Massively multiplayer online game addiction: instrument development and validation

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ABSTRACT

The primary objective of this paper is to develop and validate an instrument for massively multiplayer online game (MMOG) addiction. Three stages of instrument development were undertaken to achieve this objective: item generation, scale development, and instrument testing. The results of a confirmation factor analysis confirmed the existence of seven dimensions of MMOG addiction, namely *Salience, Mood Modification, Tolerance, Withdrawal, Conflicts, Relapse,* and *Loss of Control*. The final instrument exhibits adequate levels of reliability, convergent validity, discriminant validity, and nomological validity. The instrument is expected to assist future empirical research on MMOG addiction. The theoretical and practical implications are discussed.

Keywords: Massively multiplayer online game, Technology addiction, Conceptualization, Instrument development, Confirmatory factor analysis

1. Introduction

Massively multiplayer online game (MMOG) is one of the most popular online game genres that constitutes the largest segment of the online game business. Being highly challenging, interactive and immersive, MMOG is however often presented as being potentially dangerous of leading to addiction [1]. We have witnessed an increasing number of reported cases of negative consequences associated with excessive use of or addiction to MMOG, such as loss of consciousness and crime [2], and even notable deaths [3]. As concerns grow about the negative consequences, MMOG addiction has become a critical societal challenge and has received increasing attention from the scientific community [4-6]. However, research on MMOG addiction has been hindered by a present lack of consensus and consistency on instruments, highlighting the need for developing and validating an instrument that captures the breadth and complexity of MMOG addiction, as well as provides a consistent and solid foundation for diagnosis and assessment of MMOG addiction.

The development and validation of an instrument is an important step in advancing empirical research, as it brings rigor to the scientific inquiry process, enhances the trustworthiness and replicability of findings, and allows confirmatory research [7-10]. Theoretically and empirically rigorous instruments to measure latent constructs have frequently been called for in the information systems (IS) literature [8, 11-14]. One area that has attracted increasing attention from IS researchers, and which is in need of a consistent measurement tool, is addiction to massively multiplayer online game.

MMOG addiction in this study is defined as the use of MMOG that taps seven key dimensions of behavioral addiction, namely *Salience* (e.g., MMOG use is the most important activity in the gamer's life)*, Mood Modification* (e.g., the gamer modifies their mood with MMOG use)*, Tolerance* (e.g., an increasing amount of time or resources are given to MMOG use)*, Withdrawal* (e.g., unpleasant feelings result from the discontinuance of MMOG use)*, Conflicts* (e.g., problems result from excessive MMOG use)*, Relapse* (e.g., a tendency to revert to prior excessive MMOG use patterns)*,* and *Loss of Control* (e.g., an inability to

limit the time or resources allocated to MMOG use) to a degree when the normal functioning of gamers is impaired [15, 16].

MMOG addiction is an emerging phenomenon and the literature on the topic is still culturally diverse. The terminology used to describe MMOG addiction includes the terms "online game addiction," "pathological online game use," "excessive online gaming," and "problematic online gaming" [17]. Most of the prior studies on MMOG addiction have concentrated on examining risk factors [e.g., 1], and on understanding diagnoses, symptoms management and treatment strategies [e.g., 6]. There have been a considerable number of studies on the dimensions and scale of MMOG addiction [e.g., 4, 18], however the conceptualization and scale development across these studies has been inconsistent and ambiguous.

A considerable number of instruments of MMOG addiction have been adapted directly from diagnostic criteria based on the **D**iagnostic and **S**tatistical **M**anual of Mental Disorders [19] (e.g., substance dependency, substance abuse, impulse control disorder, and pathological gambling), which are primarily used for clinical assessment (see Table 1). These studies usually used a categorical approach for diagnosis, hindering a theoretical and empirical investigation into the development of MMOG addiction.

Some researchers operationalized MMOG addiction as a unidimensional construct with a metric scale [e.g., 20, 21, 22]. These studies attempted to identify the relationship between MMOG addiction and its antecedent variables. As shown in Table 1, most researchers have adopted a multidimensional view of MMOG addiction to best capture the breadth and complexity of the construct [e.g., 4, 18, 23, 24]. However, the existing multidimensional scales on MMOG addiction suffer from several limitations, such as a lack of vigorous instrument development and validation processes, overlapping dimensions, and missing key dimensions [4, 25]. None of these studies went beyond an initial exploration and they only included first-order factors. Although there are many plausible competing measurement models, the relative veracity of these models is poorly understood. Confirmatory studies are thus needed to complete the research cycle.

As research on MMOG addiction has emerged, it has been beset by conflicting conceptualizations and operationalizations of the MMOG addiction.

This study aims to address these limitations by (1) conceptualizing and operationalizing MMOG addiction, (2) developing and validating an instrument of MMOG addiction using a rigorous approach, and (3) uncovering the multifaceted structure underlying MMOG addiction. This study presents a theoretically derived instrument of MMOG addiction and its rigorous instrument development and validation processes. Building on the theoretical dimensions of behavioral addiction frameworks [e.g., 15, 16], an initial measurement instrument set for MMOG addiction was identified and validated empirically with a field survey. The final instrument set of 37 items demonstrated adequate psychometric properties of reliability, convergent and discriminant validity, and nomological validity. The seven-factor structure of MMOG addiction provides a good fit to the data, reflecting logical consistency.

2. Theoretical foundations

2.1. MMOG addiction conceptualization

MMOG addiction as a research concept has been examined across multiple disciplines, including social psychology, biochemistry, psychiatry, education, communication, and information systems [e.g., 1, 5, 26, 27]. Various terminologies have been used to describe the phenomenon of excessive involvement in online gaming and its associated negative outcomes, such as "online game addiction," "pathological online game use," "online game addictive behavior," and "problematic online game use" [17]. In addition to the inconsistency in terminology use, there have also been disagreements in the literature on how to theoretically and operationally define MMOG addiction. For example, MMOG addiction has been defined as MMOG use that meets half or more of the DSM diagnostic criteria [e.g., 28], causes physical and psychological problems [e.g., 17], exhibits withdrawal symptoms [e.g., 29], or taps the key dimensions of behavioral addiction [e.g., 21, 30]. A thorough and comprehensive review of MMOG addiction scales was conducted to better conceptualize MMOG addiction.

Table 1
Summary of MMOG Addiction Instruments.

Scale	Source	Basis of the Scale	Number of Item	Dimensionality	Scaling	MMOG Addiction Studies Adapting the Scale
DSM-IV: Impulse Control Disorder Criteria	[19]	DSM-IV: Impulse Control Disorder Criteria	12	Categorical Diagnostic Criteria	Yes/No	[31, 32]
DSM-IV: Pathological Gambling Criteria	[19]	DSM-IV: Pathological Gambling Criteria	10	Categorical Diagnostic Criteria	Yes/No	[33]
DSM-IV: Substance Abuse Criteria	[19]	DSM-IV: Substance Abuse Criteria	4	Categorical Diagnostic Criteria	Yes/No	[34, 35]
DSM-IV: Substance Dependence Criteria	[19]	DSM-IV: Substance Dependence Criteria	9	Categorical Diagnostic Criteria	Yes/No	[28]
Self-Evaluation for Addiction	[36]	DSM-IV: Pathological Gambling Criteria	8	Categorical Diagnostic Criteria	Yes/No	[36]
Addiction–Engagement Questionnaire	[30, 37]	Developed from past literature	22	Unidimension	Likert Scale	[18, 30, 38-40]
Exercise Addiction Inventory	[41]	Developed from past literature	6	Unidimension	Likert Scale	[42]
Generalized Problematic Internet Use Scale: Withdrawal Component	[43]	Developed from past literature	6	Unidimension (Withdrawal Subcomponent)	Likert Scale	[29]
Young's Internet Addiction Scale	[44, 45]	DSM-IV: Pathological Gambling Criteria	20	Unidimension (Multidimension [25]: Salience, Tolerance, Withdrawal, Relapse, Mood Modification, Conflict)	Likert Scale	[20-22, 27, 34, 46-53]
Chinese Internet Addiction Scale	[54]	DSM-IV: Substance Abuse Criteria DSM-IV: Substance Dependence Criteria	26	Multidimension: Compulsive Use, Withdrawal, Tolerance, Interpersonal Relationship, Health and Time Management	Likert Scale	[55, 56]
Compulsive Internet Use Scale	[57]	Developed from past literature	14	Multidimension: Withdrawal Symptoms, Loss of Control, Preoccupation/Salience, Conflict, Coping, Lying	Likert Scale	[58]
Game Addiction Scale	[23]	DSM-IV: Pathological Gambling Criteria	21	Multidimension: Salience, Tolerance, Mood Modification, Relapse Withdrawal, Conflict, Problems	Likert Scale	[16, 59, 60]
Internet Addiction Scale	[61]	Developed from past literature	14	Multidimension: Preoccupation/Salience, Conflict, Loss of Control, Withdrawal Symptoms, Tolerance	Likert Scale	[62, 63]

