of flow. As the game level or storyline progresses, players continue to shift among anxiety, flow, and boredom. This continuous behaviour of exchanging time for satisfaction may cause the experience of time distortion (Csikszentmihalyi, 2014; Rau et al., 2006). Figure 1 shows the continuous cycle of anxiety, flow and boredom and how it relates to addiction.
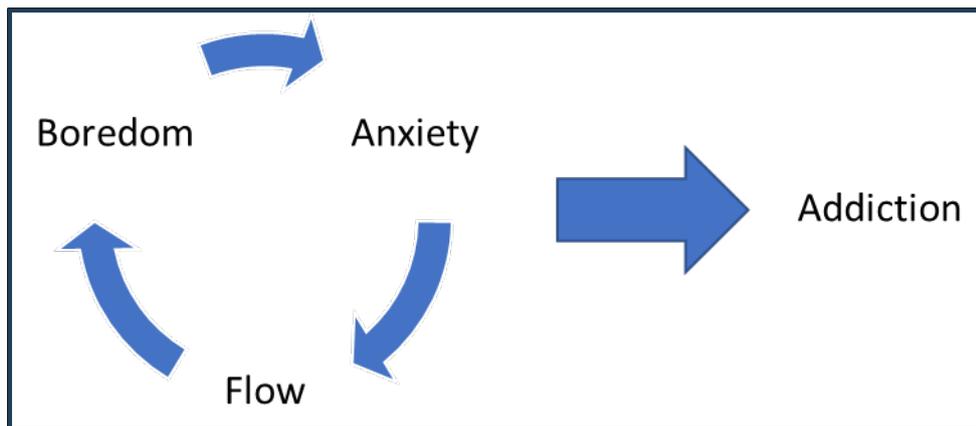
Figure 1. Flow Theory of Addiction

Empirical studies confirm that the flow state in games can cause game addiction (Ballabio et al., 2017; Chou & Ting, 2003; Hull et al., 2013; Jung et al., 2015; Liu & Chang, 2016; Park & Hwang, 2009; Seah & Cairns, 2008; Snodgrass et al., 2013; Snodgrass et al., 2014; Sun et al., 2015; Xu et al., 2012; Zhong & Yao, 2013). However, the reported correlations vary significantly across studies. Some suggest that the correlation is positive but small (Khang et al., 2013) and insignificant (Dauriat et al., 2011; Oggins & Sammis, 2012), whereas other studies report large and significant correlations (Ballabio et al., 2017; Jung et al., 2015; Seah & Cairns, 2008). In Figure 2, we depict the positive empirical relationship between flow and game addiction as reported in most relevant empirical studies.
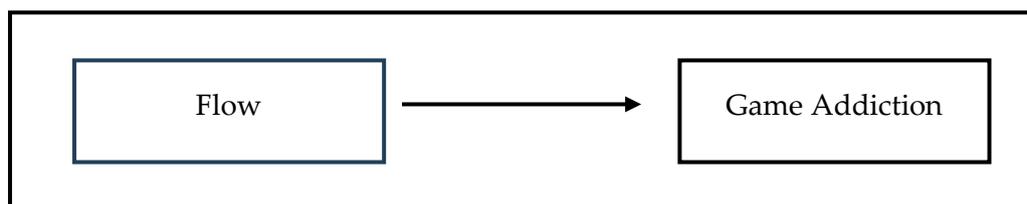

Figure 2. Relationship between Flow and Addiction in Existing Empirical Studies

Aside from flow theory, many other theories have been used to explain game addiction, including interpersonal theory (Liu & Kuo, 2007), presence theory (Park & Hwang, 2009), use and gratification theory (Wu et al., 2010), social cognitive theory (Zhang et al., 2016), and self-determination theory (Bhagat et al., 2020). The antecedents of game addiction can be broadly divided into individual characteristics and IT characteristics (e.g., ease of use, game design features, speed, graphics, and portability) (Karmakar, 2020). Juthamanee and Gunawan (2021) further divide individual characteristics into sociodemographic characteristics (e.g., gender, age, and parental economic/income status), parent and family factors (e.g., parental neglect and family relationships), peer relationships and support, personality traits (e.g., extraversion, introversion, neuroticism, conscientiousness, and agreeableness), perceived enjoyment and perceived benefits. However, as evident by the various themes that have emerged from systematic reviews in information systems (Karmakar, 2020) vs. clinical research (Kuss & Lopez-Fernandez, 2016), researchers across disciplines tend to focus on different aspects of game addiction. The lack of coordination among efforts across disciplines and the rapid growth of the literature have made it challenging to integrate the existing knowledge. Similarly, Juthamanee and Gunawan (2021) conclude their literature review with a call for

future research to understand the linkages among the many identified contributing factors of game addiction.

2.3   The Role of the Game Genre

One way to integrate existing empirical results that may seem contradictory is to identify potential contextual or moderating factors (e.g., De Jong et al., 2016). For example, Na et al. (2017) show that the statistical significance of antecedents of game addiction differs across game genres, suggesting that existing theories may not explain game addiction equally effectively across genres. MMO games are characterized by their persistent virtual worlds, advancement, and social interaction and are often described as the most addictive among all game genres (Billieux et al., 2015). It is no surprise that this game genre has received the most research attention; dedicated research efforts on MMO games include studies by Snodgrass et al. (2013), Liu and Chang (2016), Oggins and Sammis (2012), and Wan and Chiou (2006). However, establishing the moderating effects of game genre requires direct empirical comparisons between game genres, which are rare in the literature. Na et al. (2017), Lee et al. (2006), Elliott, Golub, Ream, and Dunlap (2012), and Elliott, Ream, McGinsky, and Dunlap (2012) empirically show that certain game genres are more likely to be associated with game addiction. On the other hand, Mathews et al. (2019) show that the relationship between ADHD symptom severity and addiction severity does not depend on game genre.

2.4   Research Gap and Research Question

In previous research, the role of game genre in game addiction has often been overlooked. Empirical studies on the effect of game genre on addiction are scarce and have yielded conflicting results. In this study, to evaluate the overall moderating effects of game genre based on existing empirical evidence, a meta-analysis on the reported correlation between flow and game addiction is conducted for studies that focus on MMO games vs. those that do not. The relationship between flow and game addiction is chosen to investigate the moderating role of game genre. Hence, the research question we aim to answer in this study is as follows:

"Is the correlation between flow and game addiction affected by whether the game concerned is an MMO game?"

