Video Game Pursuit (VGPu) Scale Development: Designing and Validating a Scale with Implications for Game-Based Learning and Assessment

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Abstract

Background: Recent research on **game-based assessment** and **training** demonstrates growing interest in how individual differences affect game-based outcomes. However, there is still a lack of clarity about the variables that affect important game-based outcomes and issues with measurement approaches regarding these variables (e.g., no validation of scales). This study develops a model where **video game pursuit (VGPu)** is measured as an antecedent to entering the *gaming cycle* proposed by Garris et al. (2002). We propose that VGPu-related antecedents lead to a feedback loop where engaging in the *game cycle* affects game-related outcomes which again affect the antecedents of re-entering the *game cycle*. Moreover, we **validate a measure of VGPu** and provide construct as well as criterion validity evidence.

Methods: Within three studies (N = 716) we develop and validate the **VGPu** scale - a psychometrically sound measure of intentions to pursue video games. Using Amazon's MTurk (Studies 1, 2), participants responded to the **VGPu** items and we conducted exploratory and confirmatory factor analyses showing that **VGPu** consists of a general latent **VGPu** factor with four subfactors (Intentional Game Play, Generalized Game Self-Efficacy, Enjoyment of Games, Prone to Game Immersion). In Study 3, students responded to the **VGPu** items, to items examining construct validity, and played three video games from different genres to assess criterion validity of game performance and game reactions.

Results: Results demonstrate construct and criterion validity showing that **VGPu** correlates with other game-related scales and predicts game performance and game reactions.

Discussion: The findings demonstrate the value of the **VGPu** scale for research and practice because **pursuing video games** seems to be an important variable for predicting how individuals perform and react to game-based activities. Finally, we discuss implications for future research and practice in the realm of **game-based assessment** and **training**.

Keywords: Video Game Pursuit, Game-Based Assessment, Game-Based Training, Scale Development, Scale Validation

Introduction

There is growing interest in video games for purposes other than entertainment. This is especially prevalent in assessment and education (Mayer, 2019). Example applications of video games include teaching programming in schools (Shute, Rahimi, & Lu, in press) and training workplace-related skills (Sitzmann, 2011). Furthermore, researchers and companies (e.g., Arctic Shores, Owiwi) are promoting game-based assessments (e.g., for personnel selection), because they provide insights into people's actual behavior (Chamorro-Premuzic, Akhtar, Winsborough, & Sherman, 2017).

Consistent throughout research and practice is the belief that individual differences may account for variations in reactions to games, performance in games, and learning from games when using game-based approaches (e.g., Landers & Callan, 2011; Orvis, Horn, & Belanich, 2008). For instance, some people might enjoy games more than others (Calvillo Gámez, Cairns, Gow, Back, & Capstick, 2010), some people feel more immersed when playing video games (Fu, Su, & Yu, 2009), others have a high self-efficacy when playing games (Blair, 2011). These individual differences likely affect how much time people invest in video game activities, leading to more experience with video games. As a consequence of previous experience with games, seasoned players might perceive games differently (e.g., more satisfying) than inexperienced players (Wu, Wang, & Tsai, 2010) and might be more familiar with common controls, rules, and game-based behaviors (i.e., they have a schema for playing games; Lee & Faber, 2007) which may help them perform better in video games.

There are a variety of approaches to measuring individual differences that draw people towards games. Researchers have measured individual differences such as gender (Terlecki et al., 2011), enjoyment (Calvillo Gaméz et al., 2010), confidence in playing (Blair, 2011), time-based measures of game experience (Orvis et al., 2008), self-report measures of game experience (Schrader & McCreery, 2008), knowledge of games (Keebler, Jentsch, & Schuster, 2014; Singer, & Knerr, 2010), and performance in games (Greenfield, Brannon, & Lohr, 1994). However, many of the approaches were not validated (e.g., Blair, 2011) or provided only partial validation evidence (e.g., Schrader & McCreery, 2008).

We propose an expanded model of the *game cycle* (see Figure 1; Garris, Ahlers, & Driskell, 2002) that identifies the process of pursuing games, investing time in games, and the game-related outcomes this produces. In this model, video game pursuit (VGPu) consists of underlying individual differences that draw people towards video game activities. The current set of studies attempts to investigate the factor structure of VGPu and validates a measure of VGPu. We seek to provide evidence of this scale as a tool to indicate individuals who pursue video games and as a predictor of game-based outcomes (i.e., game reactions and performance).

In the following sections, we first present the theoretical model and a definition of VGPu and describe how individual differences impact game-based approaches. Following, we discuss the advantages and disadvantages of different approaches to capturing these individual differences, highlighting the need for a validated measure of VGPu. Afterwards, we present our scale development approach where we generated a pool of items and conducted three studies to investigate the dimensionality of the scale, its construct criterion validity.

Theoretical Background

Video Game Pursuit (VGPu) as an Antecedent to the Game Cycle

In their theoretical model of game-based training, Garris and colleagues (2002) used an Input-Process-Outcome framework showing that game characteristics and instructional content lead to a *game cycle* which produces learning outcomes. Figure 1 shows our modified model, based on their theoretical approach. We propose that people self-select into the *game cycle* based on a variety of antecedents (i.e., individual differences that draw people towards video game activities; Smyth, 2007). Involvement in the *game cycle* will lead to game-related outcomes (e.g., performance in games, reactions towards games). The feedback loop of this model is between the antecedents, the *game cycle*, and the outcomes of games, where individuals who pursue video game activities engage in the *game cycle*, and experience outcomes from those game activities (e.g., knowledge of games, positive reactions). These outcomes consequently lead back to the antecedents and further investment in the *game cycle* (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). Other researchers have discussed similar ideas that game-based outcomes may generate continued game playing behavior (e.g., Connolly et al., 2012; Fu et al., 2009). However, to our knowledge, this feedback loop structure between antecedents, *game cycle*, and game-related outcomes is novel.

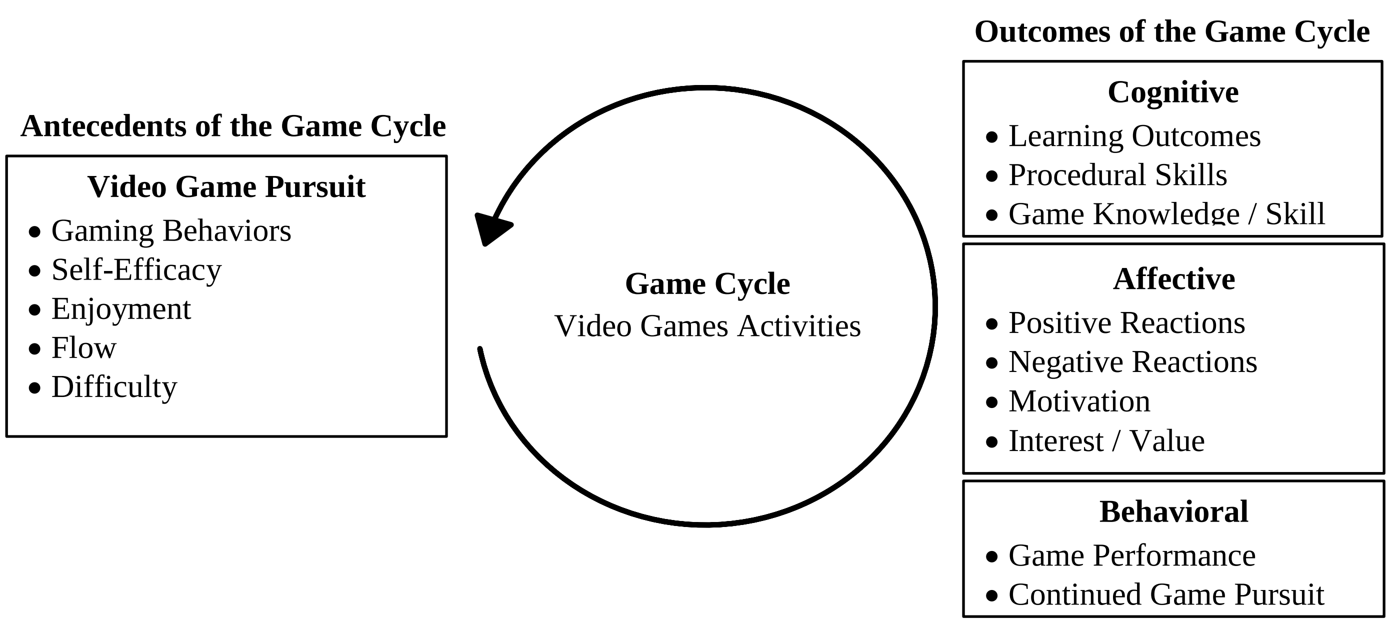

Figure 1. Game Cycle Model of Antecedents and Outcomes

We propose that VGPu is characterized by ***intentional pursuit of*** video game activities, ***confidence*** with game playing, an ***affinity*** towards video games, a tendency to experience ***flow*** with games, and a ***comfort*** with video game activities. This is not intended as a comprehensive list, but to represent characteristics most commonly used in previous research to measure individual differences towards gaming (e.g., Blair, 2011; Calvillo Gaméz et al., 2010; Fu et al., 2009; Schrader & McCreery, 2008). Based on the theoretical model, we propose that these characteristics draw people towards video game activities and into the *game cycle* which familiarizes them with video games, influences their reactions to games, and increases their expertise and ability to play games.