Internet Addiction Scale for Taiwanese	[24]	Developed from past literature	29	Multidimension: Compulsive Use, Withdrawal, Tolerance, Problematic Consequences, Interpersonal and Financial Problems	Likert Scale	[5, 64, 65]
Korean Internet Game Addiction Scale	[66]	Developed from past literature	20	Multidimension: Game-Dependence Behavior, Declined Self-Control, Hypersensitiveness, Functional Deficit, Absorption	Likert Scale	[67]
Online Game Addiction Measurement	[68]	Developed from past literature	10	Multidimension: Withdrawal, Longer Time, Conflict, Tolerance, Relapse, Cannot Stop, Salience	Likert Scale	[1]
Online Game Addiction Scale	[69]	DSM-IV: Pathological Gambling Criteria	20	Multidimension: Psychological Dependence, Compulsive Use, Withdrawal, Problems	Likert Scale	[26]
Problematic Internet Use Questionnaire	[70]	DSM-IV: Pathological Gambling Criteria	18	Multidimension: Obsession, Neglect, Control Disorder	Likert Scale	[71]
Problematic Online Gaming Questionnaire	[4]	Developed from past literature & interview	18	Multidimension: Preoccupation, Overuse, Immersion, Social Isolation, Interpersonal Conflicts, Withdrawal	Likert Scale	[4]
Problematic Video Game Playing Scale	[72]	DSM-IV: Pathological Gambling Criteria	9	Multidimension: Preoccupation, Tolerance, Loss of Control, Withdrawal, Escape, Lie and Deception, Disregard for the Physical or Psychological Consequences, Family/Schooling Disruption	Likert Scale	[73-76]
The Problematic Online Game Use Questionnaire	[17]	Developed from past literature	20	Multidimension: Euphoria, Health Problem, Conflict, Failure of Self-Control, Preference of Virtual Relationship	Likert Scale	[17]

Following the approach recommended by Kuss and Griffiths [77], 53 empirical studies measuring MMOG addiction were identified. Sets of diagnostic criteria (e.g., pathological gambling and impulse control disorders) from the DSM [19] are commonly used in assessing addiction behaviors and most of the existing MMOG addiction instruments are highly associated with these criteria. Nevertheless, a number of distinct instruments measuring MMOG addiction have emerged over the years. Twenty-one distinct instruments were found among the 53 identified studies. Despite the possible theoretical and semantic overlaps, the identified instruments were classified according to the operationalization of MMOG addiction. There are three major classifications, DSM diagnostic criteria, unidimensional MMOG addiction constructs, and multidimensional MMOG addiction constructs (Table 1).

Four sets of DSM diagnostic criteria were frequently adapted to identify potential addicts of MMOG, namely impulse control disorder criteria [e.g., 31, 32], pathological gambling criteria [e.g., 33], substance abuse criteria [e.g., 35], and substance dependence criteria [e.g., 28]. Generally, individuals who do not meet half of the stated criteria in each set are not considered pathological MMOG users. However, the categorical system inherent in using sets of DSM criteria has been criticized on several grounds. For instance, despite its categorical approach and atheoretical nature, the sets of DSM criteria used were originally derived for diagnosis purposes and thus the approach lacks a robust theoretical underpinning [78]. Although the categorical diagnostic approach is prominent in clinical assessment and research, it may not be entirely applicable to social science research.

A considerable number of the studies measured MMOG addiction as a unidimensional construct. Several unidimensional instruments measuring MMOG addiction were found in a wide variety of literature, including Young's Internet Addiction Scale [44] and the Generalized Problematic Internet Use Scale [43] from the Internet use literature, the Exercise Addiction Inventory [41] in the sport and exercise literature, and the Addiction-Engagement Questionnaire [37] from the computer use literature. Young's Internet Addiction Scale is the most popular unidimensional instrument used to measure MMOG addiction. Fifteen

of the 53 identified studies used a form of Young's Internet Addiction Scale. Unidimensional instruments, such as Young's Internet Addiction Scale, surpass the categorical diagnostic criteria of DSM by allowing the development of a theoretical and empirical understanding of the relationships between MMOG addiction and other concerning variables.

Despite the widespread adaptation of DSM diagnostic criteria and unidimensional instruments to measure MMOG addiction, some studies examined the multiple dimensions underlying MMOG addiction. The three most frequently adapted multidimensional instruments of MMOG addiction were the Game Addiction Scale [23], the Internet Addiction Scale for Taiwanese [24], and the Problematic Video Game Playing Scale [72]. After an iterative literature review process, the major dimensions pertaining to MMOG addiction were identified: Salience, Preoccupation, Obsession, Mood Modification, Absorption, Immersion, Escape, Euphoria, Tolerance, Withdrawal, Conflicts, Problems, Relapse, Loss of Control, and Failure of Self-Control (see Table 1). Although there may be semantic overlaps and some dimensions may be significantly more important than others, it is generally agreed that a multidimensional view of MMOG addiction can best capture the breadth and complexity of the phenomenon [18]. Assessing the multiple dimensions concerning MMOG addiction is important, as both a definition and an instrument structure are prerequisites to the subsequent instrument refinement, and a failure to identify the dimensionality of an instrument may lead to inappropriate or inaccurate specifications of constructs or theories [79]. The dimension scores can also provide information beyond the global score of a unidimensional instrument [80].

Referencing prior frameworks of behavioral and technological addiction [15, 16, 81], MMOG addiction was defined as MMOG use tapping key dimensions of behavioral addiction, which are *Salience, Mood Modification, Tolerance, Withdrawal, Conflict, Relapse,* and *Loss of Control*. The definitions of the dimensions specific to the context of MMOG are provided in Table 2.

Table 2

Definitions of the Dimensions of MMOG Addiction. (Sources: [15, 16, 23])

Dimension	Definition
Salience	MMOG use becomes the most important activity in the gamer's life and dominates the gamer's thinking (i.e., *Cognitive Salience*) and behavior (i.e., *Behavioral Salience*).
Mood Modification	Subjective experiences derived from playing MMOG, consisting of both an arousing "buzz," or "high," (i.e., *Mood Enhancement*) and a tranquilizing feeling of "escape" or "numbing" (i.e., *Emotional Relief*).
Tolerance	Increasing amounts of gaming are required to achieve the former experience. Gamers gradually build up the amount of time spent playing MMOG.
Withdrawal	The unpleasant feeling states, emotions, and/or physical effects (e.g., moodiness, irritability, or shakes) that occur when MMOG use is discontinued or suddenly reduced.
Conflicts	Conflicts result from excessive MMOG use, such as missing real life social engagements (i.e., *Interpersonal Problems*), missing work or classes (i.e., *Professional and Academic Problems*), and personal problems that the gamer experiences within themselves, such as physical illness (i.e., *Intrapersonal Problems*).
Relapse	The tendency to revert to earlier patterns of excessive MMOG use after periods of abstinence or control.
Loss of Control	The inability to limit the time or resources given to MMOG use, even when a decision appears to have previously been made to do so.

2.2. Dimensions of MMOG addiction

The research framework of this study is built upon the two pioneering frameworks of behavioral addiction from Brown [15] and Griffiths [16]. The component model of addiction proposed by Brown and Griffiths both argued that any behaviors meeting the criteria in the model can be operationally defined as an addiction. The criteria include *Salience*, *Mood Modification*, *Tolerance*, *Withdrawal*, *Conflict*, *Relapse*, and *Loss of Control*. The component model of addiction [15, 16] has provided a solid foundation for the line of behavioral addiction research and has been adopted to explain a wide spectrum of technology addiction, such as Internet addiction and online gaming addiction [e.g., 23, 45, 82].

Though the *Loss of Control* dimension appears only in Brown's model, it is included in the current instrument development to best capture the breadth and complexity of MMOG addiction. The concept has been extensively researched in prior human-computer interaction literature [e.g., 83, 84, 85]. The inclusion

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of *Loss of Control* dimension into the current research framework on MMOG addiction is also justifiable with both theoretical and empirical supports. First, *Loss of Control* is an important dimension to MMOG addiction. Self-regulation theories contend that addiction features a deficiency of self-control and regulation, and suggest that *Loss of Control* is a salient dimension to addiction [86, 87]. Existing literature provided further evidence that *Loss of Control* have been extensively adopted in conceptualizing and operationalizing addiction in a diverse technology context [e.g., 57, 61, 66, 72]. Second, the *Loss of Control* dimension is substantially distinct from other dimensions of behavioral addiction in the research framework. Though there is often confusion between *Relapse* and *Loss of Control* dimensions, the two are distinct theoretically and semantically. *Relapse* generally refers to the tendency to revert to earlier patterns of excessive MMOG use after periods of abstinence or control [15]. Users usually exhibit the symptom of *Relapse* in a later stage of addiction development after serious efforts have been made to eliminate the addictive activity [15]. However, *Loss of Control* generally refers to the inability to limit the time or resources given to MMOG use. Users exhibit the symptom of *Loss of Control* in earlier stages of or throughout the development of addiction. Prior literature has provided further evidence that *Relapse* and *Loss of Control* represent two different dimensions in addiction [e.g., 68].

To conclude, the seven dimensions in the current research are conceptually distinct from each other as they tap into different elements of abstraction of MMOG addiction. Collectively, they represent comprehensive yet parsimonious dimensions of MMOG addiction. Table 3 summarizes the definitions of the proposed dimensions. Many of the other dimensions proposed in existing MMOG addiction literature can be reconciled within these seven dimensions (see Table 4). The dimensions proposed in the component model of addiction are therefore adopted as the theoretical basis for the development of MMOG addiction instrument here.

Table 3

Summary of Definitions of Behavioral Addiction Dimensions.