This study is exploratory in nature (Anello and Fleiss 1995). For the purpose of statistical testing for the significance of the moderating effect of MMO games, we develop the following working hypothesis:

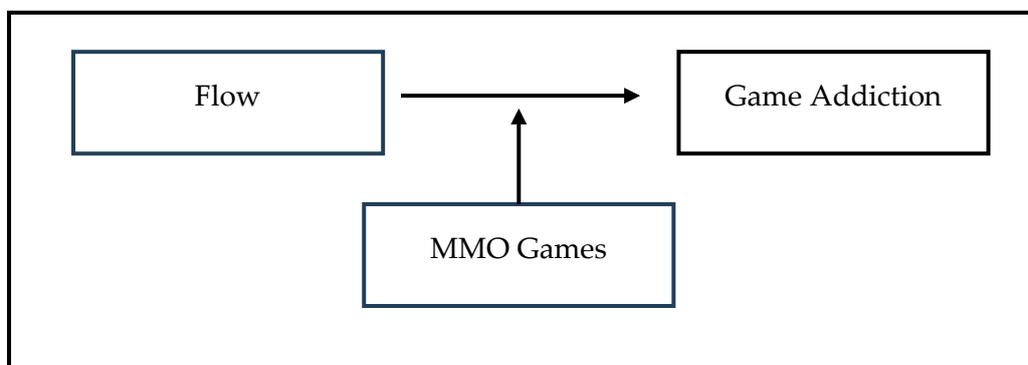*"MMO games moderate the correlation between flow and game addiction."*

Figure 3. The Moderating Role of MMO Games

Figure 3, which is an extension of Figure 2, graphically presents our working hypothesis. Since our goal is to test our working hypothesis, which is new, the use of meta-analysis is appropriate, in accordance with Higgins and Green (2011).

The decision to focus on the flow theory of game addiction is driven mainly by two reasons. First, the detection and confirmation of a moderating factor requires a reasonable number of original studies. Flow theory has received much research attention in the past, and thus, the statistics required for a meta-analysis are widely reported. Second, flow theory emphasizes the importance of matching game challenges with player skills. When there is a good match between the two, the player experiences a great sense of achievement and reaches the flow state. Hence, flow theory provides a theoretical basis for the achievement motive of game play (Yee 2006a), which is applicable across game genres, including MMO games and non-MMO games (Hilgard et al 2013). The extent to which flow theory can explain game addiction in various game genres will have implications for game developers in terms of game design.

3 Methodology

In this study, we first conducted a literature search to identify relevant papers on this topic. A number of inclusion and exclusion criteria were used to identify a final set of 24 original studies for the meta-analysis. One of the studies was identified as an outlier and was excluded from further analysis[1] . Next, we divided the studies into two groups: (1) those that focus on MMO games and (2) those that do not. We then compared the reported correlations between the psychological flow state and game addiction in these two groups using meta-analytic techniques. The details of our methodology are provided in the following subsections.

3.1 Meta-analysis

To evaluate our proposition, we conducted a meta-analysis, which is a quantitative approach to summarize existing empirical studies on a given topic. Typically, a meta-analysis involves correcting for measurement errors, computing an appropriate weighting for each study, and minimizing other possible biases in the studies (Dennis et al., 2001; Moed & Halevi, 2015; Sharma & Yetton, 2003; Wu & Lederer, 2009). The meta-analytic approach has been used to investigate research questions in many areas (Glass, 1976; Hunter & Schmidt, 1990), including the detection of moderating effects (Sabherwal et al., 2006; Sharma & Yetton, 2003). In the field of information systems, meta-analysis has been used to test theories regarding technology acceptance (King & He, 2006; Ma & Liu, 2004; Schepers & Wetzels, 2007; J. Wu & Lederer, 2009), decision support system implementation (Alavi & Joachimsthaler, 1992), enterprise system implementation (Berente et al., 2019), group support systems (Dennis et al., 2001), turnover of information technology professionals (Joseph et al., 2007), utilitarian hedonic and dual-purposed information systems (Wu & Lu, 2013), gaming consoles (Goode et al., 2017), and information technology business strategic alignment (Brinckmann et al., 2019; Desrochers et al., 2017; Gerow et al., 2014).

3.2 The Sample

We conducted our literature search in August 2020. To ensure a good coverage, we made use of Scopus and other major databases, including Google Scholar, Academic Search Premier, and IEEE, to identify empirical studies from journals, books, conference proceedings, and

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[1] We have repeated all analyses in this paper with the outlier included, and our results remain robust.

postgraduate dissertations. Such broad coverage can enhance the credibility of a meta-analysis by reducing potential publication bias (Sharma & Yetton, 2003) and is in line with recent meta-analytic research practice (e.g., Bhardwaj, et al., 2023; Verma, et al., 2023). Our main search was conducted using the following groups of keywords: 1) *immersion*, *game addiction*, and *correlation* and 2) *flow*, *game addiction*, and *correlation*. Google Scholar yielded 552 (first group) and 873 results (second group). The same set of keywords was used on three other databases (Scopus, Academic Search Premier, and IEEE) for more comprehensive coverage of publications, resulting in an additional 126 papers. Hence, the combined search resulted in 1,551 papers in total. To identify eligible papers for our meta-analysis, we used the following criteria:

1. The paper was written in English.

2. The relationship between game addiction (the dependent variable) and immersion or flow (the independent variable) was investigated.