VGPu is conceptualized as a group of characteristics that lead to purposeful behaviors of pursuing video game activities (e.g., playing, observing, researching). Therefore, VGPu encompasses multiple characteristics which likely affect game outcomes in different ways. For instance, Enjoyment of Games could have implications for learning from video games (Koivisto & Hamari, 2014), whereas Generalized Game Self-Efficacy may explain gaming performance (Boot, Blakely, & Simons, 2011).

Note that previous research on game-based approaches has regarded previous game experience as one of the most important individual difference with regard to gaming (e.g., Landers & Armstrong, 2017; Orvis, Horn, & Belanich, 2006). Previous experience playing video games is implicitly reflected by the *game cycle* process of our theoretical model. However, we do not try to measure video game experience directly because of inherent challenges to measuring it in a manner that is both comprehensive (i.e., measures experience, knowledge, and skills across game genres, eras, and systems) and applicable to a given game-based assessment or training situation (e.g., predicts knowledge, skills, and experiences relevant to the specific application). Others have remarked on this challenge of measuring game-related differences given the, “wide variety of game genres and the complex, subjective and dynamic nature” of ideas related to games (Argenton et al., 2016, p. 241). Our goal is to develop a standardized measure to be used across various applications which is feasible using our theoretical approach to identifying individuals who pursue video game activities and engage in the *game cycle*.

Individual Differences Impact Game Reactions and Game Performance

Game reactions and Game performance are common metrics used in game-based research and practice (Wiebe, Lamb, Hardy, & Sharek, 2014). These measures can have important implications towards outcomes such as acceptance, learning, or future performance (Ben-Zvi, 2007; Lee, Jeong, Park, & Ryu, 2011; Pfeiffer & Motschnig, 2015). For game reactions, people who pursue games are generally attracted to games, tend to enjoy them and feel immersed in their gaming experiences. They may thus systematically differ in their perceptions of game-based approaches (Fu et al., 2009; Wu et al., 2010). In terms of game performance, individuals who intentionally enter the *game cycle*, may have more confidence and familiarity with common game mechanics (e.g., controls, rules, and strategies) making game challenges less demanding for them and allowing them to perform better in games (Lee & Faber, 2007).

Note that game-based assessments are intended to evaluate meaningful characteristics, making it important that the assessments are accurate and not contaminated by other factors (Terlecki et al., 2011). Similarly, game-based trainings intend to teach individuals about important knowledge and skills. Having a cognitive advantage of learning because of operating in a familiar environment may have important implications in high-stakes learning situations. Thus, capturing VGPu characteristics using a standardized and validated scale would make it possible to measure, understand, and control for unintended advantages certain individuals may have in game-based approaches.

Previous Approaches to Measure Individual Differences Regarding Gaming

Following, we present the advantages and issues with previous research approaches to measuring individual differences regarding gaming.

Gender Measures. There are consistent performance differences between men and women in games (Cassidy & Eachus, 2002; Ferguson, Cruz, & Rueda, 2008; Okagaki & Frensch, 1994; Terlecki et al., 2011) indicating that gender might work as a proxy measure for characteristics that differentiate people regarding games. However, this no reliable measure given evidence that having an opportunity to practice video game reduced this gender gap (Connolly et al., 2012). Using gender as an indicator of individual differences in games falsely generalizes that men are more likely than women to pursue games, have more game experience, respond more positively to games, and perform better in games.

Frequency Measures. Frequency measures are commonly used to indicate the time a player has spent in game (e.g., "*In a typical week, how many hours do you play video games?*"; Orvis et al., 2008). These time-based measures seem to be an efficient way to distinguish people regarding gaming, as they might capture how much time people have invested in the *game cycle* (Garris et al., 2002). However, it is important to consider the game genre (i.e., broad categories that distinguish gameplay, mechanics, and gaming conventions; Wolf, 2001). Different genres place different demands on players and familiarize them with different rules, goals, mechanics, and skills. Therefore, frequency measures might have different implications if a person plays different game genres. For example, time spent in a puzzle game, such as *Candy Crush*, may mean something different than time spent in a variety of genres. A further concern is that frequency measures only account for personal time spent in video games, ignoring other forms of time spent with gaming activities (e.g., reading materials, reviewing games, and watching others play). With the popularity of streaming platforms such as Twitch that allows viewers to watch others play video games and given research on observational learning, it is possible that passively watching others play video games can contribute to one's own video game self-efficacy (Bandura, Grusec, & Menlove, 1966) but watching others playing would not be reflected by frequency measures.

Knowledge Measures. Singer and Knerr (2010) tried to capture game knowledge by presenting game screenshots to participants and asking them questions such as, *"Which enemy are you currently attacking?"* Game knowledge may seem like a reasonable indicator of individual differences because it reflects individuals who have been in the *game cycle*. However, game knowledge measures to capture individual differences regarding games seem impractical because a universally useful measure would require comprehensive content, spanning game genres, eras of games, and various gaming platforms.

Performance Measures. Actual demonstration of game skills may indicate individuals who spend more time in the *game cycle*. In one example, Greenfield and colleagues (1994) had participants play a game and divided them into groups based on their scores. Although this is the most direct measure of pre-existing game skills, there are complications to this approach. Individual differences captured through gaming skills in one game might be genre specific. For instance, player's experienced with an ego-shooter game like *Battlefield* are likely attracted to other ego-shooter games like *Star Wars Battlefront* and could learn such games easily. Those who perform well in *Battlefield* will likely also perform well in *Star Wars Battlefront*. Genre specific performance measures make it difficult to predict game performance and game reactions for the game-based approach unless a custom-built pre-assessment was generated each time to match the genre of the game-based approach, which is not feasible.

Self-Report Measures of Antecedents. Most research has relied on self-report measures to capture individual differences related to games. In terms of benchmarking, the widespread use of self-report measures indicates they usually work as intended within the respective studies. For instance, Calvillo Gaméz et al., (2010) used a self-report measure for Game Enjoyment to compare different input devices for games, Fu et al. (2009) used a measure of game immersion to predict game enjoyment, and Schrader and McCreery (2008) used a measure of game experience with Massive Multiplayer Online Role Playing Games (MMORPGs) and showed that it was related to people's perceptions of their own gaming expertise.

However, there are two major drawbacks to most previously used self-report measures of individual differences regarding games. First, those measures focused on single constructs that relate to the antecedents of pursuing games (e.g., enjoyment; Calvillo Gaméz et al., 2010). This does not inform the potentially multidimensional character of VGPu. For instance, it remains unclear if enjoyment of games, a tendency to be immersed into games, and game self-efficacy all load on the same underlying general factor and what share of variance these measures predict for different game-related outcomes.

Second, there is a lack of validation evidence for these measures (e.g., Okagaki & Frensch, 1994). Some researchers rely on validation evidence from other contexts. For instance, Blair (2011) used a measure of video game self-efficacy and adapted this measure from general self-efficacy scales assuming that the measure will work within the context of video games. Furthermore, other validation attempts are based solely on qualitative interviews. For example, Calvillo Gaméz et al. (2010) used this approach which might lead to good content validity of the developed measure, but provides no information regarding construct or criterion validity. Additionally, there are validation approaches with initial but not sufficient validation information. For example, Schrader and McCreery (2008) rely on self-report measures for validation of their scale but neither provide evidence about relations to other constructs within the nomological network of gaming, nor any criterion validation (Hinkin, 1998). Finally, papers with stronger validation evidence often measure players' state-like experiences within games rather than defining gaming characteristics as an individual difference (e.g., Qin, Patrick Rau & Salvendy, 2009).

All things considered, there are challenges with many of the aforementioned approaches towards measuring individual differences that predict game-related outcomes. The most promising attempts were frequency measures and self-report measures regarding individual differences. However, these approaches a) might not account for genre specific variations regarding individual differences, b) might not comprehensively capture individual differences that draw people towards games, and c) might not at all or not sufficiently be validated. Given these challenges, we integrate previous findings and approaches to measuring individual differences regarding gaming and conduct three studies to validate a measure of video game pursuit based on our theoretical assumptions regarding VGPu.

Study 1: Item Development and Exploratory Factor Analysis

The purpose of Study 1 was to investigate item characteristics, and to explore the dimensionality of VGPu.