Dimension	[15]	[16]	[23]	[30, 37]
Salience	The addictive activity becomes the most important thing in the person's life and dominates thinking (preoccupations and cognitive distortions), feelings (craving), and behavior (deterioration of socialized behavior).	Online gaming becomes the most important activity in the person's life and dominates their thinking (preoccupations and cognitive distortions), feelings (cravings) and behavior (deterioration of socialized behavior). For instance, even if the person is not actually gaming online, they will be thinking about the next time that they will game.	Playing a game becomes the most important activity in a person's life and dominates his or her thinking (preoccupation), feelings (cravings), and behavior (excessive use).	Domination of a person's life by the activity.
Conflicts	Disputes about the extent of the excessive behavior arise both between the addicted person and others around them, and within the addicted person themselves. Continuing conflict increases salience and the need for relief.	Conflicts between the online gamer and those around them (interpersonal conflict), conflicts with other activities (job, schoolwork, social life, hobbies, and interests), and conflicts within the individual themselves (intrapsychic conflict and/or subjective feelings of loss of control) that are related to spending too much time engaged in online gaming.	Interpersonal conflicts resulting from excessive gaming exist between the player and those around him/her. Conflicts may include arguments, neglect, lies, and deception. **(Problems)** Problems caused by excessive game play, particularly displacement problems as the object of addiction takes preference over activities such as school, work, and socializing. Problems may also arise within the individual, such as intrapsychic conflict and subjective feelings of loss of control.	The activity leads to conflict with others or self-conflicts.
Loss of Control	The apparent inability to limit the time or resources given to, or the amount of, the excessive behavior, even when a decision appears to have previously been made to do so. Explainable in terms of salience and relief.	--	--	--

Mood Modification	**(Relief)** At a late stage, the effects of the addictive activity are so powerful that there is a rebound effect when it ceases (withdrawal). The only way to avoid feeling more miserable than before (to find relief) is to repeat the behavior at the earliest opportunity. Continuing to choose this short-term pleasure and relief leads to a disregard of adverse consequences and long-term damage. In turn, salience increases with the apparent need for the addictive activity as a coping strategy.	The subjective experiences that people report as a consequence of engaging in online gaming and that can be seen as a coping strategy (i.e., they experience an arousing "buzz" or "high," or they experience a tranquilizing feeling of "escape" or "numbing").	**(Euphoria)** The subjective experiences that people report as a result of engagement in games. This dimension was previously labeled euphoria (Griffiths, 1995, 1997), referring to the "buzz" or "high" that is derived from an activity. However, mood modification can also include tranquillizing and/or relaxing feelings related to escapism.	**(Euphoria)** A "buzz" or a "high" is derived from the activity.
Relapse	**(Relapse and Reinstatement)** The tendency to repeatedly revert to earlier patterns of addictive behavior and for the most extreme patterns of behavior, typical of the height of the addiction, to be quickly restored even after many years of abstinence or control.	The tendency to repeatedly revert to earlier patterns of online gaming and for even the most extreme patterns of behavior, typical of the height of excessive online gaming, to be quickly restored after periods of abstinence or control.	The tendency to repeatedly revert to earlier patterns of game play. Excessive playing patterns are quickly restored after periods of abstinence or control.	Resumption of the activity with the same vigor subsequent to attempts to abstain.
Tolerance	Increasing amounts of the addictive activity are required to achieve the former effects.	Increasing amounts of online gaming are required to achieve the former mood modifying effects. Online gamers therefore gradually build up the amount of time that they spend online engaged in the behavior.	The gamer begins playing games more often, gradually building up the amount of time spent on games.	The activity has to be undertaken to a progressively greater extent to achieve the same "buzz."
Withdrawal	The unpleasant feeling states and/or physical effects that occur when the addictive activity is discontinued or suddenly reduced (e.g., the shakes, moodiness, irritability, etc.).	The unpleasant feeling states and/or physical effects that occur when online gaming is discontinued or suddenly reduced (e.g., the shakes, moodiness, irritability, etc.).	Unpleasant emotions and/or physical effects that occur when game play is suddenly reduced or discontinued. Withdrawal consists mostly of moodiness and irritability, but may also include physiological symptoms, such as shaking.	**(Withdrawal symptoms)** The cessation of the activity leads to the occurrence of unpleasant emotions or physical effects.

Notes: Any alternative terminology for the dimensions is provided in brackets.

Table 4

Mapping of MMOG Addiction Dimensions.

Scale	Source	Dimensions of Behavioral Addiction Framework							
		Salience	*Mood Modification*	*Tolerance*	*Withdrawal*	*Conflicts*	*Relapse*	*Loss of Control*	**Unclassified**
Chinese Internet Addiction Scale	[54]	--	--	Tolerance	Withdrawal	Interpersonal Relationships, Health and Time Management	--	Compulsive Use	--
Compulsive Internet Use Scale	[57]	Preoccupation/ Salience	Coping/Mood Modification	--	Withdrawal Symptoms	Conflicts	--	Loss of Control	Lying
Game Addiction Scale	[23]	Salience	Mood Modification	Tolerance	Withdrawal	Conflicts, Problems	Relapse	--	--
Internet Addiction Scale	[61]	Preoccupation/ Salience	--	Tolerance	Withdrawal Symptoms	Conflicts	--	Loss of Control	--
Internet Addiction Scale for Taiwanese	[24]	--	--	Tolerance	Withdrawal	Problematic Consequences, Interpersonal and Financial Problems	--	Compulsive Use	--
Korean Internet Game Addiction Scale	[66]	--	Absorption	--	--	Functional Deficit	--	Declined Self-Control	Hypersensitiveness, Game-Dependence Behavior
Online Game Addiction Measurement	[68]	Salience	--	Tolerance	Withdrawal	Conflicts	Relapse	Longer Time, Cannot Stop	--
Online Game Addiction Scale	[69]	Psychological Dependence	--	--	Withdrawal	Problems	--	Compulsive Use	--
Problematic Internet Use Questionnaire	[70]	Obsession	--	--	--	Neglect	--	Control Disorder	--
Problematic Online Gaming Questionnaire	[4]	Preoccupation	Immersion	--	Withdrawal	Social Isolation, Interpersonal Conflicts,	--	--	Overuse
Problematic Video Game Playing Scale	[72]	Preoccupation	Escape	Tolerance	Withdrawal	Disregard for the Physical or Psychological Consequences, Family/Schooling Disruption	--	Loss of Control	Lies and Deception
The Problematic Online Game Use Questionnaire	[17]	--	Euphoria	--	--	Health Problems, Conflicts,	--	Failure of Self-Control	Preference for Virtual Relationships
Young's Internet Addiction Scale	[44, 45]	Salience	Mood Modification	Tolerance	Withdrawal	Conflicts	Relapse	--	--

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3. Instrument development process

A systematic, rigorous approach to scale development has been strongly advocated for in IS research [11, 12, 88]. Following the robust paradigm in the IS literature, the instrument development process, shown in Figure 1, was therefore carried out in three stages, item creation, scale development, and instrument testing [12, 88]. This approach has been widely used by IS scholars and has worked well for developing instruments with desirable psychometric properties.
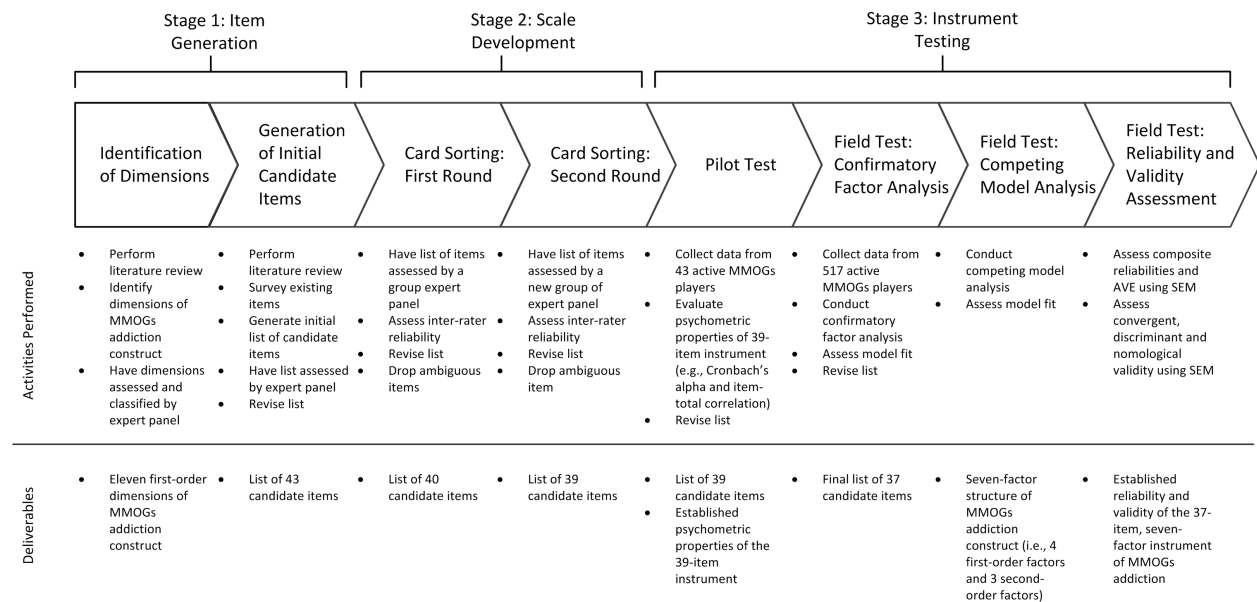
Stage 1: Item Generation		Stage 2: Scale Development		Stage 3: Instrument Testing			
Identification of Dimensions	Generation of Initial Candidate Items	Card Sorting: First Round	Card Sorting: Second Round	Pilot Test	Field Test: Confirmatory Factor Analysis	Field Test: Competing Model Analysis	Field Test: Reliability and Validity Assessment
Activities Performed							
• Perform literature review • Identify dimensions of MMOGs addiction construct • Have dimensions assessed and classified by expert panel	• Perform literature review • Survey existing items • Generate initial list of candidate items • Have list assessed by expert panel • Revise list	• Have list of items assessed by a group expert panel • Assess inter-rater reliability • Revise list • Drop ambiguous items	• Have list of items assessed by a new group of expert panel • Assess inter-rater reliability • Revise list • Drop ambiguous item	• Collect data from 43 active MMOGs players • Evaluate psychometric properties of 39-item instrument (e.g., Cronbach's alpha and item-total correlation) • Revise list	• Collect data from 517 active MMOGs players • Conduct confirmatory factor analysis • Assess model fit • Revise list	• Conduct competing model analysis • Assess model fit	• Assess composite reliabilities and AVE using SEM • Assess convergent, discriminant and nomological validity using SEM
Deliverables							
• Eleven first-order dimensions of MMOGs addiction construct	• List of 43 candidate items	• List of 40 candidate items	• List of 39 candidate items	• List of 39 candidate items • Established psychometric properties of the 39-item instrument	• Final list of 37 candidate items	• Seven-factor structure of MMOGs addiction construct (i.e., 4 first-order factors and 3 second-order factors)	• Established reliability and validity of the 37-item, seven-factor instrument of MMOGs addiction

Fig. 1. Overview of the instrument development process.