3. The independent variable (immersion or flow) was measured using a comparable measurement scale. Since the terms "flow," "immersion," and "escapism" are sometimes used interchangeably (Hagström & Kaldo, 2014; Kuss et al., 2012; Oggins & Sammis, 2012; Snodgrass et al., 2014; Wu et al., 2013), we examined the questions for these terms and incorporated them if their scales were derived from the scale in the framework of Yee (2006b). Similarly, we ensured that the dependent variable (addiction or problematic play) was measured by a comparable measurement. Based on the definition in the "Game addiction" section, two measurement scales were used in this study. These scales are from the DSM-IV (1994) and Internet addiction test (IAT). Both scales measure excessive playing of games (Griffiths, 2005; Young & Rogers, 1998).[2]

4. The correlation between the independent and dependent variables was reported.

5. The sample size was reported.

It is widely understood that published papers have higher data quality and more robust results than unpublished papers. However, PhD/doctoral dissertations and conference papers were also included to minimize publication bias. Since master's theses may not be assessed by a thesis committee or external examiners, they were not included in our meta-analysis.

Of the 1,551 papers, 1,405 met Criterion 1 regarding the English language. For each of these papers, we inspected the proposed model or correlations to determine whether they studied the relationship between flow and game addiction. One hundred papers investigated the

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[2] Since we reviewed each paper we considered, we effectively eliminated the jingle fallacy, which occurs when constructs of the same name measure different latent constructs (Larson and Bong 2016). For the flow construct, as we noted that the terms "flow," "immersion," and "escapism" are sometimes used interchangeably, these terms were also considered and they were included if their scales were derived from Yee (2006b). This alleviated the jingle fallacy to some extent. However, we did not conduct a thorough investigation on all the construct names used to refer to the psychological flow state. Some papers using a less common construct name might have been excluded. Similarly, papers using a different construct name to refer to addiction were also excluded. Although we did not fully address the jingle fallacy, we believe that a construct's name has no effect on its relationships with other constructs. The exclusion of these papers affects the sample size of the meta-analysis, but it does not introduce a systematic bias to the estimated effect size.

relationship between flow and game addiction (Criterion 2). In 45 of these papers, both flow and game addiction were measured using comparable measurements (Criterion 3). Thirty-three of these papers contained all the required information, i.e., correlations (Criterion 4) and sample size (Criterion 5).
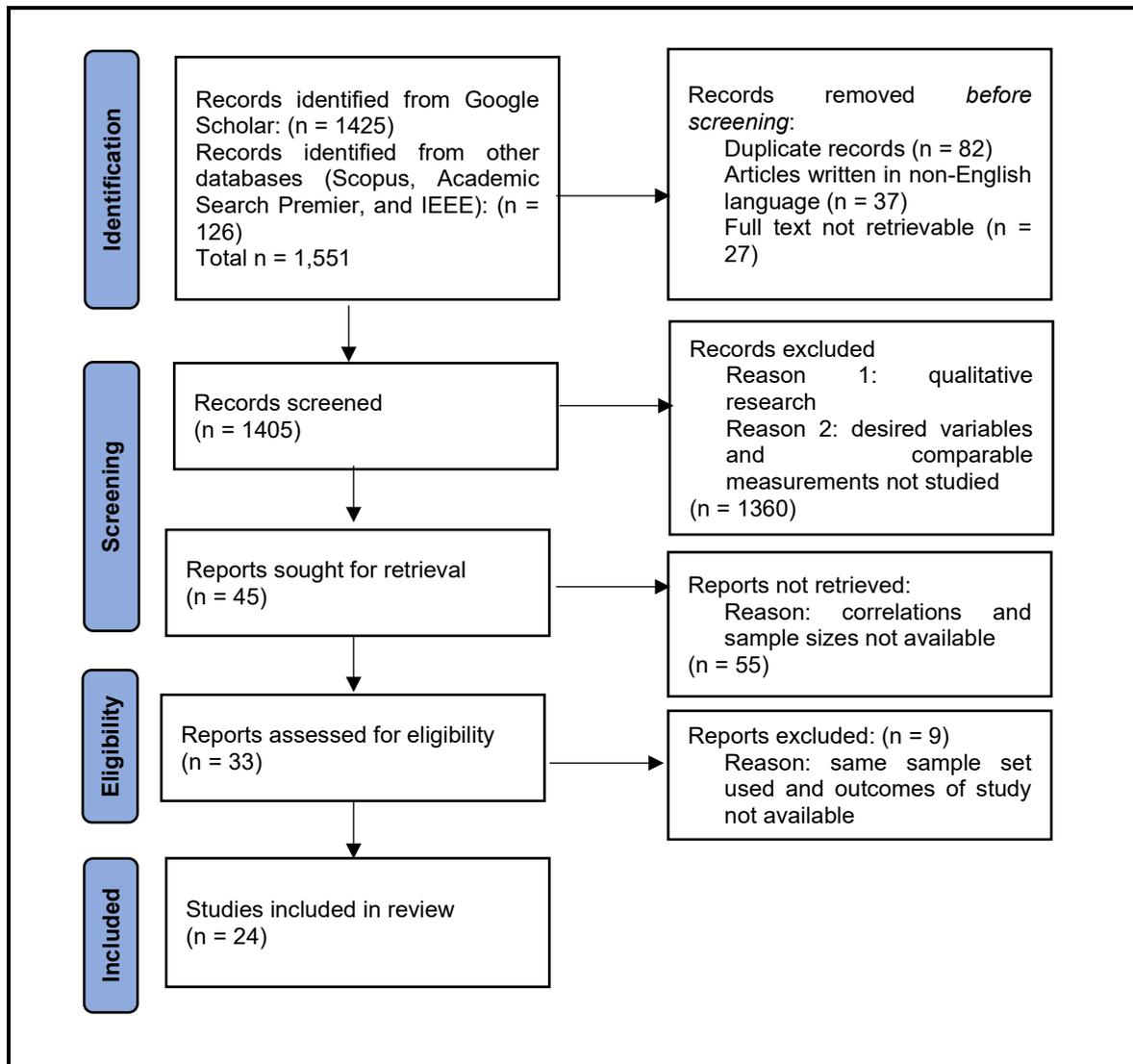

Figure 4. PRISMA diagram (Page et al., 2021)

A general meta-analysis principle is the requirement of independence among studies (Ma & Liu, 2004). For studies that used the same data set, only one of the studies was considered in our meta-analysis. The PRISMA diagram for our study is presented in Figure 4. Our final data set consists of 24 studies[3], which are shown in Table 1; for the full citations of the papers,

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[3] According to "Advances in Meta-Analysis" (Pigott, 2012) and researchers' discussions of sample size for meta-analysis (Valentine, et al., 2010), a sample size of 2 can be sufficient for conducting a meta-analysis. We conducted a brief investigation of other meta-analyses and identified a number of studies with a small sample size (e.g., Alavi and Joachimsthaler 1992; Joseph et al., 2007). Alavi and Joachimsthaler (1992) analyse 43 constructs in 33 studies. The most frequently studied construct had a sample size of 11. Our data contain 24 studies, which all focus on one relationship. The studies combined included 6,899 individual subjects; this number is comparable to that in the work by Joseph et al. (2007).

please refer to Appendix A. The final sample included 21 journal papers and 3 conference articles.[4]

In Table 1, an underlined number in the "r_i Corrected for Measurement Error" column indicates that covariance-based SEM was used for path analysis in the study; therefore, it is assumed that the reported correlations have already been corrected for measurement errors.