Item Development

First of all, the authors engaged in discussions with subject matter experts regarding their ideas of what draws people towards games.[1] To generate an item pool, the authors reviewed studies that included methods to capture individual differences regarding gaming or discussions regarding such individual differences and used these studies as a reference (e.g., Adomaityte, 2013; Blair, 2011; Brockmyer et al., 2009; Landers & Armstrong, 2017; Long, 2005; Singer & Knerr, 2010). Following the recommendations of Hinkin (1998) regarding item generation (e.g., simplicity of formulation) we generated a pool of 85 items trying to capture a comprehensive coverage of indicators that might draw individuals towards playing video games. This included adapting items from previous measurement attempts (Blair, 2011; Orvis et al., 2008; Schrader & McCreery, 2008). The authors then reviewed the items for quality, redundancy, and clarity leaving a pool of 61 items. Finally, we followed suggestions by Fabrigar, Wegener, MacCallum, and Strahan (1999) who proposed that researchers should have an initial idea of the factors that may arise in an exploratory factor analysis (EFA). Therefore, we grouped the items into categories of similarity based on our theoretical model (i.e., Intentional Game Play, Generalized Game Self-Efficacy [separated into Confidence in Ability, Ease of Play, and Learning Agility], Enjoyment of Games, Prone to Game Immersion, and Intimidation with Games).

Methods

All items were evaluated on a 5-point scale from 1 = *Strongly Disagree* to 5 = *Strongly Agree*. Participants provided their informed consent, demographic information and answered the VGPu items presented in a random order for each participant.

Previous research has suggested a 1:4 item to participants ratio for an EFA (Rummel, 1970). We therefore continued data analysis until we gathered a sample of 338 participants using

[1]We held informal conversations with subject matter experts to discuss the definitions, items, and categories used for developing this scale.

Amazons' Mechanical Turk (MTurkers; Buhrmester, Kwang, & Gosling, 2011). We removed data from 31 respondents for having incomplete surveys. A common problem with online surveys is insufficient effort participants take in responding (e.g., not reading properly; Huang, Curran, Keeney, Poposki, & DeShon, 2012). To account for this, we developed and included four Insufficient Effort Response (IER) items (Huang et al., 2012). A sample item was: "*I know the word 'Hello'.*" Responding S*trongly Disagree* or *Disagree* to this item indicated the participant did not read the item attentively. Item responses were dichotomized (0 = *attentive responding*, 1 = *insufficient effort responding*) and summed up. Participants with a score of over two for the attention items were excluded. Accordingly, we excluded 30 additional participants due to insufficient effort. The final sample consisted of 277 participants (68% male, 32% female) with an average age of 31 years (*SD* = 8.48). The ethnic distribution of the sample was 48% Caucasian, 4% Black, 7% Hispanic, 37% Asian, .5% Native American, .5% Hawaiian / Pacific Islander, and 3% Mixed Race. Participants were compensated $0.30 for completing the survey.

Results

An initial EFA was completed in SPSS to review information for item selection. Based on the Kaiser-Guttman criterion (eigenvalues over 1 constitute a factor; Kaiser, 1960), 9 factors could be extracted. Considering additional criteria for factor extraction (i.e., scree plot review, comparison to random data eigenvalues, see Horn, 1965) showed that 4 or 5 factors would be a better representation of the scale.

Following suggestions of Hinkin (1998), items were removed for loadings lower than .40 on the factors, for loading equally well onto different factors, and for item redundancy (i.e., reviewing residual correlations for each factor; McDonald & Ho, 2002). This resulted in 17 items being removed (4 items from Intentional Game Play, 3 items from Generalized Game Self-

Efficacy [Learning Agility section], 5 items from Enjoyment of Games, 1 item from Prone to Game Immersion, and 4 items from Intimidation with Games). A full list of dropped items is provided in the Supplementary Table 1 available online. This includes initial categorization and final factor loadings of remaining items from the 5-factor EFA model. The remaining 44 items loaded onto the same 5 factors as our predetermined categories with two variations (i.e., the three areas of Generalized Game Self-Efficacy [Confidence in Ability, Ease of Play, and Learning Agility] were combined, and the 5 negatively worded, reverse coded items in Learning Agility were moved to Intimidation with Games).

Study 2: Confirmatory Factor Analysis

The purpose of Study 2 was to confirm the factors identified in Study 1.

Methods

Participants gave their consent for participating and answered the 44 items in our scale on a 5-point scale from 1 = *Strongly Disagree* to 5 = *Strongly Agree*. Previous research suggested gathering data from at least 200 participants for a CFA (Hoelter, 1983) with increasing requirements when the number of items increases Hinkin (1998). We used Amazon's MTurk for data collection and gathered data from 300 people. Five participants were removed for taking less than one minute to complete the survey and three participants were removed for answering three or more of the IER items incorrectly (cf., Huang et al., 2012). The final sample consisted of 292 participants (65% male, 35% female) with an average age of 32 years (*SD* = 8.85). The ethnic distribution of the sample was 44% Caucasian, 7% Black, 6% Hispanic, 39% Asian, 3% Native American, .5% Hawaiian / Pacific Islander, and .5% Mixed Race. Participants were compensated $0.30 for completing the survey.

Results

The initial CFA (using SPSS AMOS) for Study 2 (having a latent VGPu factor with 5 subfactors) showed poor fit. Consequently, items were reviewed based on various criteria (i.e., < 1 variance, < .40 factor loading, loading equally well on different factors, and item redundancy). We removed items flagged in one or more of these areas. This resulted in 19 items being removed (1 item from Intentional Game Play, 12 items from Generalized Game Self-Efficacy, 1 item from Enjoyment of Games, 3 items from Prone to Game Immersion, and 2 items from Intimidation with Games). A full list of dropped items is provided in the Supplementary Table 2 available online.

A CFA with the remaining items demonstrated that all items loaded onto their respective factors (Table 1) and that four of the subfactors loaded onto a single latent VGPu factor with loadings of Intentional Game Play $\lambda = .84$, Generalized Game Self-Efficacy $\lambda = .97$, Enjoyment of Games $\lambda = .79$, and Prone to Game Immersion $\lambda = .68$. Results indicated that Intimidation with Games $\lambda = .18$ was not a subfactor of VGPu but instead a unique characteristic. Therefore, we removed the respective items for the CFA analyses and included them as a separate Intimidation with Games (IWG) scale for Study 3 (see Table 1).

Table 1.
Descriptives and Factor Loadings for the final set of items from the Confirmatory Factor Analysis in Study 2.

	M	*SD*	*Loading*
Video Game Pursuit (VGPu) Scale			
Intentional Game Play (IGP)			
I spend many hours each week playing video games.	3.55	1.15	.73
I have searched for information (e.g., magazine or websites) to improve my gaming skills.	3.70	1.17	.65
I plan to continue improving my video game skills.	3.84	0.94	.67
I am proactive in seeking ways to improve my video game skills.	3.67	1.10	.75
I deliberately seek out video games to play.	3.73	1.06	.71
I would call myself a *serious gamer*.	3.40	1.24	.74
Generalized Game Self-Efficacy (GSE)			
I am good at video games, compared to others.	3.72	1.02	.71
I am confident playing video games.	4.00	0.88	.77

I have good video game skills.	3.92	0.94	.78
I have a lot of experience with playing video games.	4.00	1.03	.73
Based on my knowledge of previous video games, I can easily see through the rules of a game.	3.86	0.96	.74
I can keep up with a video game that moves quickly.	3.85	0.97	.72
Enjoyment of Games (EOG)			
I enjoy playing video games.	4.32	0.76	.79
Video games are fun.	4.25	0.85	.74
I like playing video games.	4.22	0.85	.76
I think video games are entertaining.	4.28	0.85	.70
Prone to Game Immersion (PGI)			
I lose track of time when I play video games.	3.75	1.12	.52
When I play video games I lose track of my senses (e.g., can't tell if I am getting hungry or tired).	3.24	1.22	.49
I am fully immersed when I play video games.	3.92	0.96	.71
Intimidation with Games (IWG) Scale			
Video games are intimidating to me.	2.56	1.37	.81
I would need help to figure out the controls of a video game.	2.73	1.35	.79
Learning how to play a video game is confusing to me.	2.54	1.37	.83
I find video game rules confusing.	2.43	1.29	.79
It takes me a long time to understand the controls of a video game.	2.63	1.30	.76
I find it difficult to understand video games.	2.43	1.35	.81

Note. N = 292.