3.1. Mapping of MMOG addiction dimensions

Mapping of MMOG addiction dimensions was first conducted to reconcile the identified dimensions into a manageable number, to form a basis for the subsequent instrument development process. The typology of behavioral addiction proposed by Brown [15] and Griffiths [16] was used as the basis for mapping the MMOG addiction dimensions. Two independent subject experts were invited to match the proposed dimensions identified from the existing multidimensional instruments. Dimensions fitting the definitions stated in Table 3 were placed under the corresponding key dimensions of the behavioral

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addiction framework. Disagreements were solved through discussions. An unclassified option was provided to avoid the forced mapping of irrelevant dimensions. This generative method ensured that the domain of interest was sufficiently captured by the relevant dimensions.

As shown in Table 4, which summarizes the mapping of the MMOG addiction dimensions, *Conflicts* appeared to be the most ubiquitous dimension. Various types of *Conflicts* were captured and they were captured in all multidimensional instruments. *Loss of Control* and *Withdrawal* were the second most important dimensions, followed by *Salience, Mood Modification, Tolerance*, and *Relapse,* which were all commonly captured in the existing multidimensional instruments of MMOG addiction. Selection and development of dimensions were performed with caution to reflect their relevancy to MMOG addiction. In particular, dimensions which are less relevant or irrelevant to MMOGs were excluded. For example, given that a majority of MMOGs today are free-to-play and that playing MMOGs is legal and neutral, *Financial Problems* and *Deceptions* are excluded in the dimensions of MMOG addiction as they are inherent in addictive behaviors that require substantial financial input (e.g., pathological gambling) and are related to illegal activities (e.g., crime addiction) respectively. On the other hand, dimensions which are highly relevant to MMOGs were extended. For example, *Mood Modification* was further developed into two sub-dimensions, *Mood Enhancement* and *Emotional Relief*. The virtual world of MMOGs not only provides an environment for attaining excitement, but also offers an immersive space for escaping and relieving negative emotions. In addition, MMOGs are persistent in nature and require users to spend substantial amount of time. Therefore, the proposed sub-dimensions of *Conflicts* (i.e., *Intrapersonal Problems*, *Interpersonal Problems*, and *Professional and Academic Problems*) emphasized the negative consequences resulted from displacing time of daily activities (e.g., sleeping, socialization, and working) to playing MMOGs.

Many of the other dimensions proposed in the MMOG addiction literature could be reconciled within the seven dimensions of the behavioral addiction framework (see Table 4). Consistent with the definitions

of dimensions from the behavioral addiction framework, the mapping results suggest that the *Salience*, *Mood Modification*, and *Conflicts* dimensions are second-order dimensions composed of sub-dimensions. *Salience* consisted of *Cognitive Salience* (e.g., playing MMOG dominates the gamers' thoughts) and *Behavioral Salience* (e.g., playing MMOG becomes the most important activity for the gamers). *Mood Modification* consisted of *Mood Enhancement* (e.g., feeling a sense of euphoria or high) and *Emotion Relief* (e.g., escaping from or coping with negative emotions). *Conflicts* consisted of *Intrapersonal Problems* (e.g., health problems or physical illness), *Interpersonal Problems* (e.g., social isolation or interpersonal conflict), and *Professional and Academic Problems* (e.g., work or schooling disruptions).

Eleven first-order dimensions conceptually relevant to MMOG addiction were thus identified and served as the basis for the subsequent instrument development process. These dimensions were *Cognitive Salience* and *Behavioral Salience* (comprising *Salience*); *Mood Enhancement* and *Emotional Relief* (comprising *Mood Modification*); *Tolerance*; *Withdrawal*; *Intrapersonal Problems*, *Interpersonal Problems*, and *Professional and Academic Problems* (comprising *Conflicts*); *Relapse*; and *Loss of Control*.

3.2. Item generation

The objective of the item generation stage was to create pools of items with content validity for each dimension of MMOG addiction, by identifying items from existing instruments and by creating additional items that appeared to fit into the dimensions [88]. Following the deductive approach for item generation [89, 90], 11 dimensions of MMOG addiction were identified and were used as the basis for generating candidate items. Whenever appropriate, items from existing instruments that had been empirically tested were considered and adapted. A thorough, iterative literature review was conducted to survey existing MMOG addiction instruments and to obtain the initial pools of items for dimensions. Multiple items were generated for each dimension to ensure internal consistency [91]. Once the item pools were obtained, items for each dimension of MMOG addiction were then re-evaluated to eliminate redundant or ambiguous items. The culling process resulted in a total of 43 items for the 11 dimensions, as summarized in Table 5.

3.3. Scale development

The objectives of the scale development stage were (1) to assess the construct validity of the instrument being developed and (2) to identify the items that were ambiguous [88]. Panels of judges were invited to sort the various items into the construct dimensions, and provide evaluation on items.[88]. The panel members all either held Ph.D. degree or were pursuing Ph.D. studies and were either actively researching in the domain of interest or had professional experience in MMOG.

Table 5
The Dimensions and the Corresponding Number of Items.

Dimension	Number of Items
Cognitive Salience	3
Behavioral Salience	4
Tolerance	4
Withdrawal	5
Loss of Control	4
Relapse	5
Interpersonal Problems	4
Intrapersonal Problems	3
Professional and Academic Problems	3
Mood Enhancement	4
Emotional Relief	4

3.3.1. Sorting procedures

There were two rounds of card sorting. A different group of judges was used for each round. Prior to the card sorting, the judges were given a standard set of instructions that had been tested with a separate judge to ensure their comprehensiveness and comprehensibility. The judges could ask questions to ensure that they understood the procedure. In each round of card sorting, five judges were given the definitions of the 11 dimensions and were asked to carefully read each item and sort it to its corresponding dimension. After the card sorting procedure, the judges were asked to provide additional feedback to improve the instrument items.

3.3.2. Inter-rater reliabilities

Two measurements were calculated to assess the reliability of the card sorting. The level of agreement between each pair of judges was measured with Cohen's Kappa [92]. Although no general authority exists with respect to the required scores for Cohen's Kappa [88], recent studies have considered scores greater than 0.65 to be acceptable [93]. Following Moore and Benbasat [88], item placement ratios were also calculated to assess the reliability of the classification scheme and the validity of the items. Item placement ratios demonstrated the overall frequency with which all of the judges placed the items into the intended dimensions. The higher the percentage of items placed in the intended dimension, the higher the degree of inter-judge agreement across the panel [88]. Instruments with a high degree of correct item placement were considered to have a high degree of construct validity and reliability. There are no established standards for determining good levels of placement. Higher item placement ratios are considered to be better and the presentation of ratios in the matrix can also be used to highlight any problematic areas and classifications [88]. The results of the two rounds of card sorting are summarized in Tables 6, 7, and 8.

For the first round of card sorting, five judges were asked to sort the items based on the dimension definitions provided [88]. The judges were not forced to sort any items they found ambiguous into a particular category. The results showed a generally high degree of agreement between the judges, with the exception of the *Behavioral Salience* dimension. The Cohen's Kappa ranged between 0.75 and 0.85, and averaged 0.77 (see Table 6). The overall placement ratio of items within the target dimensions was 82%, indicating that the items were generally sorted into the intended dimensions (see Table 7). The *Behavioral Salience, Tolerance, Withdrawal,* and *Relapse* dimensions had relatively low item placement ratios and were examined to identify ambiguous items. Following the card sorting results and the evaluations from the judges, two items for *Behavioral Salience* were revised and one item was dropped from *Tolerance, Withdrawal,* and *Relapse* each. Forty items thus remained for the next stage of development.

For the second round of card sorting, five new judges were invited to sort the remaining items based on the definitions provided. The results revealed significantly better agreement between the judges than in the first round. The Cohen's Kappa ranged between 0.87 and 0.95, and averaged 0.91 (see Table 6). The overall placement ratio of items within the target dimensions was 94% and each item placement ratio was equal or greater than 80% (see Table 8). The results indicated that the items were sorted into the intended dimensions. It was therefore concluded that the development process had resulted in an instrument that demonstrated construct validity and had a high potential for good reliability. One ambiguous item was dropped from the *Relapse* dimension, leaving 39 items for the instrument validation tests.

Table 6
Degree of Agreement (Cohen's Kappa).

	Judges	**1**	**2**	**3**	**4**	**5**	
Card Sorting 1	**1**		0.92	0.95	0.89	0.89	**Card Sorting 2**
	2	0.72		0.95	0.87	0.89	
	3	0.79	0.77		0.89	0.95	
	4	0.82	0.74	0.85		0.87	
	5	0.74	0.74	0.74	0.74		

Table 7
Results of the First Round of Card Sorting (Item Placement Ratio).

		Actual Categories											Total	Hit
		CS	BS	LOC	TOL	IEP	PAP	IAP	WIT	ER	ME	REL	Items	Ratio%
Target Categories	CS	15											15	100
	BS	1	9	2	2			6					20	45
	LOC			18								2	20	90
	TOL			5	13						2		20	65
	IEP					20							20	100
	PAP						15						15	100
	IAP							15					15	100
	WIT					5	1	3	16				25	64
	ER		1		1					16	2		20	80
	ME			1						3	16		20	80
	REL		3	2	1							19	25	76
	Total Items Placement: 215				Hits: 172						Overall Hit Ratio: 82%			
	Notes: CS = Cognitive Salience, BS = Behavioral Salience, ME = Mood Enhancement, ER = Emotional Relief, TOL = Tolerance, WIT = Withdrawal, IAP = Intrapersonal Problems, IEP = Interpersonal Problems, PAP = Professional and Academic Problems, REL = Relapse, LOC = Loss of Control.													