Study	n_i	r_i	Construct Reliability (Flow)	Construct Reliability (Addiction)	r_i Corrected for Measurement Error	MMO
Ballabio et al. (2017)	327	0.79	0.69	0.80	0.99	0
Chou and Ting (2003)	395	0.60	0.91	0.85	<u>0.60</u>	0
Dauriat et al. (2010)	696	0.02	**0.80**	0.76	0.03	1
Hagstrom and Kaldo (2014)	141	0.34	0.66	0.75	0.48	1
Hull et al. (2013)	110	0.09	**0.80**	**0.85**	0.11	0
Jung et al. (2015)	42	0.62	0.81	0.93	0.72	0
Kardefelt-Winther (2014)	702	0.47	0.73	0.72	0.65	1
Khan and Muqtadir (2016)	357	0.39	0.75	0.75	0.52	1
Khang et al. (2013)	290	0.28	0.87	**0.85**	0.32	0
Kuss et al. (2012)	265	0.30	0.69	0.78	0.41	1
Kwok and Khoo (2013)	128	0.35	0.86	0.77	0.43	1
Lee et al. (2020)	406	0.20	1	0.93	0.21	1
Li et al. (2013)	278	0.27	0.81	0.81	<u>0.27</u>	1
Liu and Chang (2016)	215	0.58	0.95	0.96	0.60	1
Oggins and Sammis (2012)	438	0.08	**0.80**	0.89	0.10	1
Park and Hwang (2009)	133	0.46	0.9	0.88	<u>0.46</u>	0
Seah and Cairns (2008)	33	0.76	**0.80**	**0.85**	0.93	0
Snodgrass et al. (2013)	252	0.21	0.60	0.94	0.28	1
Snodgrass et al. (2014)	133	0.43	0.80	0.94	0.50	1
Sun et al. (2015)	234	0.58	0.89	0.88	0.66	0
Wan and Chiou (2006)*	127	-0.38	0.89	0.92	-0.42	1
Wu et al. (2013)	357	0.39	0.72	0.91	0.48	1
Xu et al. (2012)	623	0.39	0.86	0.82	0.46	0
Zhong and Yao (2013)	217	0.28	0.73	0.935	<u>0.28</u>	0

Table 1. The Dataset
Note. * This study is identified as an outlier. It is excluded from our analysis.

All other correlations were corrected using the corresponding construct reliability statistics reported in the original papers, in accordance with Hunter and Schmidt (2004). Missing construct reliability statistics were replaced by the average reliability statistics in accordance with Hunter and Schmidt (2004, p. 121), and they are presented in boldface in Table 1.

We note that all the reported correlations were positive, except for Wan and Chiou (2006). Therefore, we considered it as an outlier and removed it from our analysis. The forest plot in

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Hence, these 24 papers present a comprehensive coverage of existing empirical research and exhibit significant research value.

[4] The number of PhD/doctoral publications was small and none of them survived our inclusion and exclusion criteria.

Figure 5 was generated based on the uncorrected correlations using the `metafor` package of R. It graphically presents the effect sizes of the original studies and their confidence intervals. The R script used to perform the meta-analysis in this paper can be found in Appendix B.
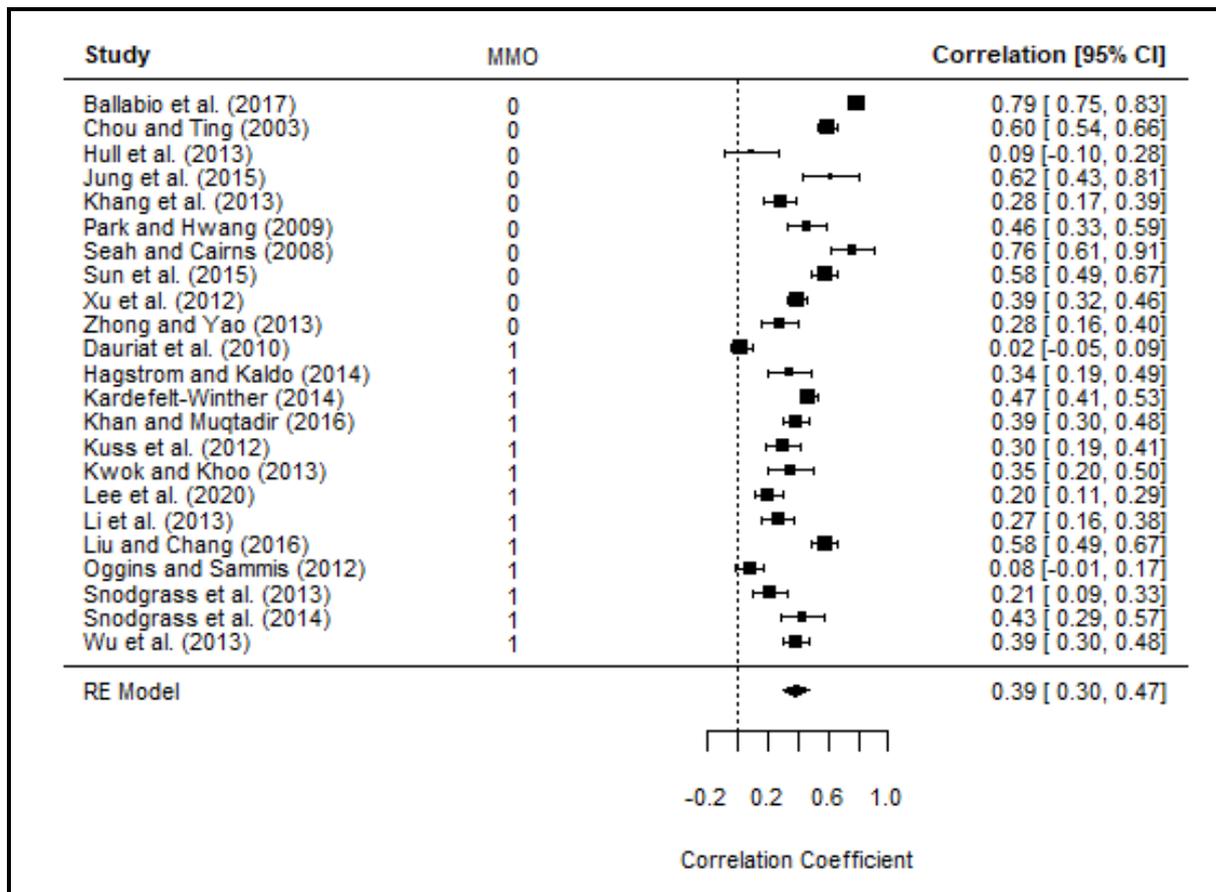