Using the four VGPu subfactors, we conducted a CFA and tested a model with one underlying VGPu factor. For this model (Model 1 in Table 2), all paths between VGPu and its subfactors as well as paths between the subfactors and their items were significant. We compared our hypothesized model to two alternative models, the first assuming a single underlying VGPu factor without subfactors, and the second assuming the subfactors are uncorrelated (i.e., no underlying VGPu factor). Overall, our hypothesized model represented the data significantly better than the other models regarding χ^2 statistics. Note that the χ^2 statistic is sensitive to sample size (Marsh, Balla, & McDonald, 1988), which is why we also considered other fit indices (see Table 2) which indicated an acceptable fit of Model 1 with $RMSEA < .06$, $CFI > .90$ (Hu & Bentler, 1999), whereas $GFI > .89$, and $AGFI > .86$ would not be interpreted as acceptable

(Bollen, 1990; Hu & Bentler, 1999; MacCallum, Browne, & Sugawara, 1996; MacCallum & Hong, 1997) but still reasonable fit (Doll & Xia, 1997; Doll, Xia, & Torkzadeh, 1994).

Table 2.
Model Fit Indices for the Hypothesized Model 1 and Alternative Models.

Model	$\chi^2(df)$	$\Delta\chi^2(df)$	*RMSEA*	*GFI*	*AGFI*	*CFI*
1. Hypothesize Four factor model	$313.32(148)^{**}$	- -	.06	.89	.86	.94
2. One-factor model	$599.01(152)^{**}$	$285.69(4)^{**}$	.10	.78	.72	.82
3. Orthogonal four factor model	$762.64(152)^{**}$	$449.32(4)^{**}$	.12	.78	.72	.76

Note. $\Delta\chi^2$ indicates difference between Model 1 and respective model. *RMSEA* = Root Mean Square Error of Approximation, *GFI* = Goodness-of-Fit Index, *AGFI* = Adjusted Goodness-of-Fit Index, *CFI* = Comparative Fit Index. *N* = 292.
$^{**}p < .01$.

Study 3: Scale Validation

The purpose of Study 3 was to validate the VGPu scale using a nomological net of expected convergence and divergence and to examine the criterion validity of the VGPu scale. Additionally, we provide validation evidence for the Intimidation with Games (IWG) scale that was removed as a subfactor of VGPu in Study 2.

Hypotheses Regarding Validation

Convergent Validity. Previous research has commonly used frequency measures to indicate individual differences regarding gaming and to predict game outcomes (e.g., Orvis et al., 2008). In our theoretical model, people who pursue video games are drawn to the *game cycle*, meaning frequency measures of playing games should correlate with our measure of VGPu. Based on this argument, VGPu is expected to correlate positively with playing video games (i.e., past and current) and the use of multimedia devices for video games (i.e., phones, computers, and gaming consoles).

Hypothesis 1a: The VGPu scale and its subfactors will positively correlate with time spent (i.e., past and current) playing video games.

Hypothesis 1b: The VGPu scale and its subfactors will positively correlate with time spent using multimedia devices for playing games (i.e., phone, computer, gaming console).

For construct validation, one would usually correlate existing and well-validated scales with a newly developed scale to understand the construct and its nomological network (Hinkin, 1998). However, there is a lack of psychometrically validated scales for video game research. For instance, the Core Elements of the Gaming Experience Questionnaire (CEGEQ) by Cavillo Gaméz et al. (2010) appears content and face valid but there was no further validation process in their study. The Video Game Self-Efficacy Scale by Blair (2011) is based on the Generalized Self-Efficacy scale (Schwarzer & Jerusalem, 1995) thus interpolating psychometric evidence from other self-efficacy scales. However, to the best of our knowledge, it was never psychometrically validated. For the Gamer's Experience measure by Schrader and McCreery (2008) there were construct and criterion validity approaches, however only based on self-report measures and only for the genre of Massive Multiplayer Online Role Playing Games (MMORPGs) which, as we stated before, might not transfer to other genres. Lastly, Fu et al., (2009) used the strongest scale validation approach (i.e., reliability and construct validity) for their measure of Game Immersion (i.e., a subscale from the Scale of EGameFlow) which captures state-like game immersion (i.e., immersion during gaming) compared to the trait-like Prone to Game Immersion characteristic of VGPu. However, there was also no clear criterion validation as recommended by Hinkin (1998).

Because no game-specific measures are available with rigorous validity evidence, we use the aforementioned scales to demonstrate convergence evidence of the VGPu scale since they appear face valid or conducted initial steps of scale validation. We predict that the overall VGPu score will be positively correlated to these measures of convergence. We also assume that the VGPu subfactors will correlate more strongly with scales that most closely relate to that subfactor (i.e., Intentional Game Play with Gamer's Experience, Schrader & McCreery, 2008; Generalized Game Self-Efficacy with Video Game Self-Efficacy, Blair, 2011, Enjoyment of Games with the Enjoyment subscale from the Core Elements of the Gaming Experience Questionnaire [CEGEQ], Cavillo Gámez et al., 2010; and Prone to Game Immersion with the Immersion Subscale from the Scale of EGameFlow, Fu et al., 2009).

Hypothesis 2a: The VGPu scale will positively correlate with measures of Game Experience, Game Self-Efficacy, Game Enjoyment, and Game Immersion.

Hypothesis 2b: The VGPu subfactors will correlate strongest with the convergence measures they are most closely matched to.

To expand the nomological net of VGPu and to demonstrate convergent validity using scales with stronger validation evidence, we propose that VGPu should relate to measures that capture people's attitudes towards computers such as Computer Self-Efficacy (i.e., the self-efficacy of using computers; Cassidy & Eachus, 2002) and Computer Anxiety (i.e., the fear of using computers or damaging them; Barbeite & Weiss, 2004). People with higher levels of VGPu may feel more comfortable using computers as they may be interacting with computers when playing video games. Yet, people do not only interact with computers for playing video games, and some players might only play video games on consoles or other devices. The relationship between VGPu and computer specific measures should be less pronounced compared to game specific measures.

Hypothesis 2c: The VGPu scale will positively correlate with Computer Self-Efficacy and negatively with Computer Anxiety. These correlations will be lower than the correlations with the game measures of convergence.

Divergent Validity. To demonstrate that VGPu is distinct from unrelated scales, we generated ideas about scales that should not correlate with VGPu. Since VGPu is a broad construct including affective, cognitive, and behavioral components, and as technology and games are a part of people's everyday lives, many constructs are potentially located, some in a more distal space, in the nomological network of VGPu. For instance, personality factors such as openness to experience and neuroticism might relate to VGPu and its subscales. After considering an extensive list of possible constructs, we identified two characteristics that should not belong to the nomological net of VGPu. These are Cultural Intelligence (i.e., knowledge of intercultural situations) and Situational Self-Awareness (i.e., current awareness of inner thoughts and feelings). We chose these constructs because they should not relate to individual differences that may draw someone towards video games or technology.

Hypothesis 3: The VGPu scale will not correlate with Cultural Intelligence or Situational Self-Awareness.

Criterion Validity. We believed that participants with higher VGPu will report more positive reactions to playing games. We argue that people with higher levels of VGPu might perceive games as less difficult due to their own familiarity and affinity with games and could be more satisfied with games. This is consistent with previous research which has discussed how a positive and enjoyable experience within a video game contributes to the player's ability and desire to play (Fu et al., 2009; Schrader & McCreery, 2008).

Hypothesis 4: The VGPu scale will predict game reactions (i.e., less Difficulty and more Satisfaction).

Most video games provide indicators of game performance (e.g., scores, points, achievements; Bedwell, Pavlas, Heyne, Lazzara, & Salas, 2012). It is likely that those with higher VGPu will demonstrate better game performance since VGPu is believed to indicate those who were in the *game cycle*, meaning those with higher VGPu will likely have greater experience, familiarity, knowledge, and skills related to playing video games. This will facilitate game performance.

Hypothesis 5: The VGPu scale will predict game performance.

The last step of our analysis will examine incremental validity of the VGPu subscales and IWG beyond the convergence game measures in predicting game reactions and game performance across three genres. This will indicate cases where different scales (e.g., VGPu scale versus other measures) and subfactors are most beneficial in predicting game reactions and game performance.

Method

G*Power (Faul, Erdfelder, Bucher, & Lang, 2009) was used to determine the number of participants needed to test the hypotheses. We assumed the relationship between VGPu and game performance would range from r = .20 to .25 which would require 97 to 153 participants for a power of $1\text{-}\beta = .80$.

Participants. Participants were students from a Western University (n = 125) in the US and a German University (n = 21). Participation was voluntary and all participants completed the study in exchange for course credit.

Procedures. Participants completed a consent form, provided demographic measures, responded to the VGPu scale, the IWG scale, and completed the measures for convergence and divergence listed in Table 3. Participants then played three video games (available at www.silvergames.com), each chosen for the unique game skills needed to do well in the game and because they represent a different genre (i.e., Arcade, Strategy, and Simulation; Qin et al., 2009). Each game was followed by a survey where participants reported their reactions to the game and their scores from the games. Participants received a debriefing on the purpose of the study before being dismissed.