Table 8
Results of the Second Round of Card Sorting (Item Placement Ratio).

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		CS	BS	LOC	TOL	IEP	PAP	IAP	WIT	ER	ME	REL	Total Items	Hit Ratio%
Target Categories	CS	13	1	1									15	87
	BS		20										20	100
	LOC			19	1								20	95
	TOL			2	12						1		15	80
	IEP					20							20	100
	PAP						15						15	100
	IAP							15					15	100
	WIT							1	18		1		20	90
	ER									20			20	100
	ME										20		20	100
	REL			4								16	20	80

The table is headed "Actual Categories" spanning the category columns.

Total Items Placement: 200　　　　Hits: 188　　　　Overall Hit Ratio: 94%

Notes: CS = Cognitive Salience, BS = Behavioral Salience, ME = Mood Enhancement, ER = Emotional Relief, TOL = Tolerance, WIT = Withdrawal, IAP = Intrapersonal Problem, IEP = Interpersonal Problem, PAP = Professional and Academic Problems, REL = Relapse, LOC = Loss of Control.

3.4. Instrument testing

3.4.1. Pilot test

A pilot test was conducted (1) to ensure that the mechanics of compiling the questionnaire were adequate, by having respondents first complete the questionnaire, and then comment on its length, wording, and instruction; and (2) to make an initial reliability assessment of the instrument [88, 94]. A self-administered questionnaire was distributed to 43 MMOG players. Entry in a lottery for shopping vouchers was offered as an incentive for participation to increase the response rate and quality. Cronbach's alphas and the item-total correlation were calculated to assess the reliability of the instrument. The reliability met the conventional standard of internal consistency [95], with Cronbach's alphas for all of the dimensions falling between 0.90 and 0.95, which were much higher than the recommended level of 0.7. The questionnaire was then refined based on the results and evaluations.

3.4.2. Field test

The refined self-administered online questionnaire was then distributed to MMOG users. An online market research firm was employed to conduct the data collection, to improve the response rate and the sample quality. The respondents were predominantly Chinese MMOG users. Screening questions were applied to filter only active, frequent MMOG users. The participants were given reward points that could

be exchanged for gifts. A total of 517 usable questionnaires were collected. Online survey methods have been the most commonly used data collection method in prior studies on the problematic use of Internet-based technology [96]. Of the 517 respondents, 54% were male and 46% were female. The majority of the respondents (41%) were aged 26-30, followed by 36% aged 31-40. The respondents spent on average 16 hours per week and had on average four-year experience playing MMOG.

3.4.3. Confirmatory factor analysis

Structural equation modeling techniques are useful for validating measurement instruments. Given the theory-driven approach used for the development of the measurement instrument, a confirmatory factor analysis (CFA) approach was used for instrument validation. CFA combines *ex ante* theoretical expectations with empirical data to validate the factor structure and is therefore a stronger statistical method than its alternatives (such as exploratory factor analysis) in theory-driven instrument development [7]. A CFA was performed with the 517 cases in the data set. The standardized residuals between the individual instrument items ranged between -0.22 and 0.26, which was well below the recommended threshold for data quality [7].

Kolmogorov-Smirnov tests ($p < 0.05$) and visual inspections of histograms and box plots showed that the data distributions exhibited a certain degree of skewness and kurtosis. However, data skewness is common in negative behavior studies, such as compulsive shopping [97], Internet overuse [98], and auction sites addiction [81] studies. The skewness and kurtosis estimates of the instrument items fell within the acceptable range (-2 to +2), suggesting no serious departure from the normality assumption [7]. Normality can have serious effects in small samples (fewer than 50 cases) [95]. Given the large sample size of this study (n=517), the small departure from the normality assumption is not a major issue.

The maximum likelihood method was used to detect the unidimensionality of each factor, which indicates the presence of a single trait or construct underlying a set of measures [99]. Following Byrne [100], a measurement model was developed that included the 11 identified factors as first-order factors.

The 11 factors were correlated, with each item having a non-zero loading on its designated factor and a zero loading on the other factors. The measurement errors associated with the items were uncorrelated. Although the χ^2/d.f. value suggested that the initial model had a reasonably good fit, most of the other fit indices were below the recommended threshold (see Table 9). The hypothesized model was thus not adequate. A re-specification of the hypothesized model was needed to detect any ill-fitting parameters and to achieve a clearer factor structure [90].

As shown in Table 9, the hypothesized model was re-specified by considering the standardized factor loadings [90] and modification indices [100]. Following Jöreskog and Sörbom [101], one item at a time was dropped from the model to avoid over-modification. At the end of the re-specification process, one item from *Emotional Relief* and one item from *Loss of Control*, were dropped. The final 37-item instrument had good fit indices (χ^2/d.f. = 2.50, GFI = 0.86, AGFI = 0.83, RMR = 0.08, RMSEA = 0.05, TLI = 0.94, NFI = 0.92, CFI = 0.95). The final model minimized the Akaike information criterion (AIC) value, indicating that it was the most parsimonious model. The MMOG addiction instrument was finalized with the 37 items, as shown in Appendix A.

Table 9
Model Fit Test Results of Initial and Revised Models.

	Threshold	Initial Model (39 items)	Revised Model (38 items)	Revised Model (37 items)
χ^2	Smaller is better	1777.600	1531.625	1435.212
d.f.		647.000	610.000	574.000
p-value	$p > 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$
χ^2/d.f.	$1 < \chi^2$/d.f. < 3	2.748	2.511	2.500
GFI	> 0.90	0.831	0.855	0.861
AGFI	> 0.80	0.796	0.824	0.830
RMR	< 0.10	0.105	0.082	0.080
RMSEA	< 0.08	0.058	0.054	0.054
TLI	> 0.90	0.926	0.938	0.940
NFI	> 0.90	0.902	0.914	0.917
CFI	> 0.90	0.935	0.946	0.948
AIC	Smaller is better	2043.638	1793.625	1693.212
CAIC	Smaller is better	2741.628	2481.118	2370.210

*3.4.4. Estimation of competing models*

Competing model analyses were conducted to corroborate the hypothesized model. Building on the literature, five plausible alternative models were proposed. Figure 2 shows only the representative items from each of these alternatives. Models 1 to 3 represented the non-hierarchical structure with only first-order factors. Model 1 was a first-order factor model. In this unidimensional model, one factor, *MMOG Addiction*, was hypothesized to account for all the common variance between the 37 observable variables. This was consistent with summing the scores of all observable variables to obtain a total MMOG addiction score [e.g., 22]. Model 2 was a first-order factor model with the 11 factors correlated with each other to represent the different dimensions of MMOG addiction. By assuming that the 11 factors were correlated, the multiple dimensions were associated with one another, capturing the common variance in the model. Demetrovics et al. [70] laid a foundation for this model in their discussion of substantial common variance between observable variables in the Internet addiction scale. In Model 3, the 37 observable variables were loaded onto 11 uncorrelated factors. Demetrovics et al. [4] performed an exploratory factor analysis with an online gaming addiction scale resulting in various uncorrelated factors. It was possible that 11 orthogonal first-order factors explained the data structure, making Model 3 a plausible alternative.

Models 4 and 5 represented two different composite latent variable models with different hierarchical structures, highlighting the different facets of MMOG addiction. Model 4 comprised a second-order factor onto which the 11 first-order factors were loaded. Model 4 tested the extent to which the correlations among the 11 first-order factors were accentuated by the second-order factor, *MMOG Addiction*, which was consistent with plausible hierarchical structures suggested in the literature [e.g., 17]. Referencing the theoretical framework of behavioral addiction from Brown [15] and Griffiths [16] and the comprehensive literature review results, Model 5 suggested an alternative hierarchical structure in which three second-order factors (*Salience*, *Mood Modification*, and *Conflict*) and four first-order factors (*Tolerance*, *Withdrawal*, *Relapse*, and *Loss of Control*) explained MMOG addiction.

The fit indices of the five competing models are summarized in Table 10. The null model stated that no latent factors had underlain the observed items and that the correlations between the items were zero in the population [102]. The null model was included to establish a zero point for the NFI [103]. As expected, the null model resulted in poor fit indices. Models 1, 3, and 4 demonstrated substantial improvements over the null model. None of these models, however, had a reasonable fit with the empirical data. Models 2 and 5 provided substantial improvements over their alternatives. The majority of the fit indices in models 2 and 5 met the recommended thresholds, except for GFI, which had a marginal fit. Therefore, models 2 and 5 were both regarded as adequate for representing the underlying factor structure of the MMOG addiction instrument.