Figure 5. Forest Plot Based on Uncorrected Correlations

The funnel plot is a plot of precision on the vertical axis against the effect size on the horizonal axis. In the absence of publication bias and heterogeneity between studies, the plot should look like an inverted funnel. The funnel plot in Figure 6 (below) was generated based on the uncorrected correlations using the `metafor` package of R. As shown, quite a few studies fell outside the triangular 95% confidence region. In Section 4, we show that there is significant heterogeneity between studies. Specifically, studies focusing on MMO games tend to have a lower correlation between flow and addiction than studies that do not focus on MMO games. The rank correlation test for funnel plot asymmetry yielded Kendall's τ = =-0.0794 and p = 0.5971, suggesting that there may not be any publication bias.

4   Analysis

Following Hwang and Schmidt (2011), we used multiple methods (i.e., Q test for heterogeneity, credibility intervals, and the Schmidt and Hunter 75% rule) to investigate whether there is sufficient heterogeneity to suggest that a moderator is in operation. Since the practice of measurement error correction is controversial (Borsboon & Mellenbergh 2002), our analysis was based on both the corrected and uncorrected correlations. To confirm the moderating effect of MMOs, we performed a meta-regression analysis and a subgroup

analysis based on the random effects model. The analyses based on both corrected and uncorrected correlations yielded the same inferences.
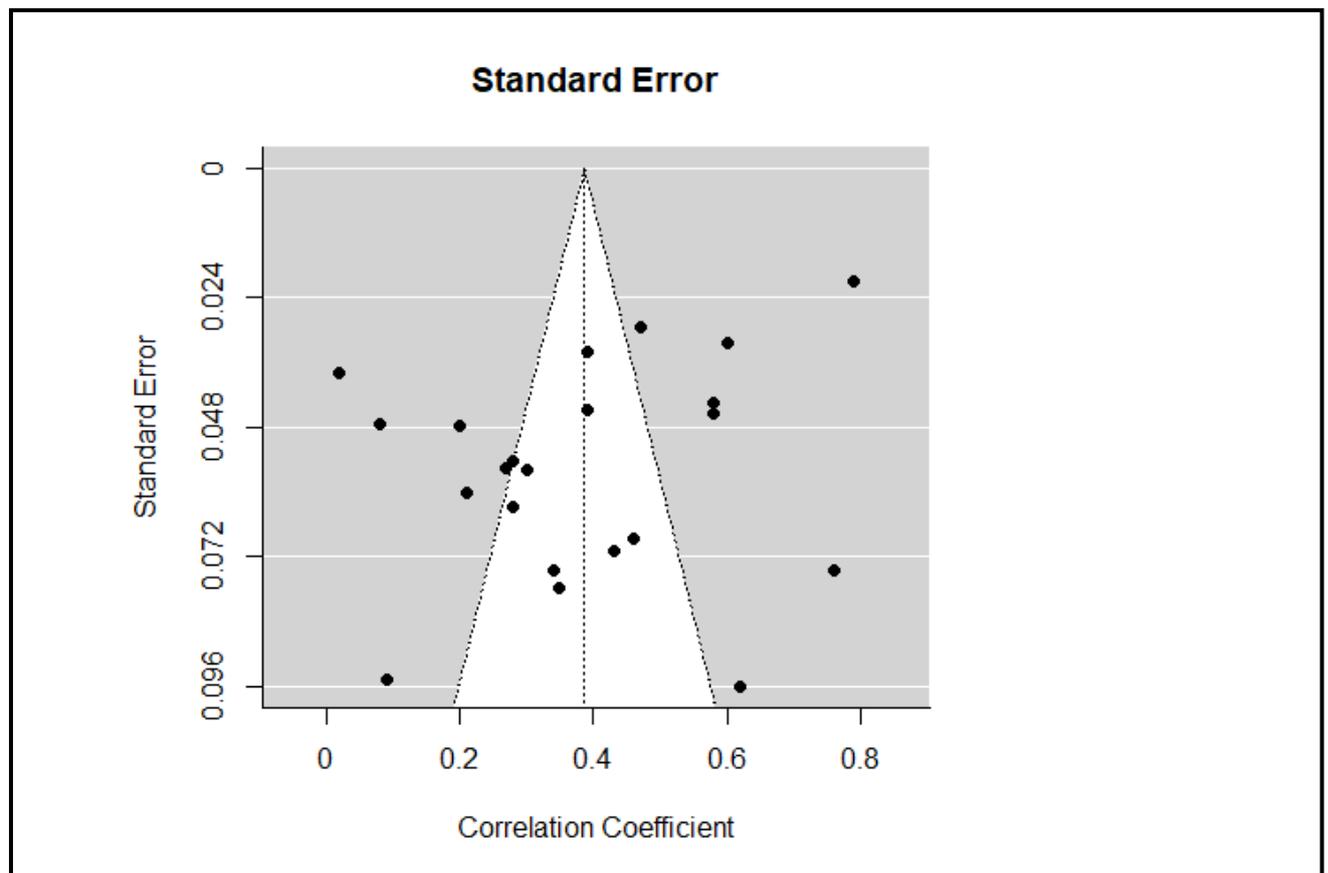

Figure 6. Funnel Plot Based on Uncorrected Correlations

4.1 Moderator Detection

4.1.1 Method 1: Q Test for Heterogeneity

Fisher z-transformed correlations were used to perform the Q Test for Heterogeneity. Based on the uncorrected correlations, the Q statistic was 501.60, whereas based on the corrected correlations, the Q statistic was 2061.22. In both cases, the test results suggest that there is significant heterogeneity between studies. Hence, there are likely to be moderators affecting the correlation between flow and addiction.