Arcade Genre. In the first game, participants played an arcade game called *Curveball*. This game has a first-person perspective of a virtual racquetball court. The game is played moving the mouse around the screen to hit an oncoming ball to return it to the opponent. Participants earned points by returning the ball and for performing trick shots. After defeating the opponent, participants move to the next level where the difficulty increases (i.e., the ball moves faster). If participants miss too many balls, they see a *Game Over* screen after which their score was recorded and they were allowed to play the game again. They continued to play until the end of a ten-minutes time period. We chose Curveball because it demands hand-eye coordination and reaction time which previous research has shown can be improved through playing video games (Hogle, Widmann, Ude, Hardy, & Fowler, 2008).

Strategy Genre. In the second game, participants played a turn-based strategy game called *Highgrounds* for ten minutes. Participants started in a tutorial for the game which explained the rules and controls of the game. The goal of the game is to defeat the opponent's base (played by the computer). In each turn players buy men for their army who generate money, attack the opponent's base, or defend their own base. At the end of each turn the player's army does their corresponding action. When the health points of one base is depleted to zero, the other base wins. If the players lose they must restart the level. If players defeat their opponent, they advance to the next level where they face a more difficult opponent. We chose this game because it demands players to show their ability to learn and apply the rules and strategies of a strategy game.

Simulation Genre. In the third game, participants played a simulation game called *Arm Surgery 2*. Participants first played a tutorial explaining the rules and controls of the game. Afterwards, they played one round of surgery in the game. The goal is to operate on a fractured arm and complete several steps of the process within a timed portion of the game. Participants use the computer mouse to fulfill the steps of an arm surgery (e.g., making an incision along the arm). During the surgery, participants are under pressure to fulfill the steps in the correct order, and without making errors that would put the patient at risk (i.e. participants are confronted with the patient's heart rate monitor and a timer counting down). We chose this game because it required players to use precise movements with the computer mouse, required players to learn and apply knowledge from the tutorial in the timed surgery portion, and included a time pressure component.

Measures

The measures for this study were evaluated on a 5-point scale from *1 = Strongly Disagree* to *5 = Strongly Agree* unless otherwise stated. Convergence and divergence measures are provided in Table 3.

Video Game Pursuit. We used our 19-item Video Game Pursuit (VGPu) scale with four subscales; Intentional Game Play (i.e., intentional actions and behaviors taken by individuals to facilitate continued video game playing), Generalized Game Self-Efficacy (i.e., general confidence one feels towards their own abilities and skills at playing video games), Enjoyment of Games (i.e., the generally positive experience that an individual tends to feel through their interactions with a video game), and Prone to Game Immersion (i.e., the tendency to become immersed in a flow state when playing video games). The current data set produced a reliability of *a* = .94.

Intimidation with Games (IWG). We define Intimidation with Games as having a general sense of discomfort or confusion when playing video games. We measured this using our 6-item Intimidation with Games (IWG) scale. The current data set produced a reliability of *a* = .88.

Table 3.
Summary of Frequency Measures, Convergence Measures, and Divergence Measures in Study 3.

Measure	Number of Items	*a*	Scale	Source	Sample Item
Frequency Measures					
Past Hours - Gaming	1	- -	- -	Orvis et al., 2008	***In the past*** *what is the greatest average number of hours per week you have played video games? (enter value)*
Hours Spent - Gaming	1	- -	- -	Orvis et al., 2008	*On average, how many hours per week do you* ***currently*** *play video games? (enter value)*
Hours Spent - Devices	3	- -	- -	- -	*How many* ***hours*** *in a typical week do you play video games on each of the following devices?"* (phone, computer, gaming console) *(enter value)*
Game Convergence Measures					
Game Experience	15	.89	Gamer's Experience	Schrader & McCreery, 2008	*I understand the underlying game mechanics well (i.e., loot, combat, chat, etc.).*
Game Self-Efficacy	10	.93	Video Game Self-Efficacy	Blair, 2011	*Thanks to my resourcefulness, I know how to handle unforeseen situations in a video game.*
Game Enjoyment	3	.93	Core Elements of the Gaming Experience Questionnaire	Calvillo Gámez et al., 2010	*I would play this game again.*

			(CEGEQ) (Enjoyment subscale)		
Game Immersion	7	.88	EGameFlow	Fu et al., 2009	*I temporarily forget worries about everyday life while playing video games.*
Computer Convergence Measures					
Computer Self-Efficacy	4	.75	Computer Self-Efficacy (General Activities subscale)	Barbeite, 2004	*I feel confident making selections from an on screen menu.*
Computer Anxiety	4	.83	Computer Anxiety (Using computers subscale)	Barbeite, 2004	*Computers make me feel uncomfortable.*
Divergence Measures					
Cultural Intelligence	4	.76	Cultural Intelligence	Ang, 2007	*I check the accuracy of my cultural knowledge as I interact with people from different cultures.*
Self Awareness	3	.76	Self-Awareness	Govern, 2001	*Right now, I am self-conscious about the way I look.*

Criterion Measures. We gathered two types of measures to analyze the use of our scales for predicting individual game outcomes across three genres of games. This included two measures of game reactions and three measures of game performance.

Game Reactions. We evaluated player's reactions using two subscales from the User Engagement Scale (Wiebe et al., 2014). This included Perceived Difficulty (7 items, *a* = .83, sample item *"Using the game was mentally taxing."*) and Satisfaction (7 items, *a* = .93, sample item *"Playing the game was worthwhile."*; O'Brien & Toms, 2010). For the Perceived Difficulty subfactor, 1 item was dropped because it did not make sense within the current study.

Game Performance. The games provided metrics that were used to calculate a game performance score for each genre. In the Arcade Genre participants completed the game multiple times, receiving a final score each time they reach the *Game Over* screen. The Arcade Genre score was calculated as the average of all final scores the participants received. For the Strategy Game, participants progressed through levels, maintaining their own points and depleting their opponent's points. The Strategy Genre Score was calculated as the total number of remaining points retained across all levels minus the opponent's remaining points. In the Simulation Genre, participants completed a timed surgery task. For the Simulation Genre we used the game provided final score which was points earned for completing the tasks quickly with a deduction for each error made during the timed task. Because each score was on its own scale, we transformed the scores into z-scores to standardize interpretation across game genres.

Results

The final sample consisted of 146 undergraduate students (69% female, 31% male) with an average age of 24 years (*SD* = 4.69). The ethnic distribution of the sample was 37% Caucasian, 29% Hispanic, 14% Asian, and 20% Mixed Race. The study took participants 1 hour to complete for which they were compensated with class credit. The correlations of the VGPu subfactors, study demographics, and IWG can be found in Table 4.

Table 4.
Descriptives and Correlations for Demographic Measures, VGPu Scale with Subfactors, and Intimidation with Games Scale from Study 3.

	M	*SD*	1	2	3	4	5	6	7	8
1. Age	23.68	4.69	- -							
2. Gender	- -	--	.07	- -						
3. IGP	2.18	1.00	-.10	.51**	**.91**					
4. GSE	2.80	0.99	-.03	.55**	.83**	**.93**				
5. EOG	3.75	0.97	-.17*	.31**	.69**	.65**	**.94**			
6. PGI	2.86	0.96	-.01	.35**	.53**	.54**	.63**	**.78**		
7. VGPu Total	2.81	0.86	-.09	.52**	.93**	.92**	.84**	.72**	**.96**	
8. IWG	2.59	0.87	<.01	-.42**	-.67**	-.75**	-.45**	-.38**	-.69**	**.88**

Note. Gender: 0 = Female, 1 = Male. Bolded items along the diagonal display Cronbach's α reliability. IGP = Intentional Game Play, GSE = Generalized Game Self-Efficacy, EOG = Enjoyment of Games, PGI = Prone to Game Immersion, VGPu = Video Game Pursuit, IWG = Intimidation with Games. *N* = 146.
$^{*}p < .05$, $^{**}p < .01$

Construct Validity. Hypothesis 1a and 1b proposed the VGPu scale and its subfactors would be positively correlated with frequency measures of hours spent playing video games and hours spent using multimedia devices for playing video games. With the exception of hours spent playing games on a phone, these frequency measures all correlated significantly with the

VGPu scale, its subfactors, and the IWG scale; ranging from $r = .19$ to .75, predominantly supporting Hypotheses 1a and 1b.

Hypothesis 2a suggested that the VGPu scale and its subfactors would be positively correlated with other game measures. All were significantly related in the expected directions ranging from $r = .40$ to .92 (see Table 5), supporting Hypothesis 2a.

