A Chinese-Language Validation of the Video Game Demand Scale (VGDS-C)

Measuring the Cognitive, Emotional, Physical, and Social Demands of Video Games

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ABSTRACT

Video games are engaging multimedia experiences that require players' cognitive, emotional, physical (in terms of controllers and exertion), and social faculties. Recent theorizing has suggested that these dimensions of demand can explain processes by which players engage with and respond to gameplay. A relatively new measure—the five-factor, 26-item Video Game Demand Scale (VGDS)—has been tested for dimensionality and measurement validity with English- and German-speaking players, but not for other play populations. Given the popularity of video games among Chinese-speaking players, this brief report demonstrates a successful translation of VGDS into Traditional Chinese (VGDS-C). A sample of $N = 863$ Chinese speakers in Taiwan were asked to recall and describe a recent gaming experience before completing the VGDS-C along with other gaming-related measures (tests of construct validity). VGDS-C was shown to be a reliable and valid way of assessing players' perceptions of the myriad demands of video gaming.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Empirical studies in HCI.

KEYWORDS

video games, interactivity, demand, scale development, user experience

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1 INTRODUCTION

Core to the experience of video games is their ability to involve players directly in the on-screen content. Meier (2012) characterized video games “a series of interesting decisions” that players address and engage throughout gameplay. This interactivity is a

primary appeal of games [26] but is also a demanding experience, *requiring* constant engagement on variably cognitive, emotional, physical, and social dimensions [7, 8]. The current study reports on the successful Chinese-language translation and validation of the Video Game Demand Scale (VGDS-C). Our data replicated the factor structure of previous VGDS scales, as well as associations between discrete demand dimensions and focal gaming entertainment outcomes, thus expanding the research scope to include a large and growing segment of the global video gaming population.

1.1 Video Games as Demanding Experiences

Interactive systems allow users control over the form or content of on-screen content. Although objective system features afford variable levels of interactivity [60], the user experience of this interactivity is best conceptualized as a perception [13]. Such perceptions are especially important in video games, in which players are cast as co-authors of the on-screen experience [66] and are required to manage myriad action potentials [20]. This latter point is critical, given that media users have a limited capacity to process on-screen content [22, 36], which can lead to situations in which different sources of demand might conflict with each other. This is one reason why interactivity presents somewhat of a paradox for understanding user experiences—it is desired by media users while at times a source of frustration [61].

Applied to video games, at least four sources of perceived demands that players much attend to during gameplay have been identified [7, 8]: (1) cognitive demands, in which players must rationalize and make sense of novel systems [23] and engage various cognitive skills relevant to on-screen content [25]; (2) emotional demands, in which players have variably intense basic and complex emotional reactions to events unfolding [29]; (3) physical demands, in which players must both learn and manipulate physical game controllers as well as exert themselves within the system at variable levels [38, 49]; (4) social demands, in which players are tasked with managing interpersonal relationships with both human [54] and non-human game characters [1].

Understanding players perceptions of these demands is useful from a user experience perspective, especially given that these demands can complement as well as conflict one another. For example, increasing the difficulty of a simple video game resulted in substantially higher perceptions of cognitive and physical demand, which resulted in players shifting their attention towards secondary in-game tasks (measured by observing response times during gameplay) [10]. This was interpreted as a cognitive offloading [21]—moving attention towards less demanding (albeit non-primary)

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game tasks to cope with an otherwise difficult and frustrating experience. During casual live-streaming of gameplay, novice gamers were so focused on the cognitive and physical demands of gameplay that the social demands of the streaming audiences were no greater than when compared to similar scores of individuals playing alone [65]. Despite being made conspicuously aware of the streaming audience and being able to recall audience chat topics, players seemed to “block out” the social demands and instead diverted their attention to focal gameplay at thus, expected social demands were not observed. Research into immersive storytelling—using virtual reality and head-mounted displays to envelop users into the experience—has found that the anticipated emotional demands of these systems are at times negated by the increased cognitive and physical demands of the systems themselves [3, 47].

Finally, although this *interactivity-as-demand* perspective is mostly rooted in media psychology theory and research, these identified sources of demand are conceptually aligned with extant human-computer interaction (HCI) research, including work on player challenge perceptions [18] as well as player challenge preferences [63]. These similarities, and their implications for future research and development, are discussed further in Section 4.3.