	Q statistic	*df*	*p*
Uncorrected correlations	426.37	22	< 0.0001
Corrected correlations	1942.06	22	< 0.0001

Table 2. Q Tests for Heterogeneity

4.1.2 Method 2: Credibility Interval

We used the formulas from Hunter and Schmidt (2004) to compute our credibility intervals. For our analysis based on uncorrected correlations, the 80% credibility interval for the true correlation was 0.3483±(1.28)(0.1931), and the 95% credibility interval was 0.3483±(1.96)(0.1931). For our analysis based on corrected correlations, the 80% credibility

interval was 0.4110±(1.28)(0.2249), and the 95% credibility interval was 0.4110±(1.96)(0.2249). Table 3 presents these results. The actual calculations can be found in Appendix C.

	mean correlation $\bar{\rho}$	80% credibility interval	95% credibility interval
Uncorrected correlations	0.3483	[0.1012, 0.5954]	[-0.0301, 0.7267]
Corrected correlations	0.4110	[0.1231, 0.6988]	[-0.0298, 0.8517]

Table 3. Credibility Intervals

Table 3 shows that all credibility intervals were quite large. Furthermore, the 95% credibility intervals included zero, suggesting that a moderating factor is likely in operation (Whitener, 1990).

4.1.3   Method 3: Schmidt and Hunter's 75% Rule

Based on the calculations in Appendix C, the variance due to sampling error (0.0026) and the variance due to measurement error (0.0010) combined represented less than 75% of the variance of the observed correlations (0.0399), i.e., (0.0026+0.0010)/0.0399<0.75. According to Schmidt and Hunter's 75% rule, we cannot rule out the presence of a moderator (Hunter & Schmidt 2004, 401).[5]

4.2   Moderator Confirmation

4.2.1   Method 1: Meta-regression

The R package `metafor` was used to perform the meta-regression analysis. Table 4 shows the results of the analysis. The dependent variable was the Fisher z-transformed uncorrected correlations. Table 5 presents the results based on corrected correlations. Table 4 suggests that the MMO game genre is a significant moderator of the relationship between flow and addiction, whereas Table 5 suggests that it is marginally significant.

	β	Standard Error	z	p
Intercept	0.5575	0.0773	7.2095	<0.0001***
MMO	-0.2308	0.1013	-2.2788	0.0227*

Table 4. Metaregression Results Based on Uncorrected Correlations
Note. *** $p \le 0.001$, * $p \le 0.05$

	β	Standard Error	z	p
Intercept	0.8360	0.1681	4.9741	<0.0001***
MMO	-0.4178	0.2227	-1.8763	0.0606+

Table 5. Metaregression Results Based on Corrected Correlations
*Note. *** $p \le 0.001$, * $p \le 0.05$, + $p \le 0.1$*

4.2.2   Method 2: Subgroup Analysis

To perform the subgroup analysis, we split the data into the MMO group and the non-MMO group and went through the same procedure in Appendix C to compute the mean and

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[5] If we ignore measurement error, the percentage 0.0026/0.0399 is even smaller, i.e., we will reach the same conclusion.

variance of the true correlation for each group. We then computed the t statistic for the difference in means between groups in accordance with Aguinis, Sturman, and Pierce (2008):

$$t = \frac{|\bar{r}_1 - \bar{r}_2|}{\sqrt{\frac{\text{var}(r_1)}{k_1} + \frac{\text{var}(r_2)}{k_2}}}$$

The *t test* results and associated statistics are presented in Table 6. As shown in the table, the MMO group was significantly different from the non-MMO group at the 0.05 level, regardless of whether the correlations were corrected for measurement error.

		Group 1: MMO	Group 2: Non-MMO	*t*-statistic	*p*
Uncorrected correlations	Mean:$\bar{r}_i$	0.2794	0.4735	2.660	0.0159*
	Variance:$\text{var}(r_i)$	0.0262	0.0331		
	# of studies:k_i	13	10		
Corrected correlations	Mean:$\bar{r}_i$	0.3402	0.5366	2.3438	0.0323*
	Variance:$\text{var}(r_i)$	0.0379	0.0411		
	# of studies:k_i	13	10		

Table 6. Descriptive Statistics of the Study Correlations between Groups
Note. * p ≤ 0.05

To summarize, our meta-analysis, which incorporated multiple techniques, supports our hypothesis that *MMO games moderate the relationship between flow and addiction*. Flow is less likely to lead to game addiction in MMO games than in non-MMO games.

5 Implications

5.1 Theoretical Implications

The moderating role of game genre in addiction theories is often overlooked in the literature. The few studies that investigate this role have yielded conflicting results on its significance. The present study employed a meta-analysis approach to consolidate existing empirical evidence and showed that MMO games have a moderating effect on the relationship between flow and game addiction. This result highlights the importance of accounting for game genre when developing theories related to game addiction. Specifically, it suggests that some of the theories that have been proposed may not be equally applicable across different game genres. Therefore, to develop a more comprehensive understanding of game addiction, it is crucial to consider how game genre may shape the factors that contribute to this phenomenon. By doing so, researchers and clinicians can better tailor interventions and treatments that are more effective in addressing problematic gaming behaviors in specific game genres, and ultimately, promote healthier gaming habits.