Hypothesis 2b proposed that the VGPu subfactors would be correlated strongest with a matched measure. Descriptively, all subfactors converged strongest with the predicted matched measure (Table 5). Using the R package cocor (Diedenhofen & Musch, 2015) and Zou's (2007) confidence interval for calculating significance tests, we compared the overlapping dependent correlation coefficients[2]. All VGPu subfactors had a significantly stronger relationship to their matched measure than all other subfactor relationships with two exceptions. First, the VGPu subfactor Intentional Game Play did not significantly correlate stronger with its matched measure than Generalized Game Self-Efficacy. Second, the VGPu subfactor Prone to Game Immersion did not correlate stronger with its matched measure than Enjoyment of Games. This predominantly supports Hypothesis 2b, demonstrating that matched convergence measures correlated strongest with the subfactor most similar in content.

Table 5.
Correlations between the VGPu Scale with Subfactors and IWG Scale with other validation measures from Study 3.

			Video Game Pursuit Scale					
	M	*SD*	IGP	GSE	EOG	PGI	Total	IWG
Frequency Measures								
Past Hours - Gaming	11.86	14.45	.69**	.67**	.46**	.37**	.68**	-.54**
Hours Spent - Gaming	3.27	6.28	.75**	.65**	.47**	.27**	.67**	-.49**
Hours Spent - Phone	1.74	5.11	.35**	.25**	.27**	.06	.29**	-.19*
Hours Spent - Computer	1.53	5.46	.35**	.28**	.22*	.19*	.32**	-.26**
Hours Spent - Console	1.32	3.56	.52**	.48**	.37**	.26**	.50**	-.43**

[2]For space we have not included the results of these significance tests. They can be made available upon request.

Convergence Measures								
Game Measures								
Game Experience	2.67	0.70	**.83****	.78**	.69**	.58**	.85**	-.58**
Game Self-Efficacy	3.11	0.80	.71**	**.84****	.69**	.58**	.83**	-.64**
Game Enjoyment	3.69	1.09	.62**	.59**	**.92****	.55**	.76**	-.40**
Game Immersion	2.87	0.88	.60**	.56**	.68**	**.75****	.72**	-.40**
Computer Measures								
Computer Self-Efficacy	2.81	0.87	.22**	.34**	.11	.10	.25**	-.28**
Computer Anxiety	1.57	0.60	-.23**	-.39**	-.30**	-.28**	-.35**	.36**
Divergence Measures								
Cultural Intelligence	4.07	0.56	-.01	.07	.01	.06	.04	-.03
Self-Awareness	4.00	0.78	.05	.04	.09	-.03	.05	.05
Criterion Measures								
Game Performance								
Arcade Game	.45	.19	.48**	.48**	.41**	.24**	.49**	-.49**
Strategy Game	.65	.18	.19*	.22**	.16*	.03	.19*	-.26**
Simulation Game	.56	.23	.22**	.27**	.28**	.16	.27**	-.22**
Game Reactions								
Perceived Difficulty								
Arcade Game	2.19	0.65	-.28**	-.42**	-.28**	-.14	-.35**	.34**
Strategy Game	2.67	0.92	-.30**	-.38**	-.22**	-.14	-.33**	.36**
Simulation Game	2.21	0.69	-.10	-.21*	-.19*	-.04	-.16*	.26**
Satisfaction								
Arcade Game	2.97	0.88	.17*	.13	.28**	.17*	.21*	.01
Strategy Game	2.71	1.02	.34**	.32**	.35**	.29**	.38**	-.11
Simulation Game	3.15	0.99	.03	$<$.01	.18*	.10	.07	.04

Note. Bolded variables demonstrate matched convergence measures hypothesized to correlate strongest with the most similar VGPu subfactor. IGP = Intentional Game Play, GSE = Generalized Game Self-Efficacy, EOG = Enjoyment of Games, PGI = Prone to Game Immersion, IWG = Intimidation with Games. Game Performance scores were converted to percentages for this table. $N = 146$.
$^{*}p < .05$, $^{**}p < .01$

Hypothesis 2c suggested that VGPu would be positively correlated with Computer Self-Efficacy and negatively with Computer Anxiety and that these correlations will be lower compared to the correlations with game measures of convergence. The first part of this hypothesis was partially supported. Computer Anxiety was significantly related to the VGPu scale and its subfactors with correlations ranging from $r = -.23$ to $-.39$. Computer Self-Efficacy however, was only significantly correlated with VGPu overall ($r = .25$, $p < .01$), with Intentional

Game Play ($r = .22$, $p < .01$), and Generalized Game Self Efficacy ($r = .34$, $p < .01$), but not with Enjoyment of Games ($r = .11$, *ns*) and Prone to Game Immersion ($r = .10$, *ns*). Applying the same procedure for significance testing before, correlations between the total VGPu scale with Computer Anxiety as well as Computer Self-Efficacy were significantly lower than correlations between total VGPu and all of the game convergence measures, supporting the second part of Hypothesis 2c.

Hypothesis 3 proposed that VGPu and its subfactors would not be correlated with the divergence measures. All relationships were non-significant supporting Hypothesis 3.

Criterion Validity. Correlations between the VGPu subfactors and criterion outcomes are provided in Table 5.

Hypothesis 4 suggested that the VGPu scale and its subfactors will predict game reactions. We calculated regressions to explore these findings for game reaction to each individual game genre and for the subscales of VGPu. Tables 6 and 7 show the results. The VGPu subfactors predicted Perceived Difficulty for all game genres with the VGPu subfactor Generalized Game Self-Efficacy being the best predictor. The VGPu subfactors also predicted Satisfaction for the Arcade genre and the Strategy genre games (i.e., not for the Simulation genre game), with the VGPu subfactor of Enjoyment with Games being the best predictor. These results predominantly support Hypothesis 4.

Table 6.
Hierarchical Regression Predicting Game Reactions of Perceived Difficulty.

	Perceived Difficulty					
	Arcade Genre		Strategy Genre		Simulation Genre	
Video Game Pursuit Scale						
Intentional Game Play	.23	.25	.01	.05	.31*	.36*
	(.15)	(.15)	(.15)	(.15)	(.16)	(.15)
Generalized Self-Efficacy	-.60**	-.53**	-.43**	-.31	-.39**	-.20
	(.14)	(.16)	(.14)	(.16)	(.15)	(.17)
Enjoyment of Games	-.14	-.15	-.00	-.02	-.25*	-.28*
	(.12)	(.12)	(.12)	(.12)	(.12)	(.12)
Prone to Game Immersion	.14	.14	.09	.08	.17	.16
	(.10)	(.10)	(.10)	(.10)	(.11)	(.10)
Intimidation with Games Scale		.10		.18		.28*
		(.12)		(.12)		(.12)
F ΔR^2	-	0.73 (1.139)	-	2.42 (1,140)	-	5.48* (1, 140)
R^2	.20	.20	.15	.16	.09	.12
F Model	8.76** (4, 140)	7.14** (5, 139)	6.13** (4, 141)	5.43** (5, 140)	3.49** (4, 141)	3.98** (5, 140)

Note. Variables were z-standardized. $N = 146$.
$^{*}p < .05$, $^{**}p < .01$

Table 7.
Hierarchical Regression Predicting Game Reactions of Satisfaction.

	Satisfaction					
	Arcade Genre		Strategy Genre		Simulation Genre	
Video Game Pursuit Scale						
Intentional Game Play	.06	.11	.13	.19	-.05	-.04
	(.16)	(.16)	(.15)	(.15)	(.16)	(.16)
Generalized Self-Efficacy	-.13	.03	.06	.25	-.18	-.14
	(.15)	(.17)	(.14)	(.16)	(.15)	(.17)
Enjoyment of Games	.31*	.29*	.16	.14	.31*	.31*
	(.12)	(.12)	(.12)	(.12)	(.13)	(.13)
Prone to Game Immersion	.01	.00	.09	.08	.02	.02
	(.11)	(.11)	(.10)	(.10)	(.11)	(.11)
Intimidation with Games Scale		.23		.29*		.06
		(.12)		(.12)		(.13)
F ΔR^2	-	3.52 (1, 139)	-	6.27* (1, 140)	-	0.19 (1, 140)
R^2	.08	.10	.15	.18	.06	.06
F Model	3.11* (4, 140)	3.24** (5, 139)	6.05** (4, 141)	6.27** (5, 140)	2.14 (4, 141)	1.74 (5, 140)

Note. Variables were z-standardized. $N = 146$.
$^{*}p < .05$, $^{**}p < .01$

Hypothesis 5 proposed that the VGPu scale and its subfactors will predict game performance across the three genres of video games. We therefore conducted a regression (see Table 8). The VGPu subfactors significantly predicted game performance for all game genres. This supports Hypothesis 5.

Table 8.
Hierarchical Regression Predicting Game Performance.