A higher-order model merely explains the covariation within its corresponding first-order model in a more parsimonious way (i.e., one that requires fewer degrees of freedom). Consequently, even when a higher-order model is able to effectively explain the factor covariations, the goodness-of-fit can never surpass that of its first-order model [103]. As shown in Table 10, the fit indices of Model 2 were slightly superior to those of Model 5, suggesting that Model 2 might provide a target or optimum fit. However, the target coefficient (T) of 0.914 (the ratio of the χ^2 between Model 2 and Model 5) suggested the existence of the second-order model, indicating that 91.4% of the variation was explained by the second-order model [103]. Therefore, the factor covariance in Model 2 can be represented in a more parsimonious way with the existence of second-order factors. Since prior literature suggested the existence of seven dimensions of MMOG addiction, Model 5 is of greater theoretical interest than Model 2. For these reasons, though both Model 2 and Model 5 were representative, researchers in this study recommended Model 5, and used it to proceed with the analysis of the validity and reliability of the factors and items.
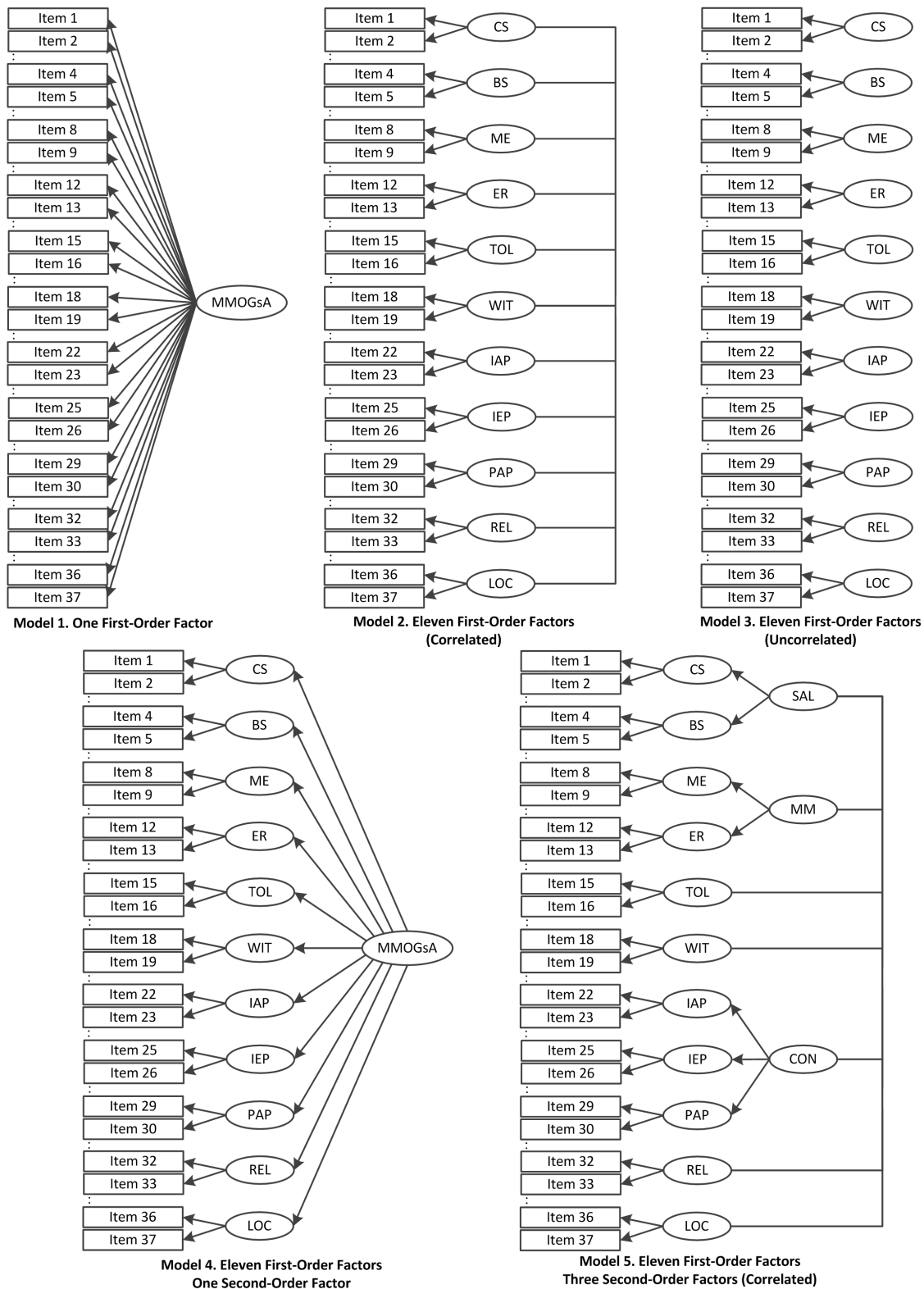
Fig. 2. Competing Models for the MMOG Addiction Instrument.

Notes: CS = Cognitive Salience, BS = Behavioral Salience, SAL = Salience, ME = Mood Enhancement, ER = Emotional Relief, MM = Mood Modification, TOL = Tolerance, WIT = Withdrawal, IAP = Intrapersonal Problems, IEP = Interpersonal Problems, PAP = Professional and Academic Problems, CON = Conflicts, REL = Relapse, LOC = Loss of Control.

Table 10
Model Fit Test Results of the Alternative Models.

	Threshold	*Null Model*	*Model 1*	*Model 2*	*Model 3*	*Model 4*	*Model 5*
χ^2	Smaller is better	17296.556	6911.539	1435.212	5895.534	2564.284	1570.979
d.f.		666.000	629.000	574.000	629.000	618.000	601.000
p-value	$p > 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$	$p < 0.05$
χ^2/d.f.	$1 < \chi^2$/d.f. < 3	25.971	10.988	2.500	9.373	4.149	2.614
GFI	> 0.90	0.109	0.421	0.861	0.476	0.758	0.844
AGFI	> 0.80	0.060	0.353	0.830	0.415	0.725	0.817
RMR	< 0.10	0.895	0.205	0.080	0.825	0.166	0.094
RMSEA	< 0.08	0.220	0.139	0.054	0.127	0.078	0.056
TLI	> 0.90	/	0.600	0.940	0.665	0.874	0.935
NFI	> 0.90	/	0.600	0.917	0.659	0.852	0.909
CFI	> 0.90	/	0.622	0.948	0.683	0.883	0.942
AIC	Smaller is better	17370.556	7059.539	1693.212	6043.534	2734.284	1774.979
CAIC	Smaller is better	17564.733	7447.894	2370.210	6431.889	3180.368	2310.279

3.4.5. Assessment of the measurement model's reliability and validity

Cronbach's alphas and the item-total correlations were calculated to examine the reliability of the instrument after specifications and estimations of the factor models. The reliability met the conventional standard of internal consistency [95], with Cronbach's alphas falling between 0.83 and 0.93 and the item-total correlations for all of the items ranging between 0.67 and 0.87, which exceeded the recommended thresholds. The convergent and discriminant validity of the measurement model were then assessed.

3.4.5.1. Convergent validity

Convergent validity refers to the extent to which the items in an instrument appear to be indicators of a single underlying construct. The convergent validity was evaluated using the criteria [95, 104] that (1) all of the measurement factor loadings must be significant and exceed 0.7, (2) the construct reliabilities must exceed 0.7, and (3) the average variance extracted (AVE) should exceed 0.5. As evident in the measurement model results in Table 11, all of the item factor loadings were significant ($p < 0.001$) and the lowest value was 0.75. The composite reliability (CR) fell between 0.85 and 0.98, and the AVE ranged from 0.66 to 0.96. The results suggested that the instrument demonstrated convergent validity.

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Table 11

CFA Measurement Model Results.

Item	Mean	Standard deviation	Standardized item loading (λ)
CS1	5.41	1.21	0.85
CS2	5.44	1.23	0.79
CS3	4.98	1.36	0.85
BS1	5.41	1.26	0.87
BS3	5.48	1.20	0.83
BS4	5.07	1.31	0.84
BS5	5.18	1.38	0.87
ME1	5.41	1.12	0.85
ME2	5.50	1.14	0.85
ME3	5.50	1.10	0.84
ME4	5.61	1.13	0.82
ER2	5.00	1.37	0.74
ER3	5.36	1.25	0.82
ER4	5.26	1.20	0.81
TOL1	4.75	1.48	0.95
TOL2	4.66	1.52	0.94
TOL3	4.73	1.49	0.93
WIT1	4.57	1.50	0.91
WIT2	4.68	1.48	0.90
WIT3	4.72	1.45	0.93
WIT4	4.80	1.44	0.92
IAP1	4.82	1.46	0.82
IAP2	4.98	1.45	0.82
IAP3	4.74	1.43	0.86
IEP1	4.92	1.35	0.85
IEP2	5.08	1.42	0.82
IEP3	4.82	1.46	0.83
IEP4	4.87	1.41	0.87
PAP1	4.54	1.52	0.86
PAP2	4.47	1.54	0.85
PAP3	4.31	1.57	0.81
REL1	5.00	1.35	0.87
REL2	4.86	1.36	0.90
REL3	4.63	1.45	0.89
LOC2	4.59	1.51	0.88
LOC3	4.92	1.47	0.93
LOC4	5.15	1.42	0.89

Notes: CS = Cognitive Salience, BS = Behavioral Salience, ME = Mood Enhancement, ER = Emotional Relief, TOL = Tolerance, WIT = Withdrawal, IAP = Intrapersonal Problems, IEP = Interpersonal Problems, PAP = Professional and Academic Problems, REL = Relapse, LOC = Loss of Control.

Table 12

Scale Properties and Correlations Matrix.

Construct	Composite Reliability	AVE	Correlations Matrix						
			MM	TOL	WIT	REL	LOC	SAL	CON
Mood Modification (MM)	0.93	0.67	**0.81**						
Tolerance (TOL)	0.96	0.88	0.52	**0.94**					
Withdrawal (WIT)	0.95	0.84	0.54	0.76	**0.92**				
Relapse (REL)	0.92	0.78	0.51	0.69	0.67	**0.88**			
Loss of Control (LOC)	0.93	0.80	0.60	0.70	0.77	0.69	**0.89**		
Salience (SAL)	0.95	0.71	0.61	0.65	0.63	0.56	0.61	**0.84**	
Conflicts (CON)	0.96	0.70	0.42	0.55	0.67	0.58	0.73	0.44	**0.84**

Notes: AVE = average variance extracted

3.4.5.2. Discriminant validity

Discriminant validity refers to the degree to which the measures of distinct constructs differ. Discriminant validity is demonstrated when the squared root of the AVE for each construct is higher than the correlations between it and the rest of the constructs [95, 104]. The square root of the AVE for each construct is shown in Table 12, located in bold on the diagonal of the table. The value for each construct was higher than the correlations between it and the other constructs, suggesting the discriminant validity of the instrument. An additional test was performed to further assure the discriminant validity. An item loading and cross-loading matrix was computed to test the discriminant validity. All of the items loaded on their intended constructs above a 0.7 level and those loadings were higher than any cross-loadings on any other constructs, thus further supporting the discriminant validity (see Appendix C) [105, 106].