Specifically, we found that the moderating effect of MMO games is negative, i.e., MMO games tend to weaken the correlation between flow and game addiction[6] . Given that MMO games

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[6]It is important to note that even when the MMO genre is considered, the relationship between flow and game addiction is still positive (e.g., Dauriat et al., 2010; Hagstrom and Kaldo, 2014; Kardefelt-Winther; 2014).

are often reported to be the most addictive among game genres (Billieux et al., 2015), it is important to understand why the correlation is weakened. We note that flow theory can be used to explain the achievement motive behind game play (Yee, 2006a). Continuous game play allows a player to experience a repeated cycle of anxiety, flow, and boredom as the game level and the player's skill increase (Rau et al 2006). This progression in game creates a sense of achievement and motivates the player to continue to play. Our results suggest that the achievement motive may not be very strong in MMO games compared to non-MMO games.

Based on Billieux et al. (2013, 2015), we posit that problematic play in MMO games likely represents a maladaptive strategy to cope with negative affect (e.g., boredom, anxiety, dysphoria). This interpretation is consistent with Psychguides.com (n.d.), where game addiction is divided into two categories: (1) standard video games, typically with a clear goal such as saving a princess, and (2) online multiplayer games, typically with no ending. It is suggested that the addiction in the first category is mostly driven by completing a mission or beating a high score or preset standard, in line with the achievement motive. On the other hand, addicted players in the second category tend to form virtual social networks with other players and use game play as a means to escape from reality and gain acceptance. More empirical evidence should be collected in the future to support this interpretation.

As shown in Table 7, the heterogeneity tests based on *z*-transformed correlations in each subgroup suggest that there could be other moderating factors affecting the correlation between flow and game addiction. This points to the need for future investigation of other relevant factors in the theory development for game addiction.

	Group 1MMO	**Group2 Non MMO**
Uncorrected correlations	Q (df = 12) = 152.9711 $p < .0001$***	Q (df = 9) = 175.5068 $p < .0001$***
Corrected correlations	Q (df = 12) = 293.7331 $p < .0001$***	Q (df = 9) = 1369.9709 $p < .0001$ ***

Table 7. Q Tests for Heterogeneity

Finally, as discussed in the literature review, flow theory has been applied in other IS research problems to explain online consumer behaviour, technology acceptance and game-based learning (Kaur, et. al., 2016; Kunz & Santomier, 2019; Naglis & Bhatiasevi, 2019; Lin, et al., 2020; Krath, et al., 2021). The results of this study highlight the computer-mediated environment (e.g., game genre) as a potential inhibitor of flow along side individual characteristics (Valinatajbahnamiri & Siahtiri 2020).

5.2 Practical Implications

From the perspective of a game developer who wants to make addictive games, the stronger correlation between flow and game addiction observed for non-MMO games than for MMO games suggests that providing a good match between game challenge and player skill level, which is essential to the flow experience, is particularly important for non-MMO games. Hence, it is important to ensure that the level of challenge can adapt to the player's skill level as it changes over time. Such adaptation can avoid users having a boring experience (when the game is not challenging enough) or a frustrating experience (when the game is too challenging). That said, an engaging game experience can be addictive. Balancing the pursuit of profit with the potential negative impacts on players' finances or mental health is a common ethical dilemma faced by game developers (Amano-Smerling 2021). Guidelines such as the

Children's Code issued by the Information Commissioner's Office of the UK and the *Code of Ethics for the Game Industry* published by EthicalGames.org can be consulted to help game developers strike the right balance.

On the other hand, the lower correlation between flow and game addiction observed for MMO games suggests that game developers may need to find other ways to engage players in MMO games. The results of this study do not provide insights into how this player engagement can be achieved. However, systematic reviews on game addiction (e.g., Juthamanee & Gunawan, 2021; Karmakar, 2020; Kuss & Griffiths, 2012) have summarized various factors that contribute to game addiction. Future empirical efforts should investigate which of these factors are more prominent in MMO games.

6 Conclusion

6.1 Summary

The literature has not firmly established the moderating effects of game genre on game addiction. Our study makes an incremental contribution to the literature by empirically demonstrating via a meta-analysis that MMO games significantly lower the correlation between flow and game addiction. After removing an outlier, our analysis covered 23 studies representing a total of 6,772 subjects. Our results suggest that game genre should be considered in the development of a general theory of game addiction.

6.2 Limitations

Our study has several limitations. First, while our aim is to empirically demonstrate that the MMO game genre moderates the relationship between flow and game addiction, we do not provide a theoretical explanation for why this effect exists. Second, while MMO games are often perceived as more addictive than other genres (Billieux et al., 2015), we do not investigate the psychological and cognitive mechanisms that lead to addiction in MMO games. Third, the moderating effect we observe is based on results reported in existing correlational studies, and the research contexts of these studies may differ, leading to potential confounding factors. Fourth, while there may be other moderating factors, as suggested by Table 7, we do not identify or discuss them in this study. Finally, although many existing correlational studies use structural equal models (SEM) to analyse their data and report correlations between many other variables, we do not explore these relationships in our study.

6.3 Future Research

Based on the aforementioned limitations, several potential directions for future research could be pursued. First, it may be beneficial to develop a theoretical model to explain the weakened relationship between flow and addiction in MMO games. This model could help identify the unique characteristics of MMO games that may lead to this moderating effect. Second, conducting experiments could strengthen the empirical evidence on the causal relationship between game features and game addiction, while also minimizing the impact of confounding factors. Third, other potential moderating factors should be explored to improve the effectiveness of addressing game addiction in various contexts. Fourth, a meta-analysis structural equation model (SEM) could provide a more comprehensive summary of the relationships between different constructs that affect game addiction. Finally, it is worth noting that using gap-spotting to formulate a research question is unlikely to generate significant research theories. As an alternative, we recommend problematization as a

technique for constructing future research questions by challenging the assumptions underlying existing theories (Sandberg & Alvesson, 2011).

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Appendix A

List of Studies Included in the Meta-Analysis

1. Ballabio, M., Griffiths, M. D., Urbán, R., Quartiroli, A., Demetrovics, Z., & Király, O. (2017). Do Gaming Motives Mediate between Psychiatric Symptoms and Problematic Gaming? An Empirical Survey Study. *Addiction Research & Theory*, 25(5), 397–408.