	Game Performance					
	Arcade Genre		Strategy Genre		Simulation Genre	
Video Game Pursuit Scale						
Intentional Game Play	.19	.13	.02	-.02	-.12	-.14
	(.14)	(.14)	(.16)	(.16)	(.15)	(.16)
Generalized Self-Efficacy	$.27^{*}$	.08	.22	.08	.25	.20
	(.13)	(.15)	(.15)	(.17)	(.15)	(.17)
Enjoyment of Games	.18	.21	.11	.13	.23	.24
	(.11)	(.11)	(.12)	(.12)	(.12)	(.12)
Prone to Game Immersion	-.12	-.11	-.17	-.17	-.06	-.05
	(.10)	(.09)	(.11)	(.11)	(.11)	(.11)
Intimidation with Games Scale		$-.28^{**}$		-.21		-.08
		(.11)		(.12)		(.12)
$F\ \Delta R^2$	-	6.91^{**} (1, 140)	-	2.92 (1, 140)	-	0.37 (1, 140)
R^2	.27	.30	.07	.09	.10	.10
F Model	12.91^{**} (4, 141)	12.14^{**} (5, 140)	2.47^{*} (4, 141)	2.58^{*} (5, 140)	3.78^{**} (4, 141)	3.08^{*} (5, 140)

Note. Variables were z-standardized. $N = 146$.
$^{*}p < .05$, $^{**}p < .01$

Analyses for Intimidation with Games. Findings for IWG were consistent with those for VGPu. IWG was significantly negatively correlated with VGPu and all subfactors (Table 4). It also significantly correlated with the convergence measures and was not significantly related to the divergence measures (Table 5). The zero-order correlations of IWG indicated that it was significantly related to the game reaction Perceived Difficulty but not Satisfaction. We included IWG as a last step for all hierarchical regressions predicting game reactions and game performance (see Tables 6-8). When including the VGPu scales as a first step and IWG as a second, IWG showed incremental validity regarding Perceived Difficulty for the Simulation genre game and improved the prediction of Satisfaction for the Strategy genre game. Regarding game performance, including IWG significantly increased R^2 for the Arcade genre game. Results demonstrated that there are instances where the IWG scale predicts a significant unique portion of variance beyond the VGPu scale.

Comparing Predictions of Game Performance. We compared the predictive validity of game reactions and performance using the VGPu scale and subfactors and using other measures of individual differences regarding games. For this purpose, we calculated hierarchical regressions, first including gender (cf., Terlecki et al., 2011) and one other measures (i.e., current hours spent gaming, Game Experience, Game Self-Efficacy, Game Enjoyment, Game Immersion). In the second step, we included the four subfactors of VGPu. In the third step we included IWG. This resulted in 15 regressions for game performance outcomes (i.e. three game genres and five measures) and 30 regressions for the game reactions. For brevity's sake, we report these results in the Supplementary Material 2 online and provide a summary of the regression results in Table 9.

Table 9.

Summary Statistics (ΔR^2 and a note on the best predictor in the respective model) of the Regression Results for Predicting Game Performance, Perceived Difficulty and Satisfaction through the VGPu Scales and IWG above the Convergence Measures.

	Game Performance						Game Reactions Perceived Difficulty						Game Reactions Satisfaction					
	Arcade Genre		Strategy Genre		Simulation Genre		Arcade Genre		Strategy Genre		Simulation Genre		Arcade Genre		Strategy Genre		Simulation Genre	
	VGPu ΔR^2 BP	IWG ΔR^2 BP	VGPu ΔR^2 BP	IWG ΔR^2 BP	VGPu ΔR^2 BP	IWG ΔR^2 BP	VGPu ΔR^2 BP	IWG ΔR^2 BP	VGPu ΔR^2 BP	IWG ΔR^2 BP	VGPu ΔR^2 BP	IWG ΔR^2 BP	VGPu ΔR^2 BP	IWG ΔR^2 BP	VGPu ΔR^2 BP	IWG ΔR^2 BP	VGPu ΔR^2 BP	IWG ΔR^2 BP
Frequency	.12**	.02*	.12**	.01	.13**	.00	.17**	.00	.10**	.01	.10*	.02	.05	.03	.15**	.04*	.07	.00
	GSE	**IWG**	**GSE**	G	**GSE**	**GSE**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**EOG (-)**	**EOG (-)**	**EOG**	**EOG**	**GSE**	**GSE**	**EOG**	**EOG**
E	.04	.03*	.06	.02	.04	.01	.11**	.00	.12**	.01	.05	.03*	.03	.02	.04	.03	.04	.00
	E	**IWG**	E	E	**GSE**	**GSE**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**IGP (-)**	E	E	E	E	**GSE (-)**	**GSE (-)**
I	.09**	.03**	.07*	.02	.06*	.00	.16**	.00	.14**	.02	.09*	.03*	.08*	.01	.12**	.03*	.11**	.00
	GSE	**IWG**	**GSE**	**IWG**	**GSE**	**GSE**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**IGP (-)**	**EOG**	**EOG**	**IGP**	**IGP**	**EOG**	**EOG**
X	.07*	.03*	.04	.02	.04	.00	.13**	.00	.07*	.02	.09*	.03*	.07*	.02	.02	.03*	.06	.00
	GSE	**IWG**	X	X	**GSE**	**GSE**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	E (-)	**EOG**	**EOG**	X	**IWG**	**EOG**	**EOG**
S	.05	.03*	.04	.02	.01	.00	.09**	.00	.06	.01	.05	.02*	.07*	.02	.05	.03*	.06	.00
	IGP	**IWG**	S	S	**GSE**	**GSE**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**GSE (-)**	**IGP (-)**	**EOG**	**EOG**	**IGP**	**IGP**	**EOG**	**EOG**

Note. Calculations based on hierarchical regression with Gender first, then convergence measures, then VGPu subscales and IWG. VGPu = Video Game Pursuit, IWG = Intimidation with Games, BP = Best Predictor in the Model. Bolded values highlight when VGPu subscales or IWG were the best predictor.

VGPu subfactors include: IGP = Intentional Game Play, GSE = Generalized Game Self-Efficacy, EOG = Enjoyment of Games.

Other measures include: G = Gender, E = Game Enjoyment (Calvillo Gaméz et al., 2011), I = Game Immersion (Fu et al., 2009), X = Game Experience (Schrader & McCreery, 2008), S = Game Self-Efficacy (Blair, 2011), (-) = best predictor was negatively related to respective outcome.

For the Arcade genre game, the VGPu subfactors and IWG significantly improved the prediction of game performance above all other measures and IWG was the best predictor in the full models. For the Strategy genre game, the VGPu subfactors significantly improved the prediction of game performance above the frequency measure and Game Immersion but not above Game Enjoyment, Game Experience, and Game Self-Efficacy. The best predictors in these models varied. For the Simulation genre game, the VGPu subfactors significantly improved the prediction of game performance above the frequency measure and above Game Immersion but not above Game Enjoyment, Game Experience and Game Self-Efficacy. The VGPu subfactor Generalized Game Self-Efficacy was the best predictor in all models.

Regarding Perceived Difficulty, adding the VGPu subfactors significantly increased the explained variance for the Arcade genre game above all other measures with the VGPu subfactor Generalized Game Self-Efficacy being the best predictor in all models. Similar results arose for predicting Perceived Difficulty for the Strategy genre game. However, there was no significant improvement in prediction above the other measure of Game Self-Efficacy (Blair, 2011). For the Simulation genre game, adding the VGPu subfactors and IWG improved prediction above all other measures. The best predictor varied between the VGPu subfactors Game Enjoyment, Generalized Game Self-Efficacy, and Intentional Game Play being the best predictors in various models.

Regarding Satisfaction, adding the VGPu subfactors significantly improved the prediction for the Arcade genre game above other measures of Game Immersion, Game Experience, and Game Self-Efficacy but not for the frequency measure and Game Enjoyment. The VGPu subfactor Enjoyment of Games was the best predictor in all models except when the other measure of Game Enjoyment (Calvillo Gaméz et al., 2010) was included. For the Strategy genre game, adding the VGPu subfactors and IWG significantly improved prediction above frequency measures, Game Immersion, and Game Experience but not above Game Enjoyment and Game Self-Efficacy with various scales being the best predictors in different models. For the Simulation genre game, adding the VGPu subscales improved prediction above Game Immersion only and the best predictors in most of the models was the VGPu subscale Enjoyment of Games.

To conclude, the VGPu subfactors and IWG led to incremental validity for game reaction and game performance outcomes in a variety of cases. Furthermore, the VGPu subfactors and IWG seem to be the best predictors in most of the models. However, there are instances where adding the VGPu subfactors and IWG did not lead to significant increases in R^2 and where other game-related scales capture a larger share of the variance.