3.4.5.3. Nomological validity

Nomological validity refers to the degree to which predictions based upon the measured constructs are confirmed within a wide theoretical context or network of constructs. Nomological validity can be supported by demonstrating that the constructs are related to other constructs not included in the model in a manner that supports the theoretical framework [95]. To assess the nomological validity of the MMOG addiction instrument, we assumed that there were positive relationships between the factors underlying

MMOG addiction and a personality trait, *Deficient Self-Control*, which has been suggested as one of the dominant predictors of behavioral addiction and MMOG addiction in the literature [e.g, 29].

Based on the work of Tangney et al. [107], *Deficient Self-Control* was measured with a 13-item scale, including items such as "*I wish I had more self-discipline,*" "*I have trouble concentrating,*" and "*I often act without thinking through all of the alternatives*" (see Appendix B). A seven-point Likert-type scale (ranging from "1 = strongly disagree" to "7 = strongly agree") was used to measure these items. Two items were dropped from the analysis because of low factor loadings (i.e., lower than 0.7). *Deficient self-control*'s composite reliability was 0.94 and its AVE was 0.61. The square root of AVE was larger than all of its inter-construct correlations, lending support to the reliability and validity of the scale. As expected, there were strong positive relationships between the *Deficient Self-Control* trait and the dimensions of *Salience* ($\beta = 0.37$, $p < 0.001$), *Mood Modification* ($\beta = 0.47$, $p < 0.001$), *Tolerance* ($\beta = 0.49$, $p < 0.001$), *Withdrawal* ($\beta = 0.57$, $p < 0.001$), *Conflicts* ($\beta = 0.63$, $p < 0.001$), *Loss of Control* ($\beta = 0.65$, $p < 0.001$), and *Relapse* ($\beta = 0.53$, $p < 0.001$). The results corroborated those in the behavioral addiction literature, thereby confirming the nomological validity of the MMOG addiction instrument.

4. Discussion and conclusion

The purpose of this study was to conceptualize and operationalize MMOG addiction, to develop and validate its scale, and to uncover the multifaceted structure underlying the construct. Building on the existing behavioral addiction literature, MMOG addiction was defined as MMOG use that taps the seven key dimensions of behavioral addiction. Of these seven dimensions, three were second-order dimensions consisting of multiple first-order dimensions: *Salience* consisted of *Cognitive Salience* and *Behavioral Salience*; *Mood Modification* consisted of *Mood Enhancement* and *Emotional Relief*; and *Conflicts* consisted of *Intrapersonal Problems*, *Interpersonal Problems*, and *Professional and Academic Problems*. The remaining four dimensions were the first-order dimensions of *Tolerance*, *Withdrawal*, *Loss of Control*, and *Relapse*. We performed a content validity assessment in multiple rounds to ensure that there was

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sufficient rigor in the measures. These steps addressed the concern that many instrument development practices include measures that lack content validity in the item development stage. Rigorous instrument development and validation processes were used to develop and validate the measures of the identified dimensions of MMOG addiction.

The results suggested that two frequently applied conceptualizations and operationalizations, the categorical diagnostic assessment approach and the unidimensional approach, may not adequately capture the breadth and complexity of MMOG addiction. A comprehensive review of the existing instruments revealed that there were at least seven distinctive, important dimensions underlying MMOG addiction. Given the theory-driven approach for the development of measurement instruments, a CFA approach was used for the instrument validation. The CFA confirmed the stability of the seven dimensions underlying MMOG addiction. Based on the seven key dimensions of MMOG addiction, an initial domain-specific MMOG addiction instrument with 43 items was constructed. Rigorous instrument development processes and empirical validations helped to refine the scale into a 37-item instrument with adequate psychometric properties, reliability, and validity. A competing models analysis suggested the existence of second-order factors for *Salience*, *Mood Modification*, and *Conflicts*, whereby *Salience* consisted of the two first-order factors *Behavioral Salience* and *Cognitive Salience*; *Mood Modification* consisted of *Mood Enhancement* and *Emotional Relief*; and *Conflicts* consisted of *Intrapersonal Problems*, *Interpersonal Problems*, and *Professional and Academic Problems*. The recommended model (Model 5) provided a good fit to the data and was more theoretically valid than the other models, reflecting logical consistency and the multifaceted structure of a MMOG addiction instrument.

4.1. Theoretical and practical implications

This study is timely, as it enhances our theoretical understanding of the growing phenomenon of MMOG addiction. The results will provide researchers and practitioners with substantial implications and valuable insights.

This study theoretically conceptualized and operationalized MMOG addiction as a multidimensional construct tapping seven key dimensions that can be observed and measured. Although a considerable number of studies have used the diagnostic approach or the unidimensional approach to conceptualize and operationalize MMOG addiction, there are concerns about whether these approaches can best reflect and capture the complexity of the phenomenon. This investigation contributes to the knowledge base by providing a better understanding of the multidimensionality and multifaceted structure underlying MMOG addiction, which will be highly beneficial to future MMOG addiction research. A multidimensional view of MMOG addiction is believed to best capture the breadth and complexity of the phenomenon here. The use of multidimensional or hierarchical constructs has received increasing attention in IS research because of its potential [108]. For instance, it can reduce model complexity, achieve theoretical parsimony, and allow matching of levels of abstraction for constructs [108, 109]. This study can thus serve as a foundational work and provide researchers with insights into the conceptualization and operationalization of technology addiction in future IS research.

This study has advanced existing theoretical frameworks and typologies by identifying a set of core, consistent dimensions and sub-dimensions pertaining to MMOG addiction. As revealed in the literature analysis (Table 4), there was a lack of consensus on the key dimensions of MMOG addiction. For instance, some studies used varied terminology and others used only parts of the dimensions from existing frameworks and typologies without justification. Through a comprehensive literature analysis of the existing scales and mapping of dimensions, important dimensions pertaining to MMOG addiction were selected and reconciled into the existing theoretical frameworks to provide a systematic, consistent reference for future research. Ambiguous or irrelevant dimensions (those that did not fit into the context of MMOG) were identified and excluded.

The *Loss of Control* dimension, which has been omitted in some pioneering typology of behavioural addiction [e.g., 16], was extensively examined in MMOG addiction studies. *Loss of Control* and its related

concepts were found to be critical in determining the various forms of behavioral addictions [86, 110]. Therefore, the *Loss of Control* dimension was included here to advance and complement the existing frameworks and typologies. This study also identified sub-dimensions of certain MMOG addiction dimensions (e.g., *Mood Modification* consisted of the two sub-dimensions *Mood Enhancement* and *Emotional Relief)*. It enriches our existing knowledge on the complexity of MMOG addiction-related dimensions and allows for future investigations into which dimensions or sub-dimensions are more important in determining MMOG addiction.

The developed, validated MMOG addiction instrument is important to future research in the IS field, as a psychometrically sound measurement instrument is a prerequisite for any theoretical advancement [89]. The validated instrument will be added to the repository of rigorous research instruments for IS researchers' future applications, helping to develop a cumulative tradition for IS research in MMOG addiction. This study has substantial implications for the understanding of the developmental processes and mechanisms of MMOG addiction. As indicated in the technology addiction literature, it is possible that the dimensions within the addiction construct interplay with one another and together depict the developmental mechanism of addiction [111].

The MMOG addiction instrument was developed using a vigorous approach and demonstrated desirable psychometric properties. Given that most of the existing instruments measuring MMOG addiction were adapted from other behavioral and technological addiction contexts, there was a general lack of vigorous instrument development and validation specific to MMOG addiction. Following the robust paradigm of instrument development in the IS literature, this study used vigorous instrument development and validation processes, including item creation, scale development, and instrument testing. The instrument was developed specifically for the MMOG addiction context and was empirically proven to be reliable and valid. It can be used with confidence by researchers and practitioners.

The 37-item MMOG addiction instrument is a comprehensive yet easily administered measure of MMOG addiction. Practitioners (e.g., educators and MMOG operators) can administer the measurement instrument to MMOG users to evaluate their likelihood of developing MMOG addiction. The administration of the MMOG addiction instrument could be carried out over successive periods to assess the changes in degree of different dimensions and to track the development of potential addiction. By examining the relative importance and contribution of each dimension in determining MMOG addiction, dimension-specific corresponding measures could be taken to prevent or cope with MMOG addiction.

4.2. Limitations and directions for future research

Although the MMOG addiction instrument has been subjected to rigorous development and validation processes, it is not without limitations. There may be concerns about the comprehensiveness and relevance of the dimensions identified in the proposed MMOG addiction instrument. The content validity of the instrument was assured as much as possible through an extensive literature review to uncover any relevant, possible addiction dimensions, followed by careful mapping of these dimensions and an examination of the relevance of the dimensions within the MMOG context. The resulting dimensions and instrument are not only theoretically justified, but also capture the relevant behavioral addiction dimensions across a wide range of MMOG contexts. In addition, most of the resulting dimensions contain only three measurement items (e.g., Tolerance, Relapse and Loss of Control), which is the minimum required for empirical computations with covariance-based statistical tools. Therefore, future research on instrument development and validation should begin by generating a larger pool of initial items.

Even after several model re-specifications, the final seven-factor model (Model 5) of MMOG addiction still had a significant χ^2 statistic. It should be noted that the χ^2 index is sensitive to and affected by the sample size [95]. Models with a good fit can be rejected merely because of a small difference between the predicted and observed covariance matrices attributed to a larger sample size. Similarly, ill-fitting models can be accepted by having an adequate fit attributed to a small sample size. As a mere reliance on

the χ^2 index does not warrant statistical merit, a number of fit indices were used to assess the overall fit of the measurement model here [90, 95, 101]. It is common in the IS literature to assess the overall model fit with numerous fit indices [90]. Alternative types of fit indices (i.e., GFI, AGFI, RMR, RMSEA, TLI, NFI, CFI, AIC, and CAIC) were used here and all of these indices were within the recommended thresholds. The decision to retain the selected model (Model 5) was therefore substantiated and reasonable.