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Appendix B

R Script Used in the Meta-Analysis

```
library("metafor")
meta_data = read.csv("C:\\working directory\\meta_data.csv")

### SECTION 3 DATA VISUALIZATIONS ###

# Compute relevant outcome measures for correlations
meta_data_corr = escalc(measure="COR", ri=ri, ni=ni, data=meta_data)
# For analysis based on corrected correlations, use the following
statement instead:
#  meta_data_corr  =  escalc(measure="COR",  ri=corrected_ri,  ni=ni,
data=meta_data)

# Random Effects Model for Correlations
res_corr = rma(yi, vi, data=meta_data_corr)

# Forest Plot for Correlations (Figure 5)
forest(res_corr,
      slab = meta_data_corr$Study,
      ilab = MMO, ilab.xpos =-1.5,
      cex=0.7, header = TRUE,
      xlim=c(-3.5,2), digits=c(2,1))
text(-1.5, res_corr$k+2, "MMO", cex=0.7)

# Funnel Plot (Figure 6)
funnel(res_corr, main="Standard Error")
ranktest(res_corr)

### SECTION 4 ANALYSIS ###

# Compute z-transformed correlations and associated outcome measures
meta_data = escalc(measure="ZCOR", ri=ri, ni=ni, data=meta_data)
# For analysis based on corrected correlations, use the following
statement instead:
#  meta_data  =  escalc(measure="ZCOR",  ri=corrected_ri,  ni=ni,
data=meta_data)

# Random Effects Model (Showing the Q Test for Heterogeneity in 4.1.1)
res = rma(yi, vi, data=meta_data)
res

# inverse transform back to r
predict(res, transf=transf.ztor)

# Meta-regression
moderator = rma(yi, vi, mods = ~ factor(MMO), data=meta_data)
moderator

### SECTION 5 ANALYSIS ###

meta_data = read.csv("C:\\working directory\\meta_data.csv")

# subgroup heterogeneity test for non-MMO
```

```
meta_data_non_mmo = subset(meta_data, MMO == 0)
meta_data_non_mmo   =   escalc(measure="ZCOR",   ri=ri,   ni=ni,
data=meta_data_non_mmo)
# For analysis based on corrected correlations, use the following
statement instead:
# meta_data_non_mmo = escalc(measure="ZCOR", ri=corrected_ri, ni=ni,
data=meta_data_non_mmo)
res_non_mmo = rma(yi, vi, data=meta_data_non_mmo)
res_non_mmo

# subgroup heterogeneity test for MMO
meta_data_mmo = subset(meta_data, MMO == 1)
meta_data_mmo   =   escalc(measure="ZCOR",   ri=ri,   ni=ni,
data=meta_data_mmo)
# For analysis based on corrected correlations, use the following
statement instead:
#  meta_data_mmo  =  escalc(measure="ZCOR",  ri=corrected_ri,  ni=ni,
data=meta_data_mmo)
res_mmo = rma(yi, vi, data=meta_data_mmo)
res_mmo
```

Appendix C

Calculation of the Credibility Intervals

We use the formulas from Hunter and Schmidt (2004) to compute our credibility intervals. For our analysis on uncorrected correlations, the population correlation is estimated by the sample size-weighted mean observed correlation (Hunter and Schmidt 2004, p. 81) as $\bar{\rho} = \bar{r} = \sum n_i r_i / \sum n_i = 0.3483$. The variance of the observed correlation is given by

$$s_r^2 = \sum n_i (r_i - \bar{r})^2 / \sum n_i = 0.0399.$$

The variance due to sampling error can be approximated by (Hunter and Schmidt 2004, p. 87)

$$s_e^2 = k(1 - \bar{r}^2)^2 / \sum n_i = 0.0026,$$

where k is the number of original studies in the meta-analysis. In this case, $k = 23$. Hence, the standard deviation of the correlation corrected for sampling error is $s_\rho = \sqrt{0.0399 - 0.0026} = 0.1931$. The 80% credibility interval is $0.3483 \pm (1.28)(0.1931)$, and the 95% credibility interval is $0.3483 \pm (1.96)(01931)$, as shown in Table 3.

For our analysis of corrected correlations, we first compute the mean compound attenuation factor

$$\bar{A} = \bar{a}\bar{b} = \left(\frac{1}{k} \sum \sqrt{\alpha_i}\right)\left(\frac{1}{k} \sum \sqrt{\beta_i}\right),$$

where α_i is the construct reliability of flow and β_i is the construct reliability of addiction in Study i if the construct correlations reported have not already been corrected for measurement error. If the construction correlations have already been corrected for measurement error, as in most covariance-based SEM analyses, α_i or β_i is simply equal to unity. For our dataset, $\bar{A} =$

0.8475. Following the steps in Hunter and Schmidt (2004, p. 152), the estimated true correlation after correcting for measurement error is

$$\bar{\rho} = \frac{\bar{r}}{\bar{A}} = \frac{0.3483}{0.8475} = 0.4110.$$

Let the standard deviations of $\sqrt{\alpha_i}$ and $\sqrt{\beta_i}$ be s_a and s_b, respectively. The sum of the squared coefficients of variation is

$$V = \left(\frac{s_a}{\bar{a}}\right)^2 + \left(\frac{s_b}{\bar{b}}\right)^2 = \left(\frac{0.0653}{0.9082}\right)^2 + \left(\frac{0.0482}{0.9332}\right)^2 = 0.0078,$$

and the variance due to measurement error can be found by

$$s_m^2 = \bar{\rho}^2 \bar{A}^2 V = 0.4110^2 \times 0.8475^2 \times 0.0078 = 0.0010.$$

The variance in true correlation is given by

$$s_\rho^2 = \frac{s_r^2 - s_e^2 - s_m^2}{\bar{A}^2} = \frac{0.0399 - 0.0026 - 0.0010}{0.8475^2} = 0.0506.$$

Hence, the standard deviation of the true correlation corrected for measurement error is $s_\rho = \sqrt{0.0506} = 0.2249$. The 80% credibility interval for ρ is $0.4110 \pm (1.28)(0.2249)$, and the 95% credibility interval is $0.4110 \pm (1.96)(0.2249)$, as shown in Table 3.