Discussion

The current study proposed a theoretical model regarding how individual differences influence the *game cycle* and game-related outcomes. Through a set of three studies we found that Video Game Pursuit (VGPu) is an individual characteristic with the subfactors Intentional Game Play, Generalized Game Self-Efficacy, Enjoyment of Games, and Prone to Game Immersion. Considering these subfactors in future studies might advance research and practice using video games for assessment and training purposes. The validation approach followed rigorous psychometric guidelines by Hinkin (1998) and supported construct and predictive validity of the VGPu scale. As a by-product, we developed and validated the Intimidation with Games (IWG) scale as an indicator of individuals who are more likely to avoid the *game cycle*. This scale showed promising psychometric properties and additional value for the prediction of reactions to and performance in games above the VGPu scale in some circumstances. Finally, Study 3 compared the VGPu and IWG scale to other existing game-related measures and offers an overview of strengths and weaknesses of the different measures of predicting reactions to and performance in games. Future research can build on the theoretical model of this study and the findings using two scales which a) showed good reliability, b) fit into a comprehensive nomological network of measures related to video games, use of multimedia for games, and comfort interacting with computers, and c) predicted game reactions and game performance.

Theoretical Implications

The results of Study 3 suggest that it might not be enough to measure frequency of gaming (Orvis et al., 2008) or single factor that draw people towards gaming. Specifically, frequency measures showed lower predictive value concerning game performance compared to the VGPu scale. This implies that playing video games for a long time might not predict game outcomes. Further, other single facets of VGPu, such as enjoyment or immersion, might not be sufficient for predicting game performance considering the findings that VGPu is a multifaceted construct. In a similar vein, we found that people who pursue video games seem to develop beneficial knowledge and skills through previous *game cycles* which transferred to the game genres tested in Study 3. This supports our theoretical proposal that VGPu may predict individuals' continuous involvement in the *game cycle* which in turn affects game-related outcomes.

We also provided results for a measure of Intimidation with Games (IWG). In Study 2 our results indicated that IWG was a separate but related factor to VGPu. Specifically, IWG could be another antecedent in our model that, in comparison to VGPu, is more related to negative attitudes or negative experiences with games. In the theoretical background, we focused on the positive experiences within the *game cycle* that can affect game-related outcomes. Similarly, negative experiences in the *game cycle* (e.g., overwhelmed with controls, poor performance, hostile interactions with other players) might inhibit people from the *game cycle*. The results imply that adding IWG can improve the prediction of game reactions and game performance. This might speak in favor of the aforementioned assumption that people can possess negative feelings towards games that can detrimentally affect game outcomes. People with high levels of IWG are intimidated by games, confused by controls, would likely enjoy game-based approaches less, may be disadvantaged in gaming contexts, and may leave the *game* *cycle* with increased negative attitudes and beliefs about games. Thus, the positive feedback loop of VGPu and involvement in the *game cycle* could be translated as a negative feedback loop of IWG and avoiding the *game cycle*.

Furthermore, the regression results regarding game reactions and game performance measures revealed that the VGPu subfactors may contribute differently to the explained variance in different game-related outcomes. For instance, the VGPu subfactor Generalized Game Self-Efficacy was a strong predictor in the case of game performance, whereas the VGPu subfactor Enjoyment of Games was a strong predictor of game reactions. This indicates that (like with all research) it makes sense to derive solid theoretical assumptions why a subfactors of VGPu should relate to certain outcomes.

Additionally, the current studies showed that VGPu predicts reactions to games. These findings support our definition of VGPu as those who pursue video games perceived the games to be easier to play (potentially demonstrating accumulated experience with games, Orvis et al., 2008), and were more satisfied with the games (potentially showing a stronger affinity for video games).

Most importantly, the results of the current set of studies might have important implications for game-based assessment and training. Within game-based assessment, players who are prone to pursuing and playing video games potentially have advantages. The opposite is true for people expressing a high level of IWG. If an organization uses video games for assessment or training purposes (e.g., serious games; Chamorro-Premuzic et al., 2017), there might be unwanted advantages for those who pursue video games as it seems plausible that they can transfer their prior experience with video games and benefit from their attitudes towards games (e.g., enjoyment, self-efficacy) in assessments or trainings in a game context. In settings where games are used for learning, this could mean that people with lower VGPu could be left behind. More precisely, lower VGPu people might struggle with training games, which potentially leads to negative reactions (cf., the results of Study 3 for Perceived Difficulty and Satisfaction with games) and lower learning from games (Pekrun, Elliot, & Maier, 2009). In sum, VGPu could affect the central outcomes when using game-based approaches for training and assessment: acceptance of these approaches, as well as learning from and performance in these approaches.

Limitations

First, there were high correlations between the VGPu scale and other game-related scales. This is understandable as some of the items used for generating the item pool for the VGPu scale were based on previous definitions and measures. One could argue that the VGPu scale does not measure anything beyond other scales. However, most subfactors of the VGPu scale did not extensively correlate with other game-related scales speaking in favor of separate constructs on the level of subfactors. Additionally, certain other scales were developed for specific game genres (e.g., MMORPGs, Schrader & McCreery, 2008), for state-like experiences within games (e.g., Fu et al., 2009) whereas our scale is designed for use across video games. Furthermore, the VGPu scale and the other scales differed in their prediction of game performance across the different game genres (i.e., for certain games the VGPu subfactors showed higher validity, for others the measure of Game Self-Efficacy by Blair, 2011).

Second, the video games in Study 3 were entertainment games not designed for educational or assessment purposes. Therefore, performance within these games might be different than performance within games designed for assessment or educational purposes. Furthermore, participants were not in a real assessment situation. Therefore, we cannot say that the VGPu scale can validly predict advantages for people who pursue video games in high stake assessment situations. However, we found that those people performed better in games they have never played before, possibly implying faster learning of new games and transfer from prior experience with video games.

Third, all games were PC-based and mouse-controlled. Based on the current results we cannot conclude if the scales predict game performance in controller-based games or in highly-immersive VR games[3].

Implications for Practice

Within assessment situations based on video games, the VGPu scale might be useful to clarify potential advantages for those who pursue video games. If VGPu benefits some people during assessment situations, it is important to consider how to account for this prior to deploying the game-based assessment. The same applies to an educational setting. If people with high VGPu learn better from serious games or enjoy them to a greater extent, caution must be taken when using serious games for learning purposes (Landers & Armstrong, 2017). Furthermore, our results imply that the VGPu scale could be used in the multi-million-dollar economic branch of game development (Marchand & Henning-Thurau, 2013). Specifically, practitioners in this area could apply the VGPu and IWG scales to assess test players and analyze if the newly developed game is only appreciated by only those who really pursue video games (i.e. serious gamers) or also by people from all levels of VGPu.

Future Research

This study might open several areas for future research. First, researchers could use the scale in practical learning and assessment settings with serious games and a variety of different

[3]In two other studies using controller-based and VR-based games, we measured both VGPu and IWG. In both studies VGPu and IWG predicted game-scores. Both studies are currently in preparation for submission.

game environments (e.g., VR games) to see if VGPu affects outcomes (e.g., learning). Second, the model we proposed in the theoretical background was meant to expand Garris et al.'s (2002) game cycle by theorizing what characteristics draw people towards engaging in the game cycle and how experiences in the game cycle relate to those characteristics and to game-based outcomes. The current study did not formally test its paths and boundary conditions, thus this could be a fruitful area for future research. For instance, we proposed a feedback loop between game performance and video game pursuit. However, it is not yet clear if this feedback loop might be affected by, for instance, the difficulty level of games, which could constitute a moderator variable (e.g., difficult games lead to pronounced increases in game self-efficacy). Moreover, we need to highlight that our list of variables that make people prone of engaging in the game cycle is probably not exhaustive. There might be more individual factors that drive people towards or away from games. For instance, as competitiveness and cooperation are crucial parts of many games (Peng & Hsieh, 2012), people's trait competitiveness and cooperation might be factors that draw them towards certain genres or games. Additionally, trying to predict game performance and reactions towards games using a generalized scale (such as most common scales, including our own) likely ignores the fact that video games (and genres) are very diverse. For instance, there might be even more predictive potential when adapting subscales such as Generalized Game Self-Efficacy or Game Enjoyment to specific genres.

Conclusion

Game-based training and assessment is booming and playing video games has become more professionalized and monetized (Marchand & Henning-Thurau, 2013). Thus, the importance of research investigating individual differences that relate to game-based outcomes will likely increase. This study introduced a theoretical model regarding antecedents and outcomes of engaging in the game cycle, a definition for VGPu, developed, tested, and validated the Video Game Pursuit scale as well as the Intimidation with Games scale and found that VGPu and IWG affect people's reactions to and performance in games. Hopefully, this study and resulting scales inspire further research to understand the differences between *serious gamers, casual gamers*, as well as *non-gamers,* the implications of individual differences within game-based contexts and proves useful in a variety of game-related contexts.

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