When compared with previous studies on MMOG addiction, a moderate-high level of addiction among respondents in this sample was observed. For instance, gamers spent on average 16 hours per week playing MMOG. One possible explanation is that our respondents were predominantly Chinese MMOG users. MMOG addiction is particularly serious among users in Asian countries (e.g., China, South Korea, and Taiwan) [112, 113]. In addition, screening questions have been applied to filter only active and frequent MMOGs users who have ranked MMOGs use as their top three online activities. It is believed using a single sample of respondents may contain bias that precludes generalizing the findings. Thus, future research should test the measurement instrument with new data sets in alternative settings. For example, cultural studies could be performed with samples from different countries for greater generalizability of the measurement.

Finally, the main purposes of this study were to conceptualize and operationalize MMOG addiction, to develop and validate an instrument for measuring addiction in the MMOG context, and to uncover the multifaceted structure of MMOG addiction. The identified dimensions and validated instrument in this study can serve as a base for future investigations of the developmental mechanisms of MMOG addiction, by allowing interplays and estimations of the relationships between the addiction dimensions and other concerning internal and environmental variables (e.g., addiction-prone personalities, IT features, and preferences for online social interaction). For example, the relationship between MMOG motivations and addiction has been empirically examined and validated in previous literature. Yee [114, 115] examined how MMOG motivations (i.e., achievement, social relationship, and immersion) were associated with

problematic use of MMOG, in which problematic use was measured with Young's Internet addiction scale [116]. Similarly, Xu et al. [117] explored the relationship between the four motivations (i.e., advancement, mechanics, relationship, and escapism) and online gaming addiction, in which addiction was measured with computer addiction scale [30]. It would be interesting to extend prior studies by exploring how MMOG motivations influence this new set of instrument for MMOG addiction.

To conclude, this set of newly developed instrument is expected to assist future empirical research on MMOG addiction. Furthermore, practitioners could also use the instrument to assess the potential development of MMOG addiction among users and to propose corresponding prevention and coping strategies.

Appendix A
The Final 37-item Scale of MMOG Addiction[1].

Salience
Cognitive Salience
CS1   I am preoccupied with playing MMOG.
CS2   When I am offline, I wonder what is happening in the MMOG world.
CS3   I think about playing MMOG all day long.
Behavioral Salience
BS1   Playing MMOG has become one of the most important activities to me.
BS3   I play MMOG much more than other activities, prior hobbies, or interests.
BS4   I play MMOG before something else I need to do.
BS5   I spend a good deal of time playing MMOG
Mood Modification
Mood Enhancement
ME1   I feel good while I play MMOG.
ME2   Playing MMOG is when I feel the most pleasure.
ME3   I experience a buzz of excitement while playing MMOG.
ME4   Playing MMOG makes me happy.
Emotional Relief
ER2   Playing MMOG relieves my dysphoric feelings.
ER3   Playing MMOG releases my stress.
ER4   Playing MMOG eliminates my bad feelings (e.g., sadness, nervousness, or anger).
Tolerance
TOL1   There is a need to increase the amount of time playing MMOG to achieve my former excitement.
TOL2   I play MMOG with a marked increase in duration to attain satisfaction.

TOL3   I play MMOG more extensively than before.

Withdrawal

WIT1   I feel restless when I attempt to cut down my MMOG use.

WIT2   I become irritable when I attempt to stop my MMOG use.

WIT3   I feel bad when I am unable to play MMOG.

WIT4   I feel bored when I am unable to play MMOG

Conflicts

Intrapersonal Problems

IAP1   Playing MMOG causes me sleep deprivation.

IAP2   I experience physical problems (e.g., backache, fatigue, or headache) because of playing MMOG.

IAP3   My health gets worse because of playing MMOG.

Interpersonal Problems

IEP1   I miss real life social engagements because of playing MMOG.

IEP2   I give up or reduce social activities because of playing MMOG.

IEP3   Others in my life complain about my MMOG use.

IEP4   I neglect others (e.g., friends or family) because of playing MMOG.

Professional/Academic Problems[2]

PAP1   My work or studies suffered because I play MMOG.

PAP2   Playing MMOG often interferes with my work or my studies.

PAP3   I am not able to fulfill my role obligations at my workplace or campus because of playing MMOG.

Relapse

REL1   I tend to resume playing MMOG after periods of abstinence.

REL2   I have a tendency to revert to the previous pattern of MMOG use after a stop.

REL3   I return to playing MMOG after I have cut back, and play more excessively.

Loss of Control

LOC2   I have difficulty controlling the amount of time playing MMOG.

LOC3   I am not able to resist the impulse to play MMOG.

LOC4   I play MMOG longer than intended.

Notes: [1]All items were measured using a 7-point Likert scale ranging from "1 = Strongly Disagree" to "7 = Strongly Agree"; [2]There is an assumption associated with the Professional and Academic Problems dimension that the respondent is either employed or in school.

Appendix B

Measures of Deficient Self-Control. [107]

Deficient Self-Control
DSC1   I am good at resisting temptation.
DSC2   I have a hard time breaking bad habits. (R)
DSC3   I am lazy. (R)
DSC4   I say inappropriate things. (R)
DSC5   I do certain things that are bad for me, if they are fun. (R)
DSC6   I refuse things that are bad for me.
DSC7   I wish I had more self-discipline. (R)*
DSC8   People would say that I have iron self-discipline.
DSC9   Pleasure and fun sometimes keep me from getting work done. (R)*
DSC10 I have trouble concentrating. (R)

DSC11 I am able to work effectively toward long-term goals.
DSC12 Sometimes I can't stop myself from doing something, even if I know it is wrong. (R)
DSC13 I often act without thinking through all the alternatives. (R)

Notes: All items were measured using a 7-point Likert scale ranging from "1 = Strongly Disagree" to "7 = Strongly Agree"; (R) = Reversed Item; * = Item dropped from analysis because of low factor loading.

Appendix C
Cross-loading Matrix.

Item	Mood Modification	Tolerance	Withdrawal	Relapse	Loss of Control	Salience	Conflicts
ER2	**0.74**	0.46	0.54	0.51	0.61	0.45	0.50
ER3	**0.82**	0.44	0.45	0.45	0.48	0.51	0.37
ER4	**0.81**	0.41	0.43	0.42	0.48	0.46	0.31
ME1	**0.85**	0.38	0.41	0.39	0.46	0.52	0.32
ME2	**0.85**	0.38	0.39	0.35	0.45	0.52	0.28
ME3	**0.84**	0.46	0.45	0.42	0.49	0.54	0.34
ME4	**0.82**	0.40	0.40	0.39	0.44	0.51	0.28
TOL1	0.49	**0.95**	0.72	0.67	0.66	0.61	0.53
TOL2	0.44	**0.94**	0.71	0.65	0.66	0.59	0.52
TOL3	0.52	**0.93**	0.73	0.66	0.68	0.63	0.53
WIT1	0.48	0.74	**0.91**	0.65	0.70	0.60	0.62
WIT2	0.46	0.68	**0.90**	0.60	0.71	0.54	0.63
WIT3	0.51	0.70	**0.93**	0.62	0.70	0.58	0.60
WIT4	0.53	0.69	**0.92**	0.60	0.70	0.59	0.59
REL1	0.47	0.60	0.59	**0.87**	0.59	0.49	0.52
REL2	0.49	0.56	0.57	**0.90**	0.61	0.49	0.50
REL3	0.41	0.69	0.63	**0.89**	0.63	0.50	0.52
LOC2	0.43	0.60	0.68	0.61	**0.88**	0.45	0.70
LOC3	0.59	0.66	0.71	0.63	**0.93**	0.59	0.64
LOC4	0.60	0.64	0.67	0.61	**0.89**	0.58	0.62
BS1	0.57	0.53	0.55	0.47	0.55	**0.87**	0.39
BS3	0.56	0.51	0.50	0.44	0.47	**0.83**	0.33
BS4	0.48	0.60	0.54	0.51	0.49	**0.84**	0.36
BS5	0.51	0.57	0.56	0.50	0.54	**0.87**	0.41
CS1	0.52	0.51	0.50	0.44	0.50	**0.85**	0.33
CS2	0.53	0.50	0.47	0.42	0.48	**0.79**	0.32
CS3	0.44	0.61	0.59	0.52	0.54	**0.85**	0.41
IAP1	0.41	0.52	0.56	0.49	0.63	0.42	**0.82**
IAP2	0.38	0.43	0.53	0.47	0.59	0.33	**0.82**
IAP3	0.30	0.44	0.52	0.46	0.60	0.30	**0.86**
IEP1	0.42	0.48	0.59	0.50	0.64	0.42	**0.85**
IEP2	0.46	0.43	0.56	0.48	0.62	0.43	**0.82**
IEP3	0.40	0.45	0.55	0.48	0.61	0.43	**0.83**
IEP4	0.39	0.49	0.61	0.53	0.66	0.42	**0.87**

PAP1	0.29	0.49	0.57	0.51	0.62	0.32	**0.86**
PAP2	0.26	0.45	0.52	0.45	0.57	0.27	**0.85**
PAP3	0.22	0.50	0.57	0.49	0.57	0.29	**0.81**

Notes: CS = Cognitive Salience, BS = Behavioral Salience, ME = Mood Enhancement, ER = Emotional Relief, TOL = Tolerance, WIT = Withdrawal, IAP = Intrapersonal Problems, IEP = Interpersonal Problems, PAP = Professional and Academic Problems, REL = Relapse, LOC = Loss of Control.

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