1.2 Measuring Demands via the Video Game Demand Scale

The Video Game Demand Scale-English (VGDS-E) was developed as a self-report measure of cognitive, emotional, physical (both controller and exertional), and social demands of video games [12]. In their survey of $N = 660$ English-speaking, self-identified video gamers, they used 80 candidate items before extracting a robust and valid scale containing 26 items (made available online by those authors: <https://osf.io/x5jch/>). Moreover, those discrete demand perceptions were useful in explaining differential reactions to video games. Players were asked to report on their most recent gaming experience, and among their findings, they reported increased game enjoyment (hedonic) correlated most strongly with decreased controller demands and increased game appreciation (eudaimonic) correlated most strongly with increased emotional demands—associations matching the underlying roots of both concepts [43]. Intrinsic need satisfaction [48] was also correlated with demands such that decreased controller demands were most strongly associated with feelings of competence, emotional and controller demands impacted feelings of autonomy, and both social and emotional demands influenced feelings of relatedness. Finally, players’ ratings of gameplay and control quality were higher when controller demands were less, and ratings of game narratives were boosted when games had increased emotional demands. Most of these patterns, as well as the dimensionality of the scale itself, was replicated in a recent translation and scale validation of this work into German (VGDS-G) [35].

1.3 Utility of the VGDS-C

Given the popularity of video games among Chinese-speaking gaming populations, validating survey measures in multiple languages provides a useful tool for better understanding a broader set of gamers—especially when normative differences might exist with respect to video games among cultures [17]. To this end, our study

follows an important movement in video games research (and social sciences broadly) to expand focus to non-Western populations [30]—for this study, translation to a language (Mandarin Chinese) that is the most common native language spoken and second-most common language spoken overall (nearly 1.12 billion speakers, or 15% of the global population [19]).

VGDS-C was developed for initial use with Taiwanese gamers. Taiwan is the largest game market in greater Southeast Asia (generating over \$1.26 billion with expected growth to \$2.8 billion by 2021) and has distinctively different gaming behavior from mainland China and the rest of Southeast Asia, with specific growth regarding mobile gaming (53% of the market, rising to 60% and fewer regulatory hurdles for companies (including Chinese firms) hoping to access Chinese-speaking players but operate outside of China [44, 45].

1.4 Current Study

For the current study, our goal was to establish measurement validity of the VGDS-C scale using a Taiwanese sample of self-identified video game players. Moreover, the study is best understood as an exact replication of prior work, in which we strictly follow established sampling protocols and existing predictions, measures, and analyses [12, 35] with a primary goal of demonstrating the veracity of prior findings when extended to novel contexts [34, 40].

Comprehensive logics driving all validity tests are presented in original research [12, 35], but the most critical point is that we expect VGDS scores to be differentially related to our measured constructs. For example, with respect to convergent validity, we expect cognitive and exertional demand scores to be positively correlated with overall task load given the centrality of physical and mental load to the task load construct [11, 27]. With respect to predictive validity, we expect positive associations between discrete VGDS dimensions and corresponding measures of effort expenditure towards mental, emotional, physical, and social tasks [46]. With respect to concurrent validity, we expected cognitive demands to be related to increased enjoyment and overall gameplay ratings [42]. We expected emotional demands to play a prominent role overall, for example having positive associations with feelings of appreciation, game narrative ratings and aesthetic game assessments (such as sound and graphics). Increased controller demands (suggesting a steeper learning curve [38]) were expected to decrease enjoyment [49], feelings of autonomy and competence [48], and reduce ratings of game controls. Exertional demands were expected to have an overall muted impact on concurrent validity given the measures used in the current study. Finally, social demands should be most relevant for assessments of relatedness with in-game others but mostly unrelated to other measures.

2 METHOD

Our study solicited Chinese-speaking video game players from Taiwanese gaming forums and other online communities, asking them to discuss their most recent video game experiences. The VGDS-E [12] was translated to Mandarin Chinese and back-translated to English for verification [53]—the initial translation to Chinese was done by the third author and then given to a group of four other researchers fluent in Chinese and English for verification. The

scale was then translated back to English by the second author, and those translations confirmed by the first author. All data and translated study materials from the current study are available online at <https://osf.io/h7ruq>. With permission, the current study materials are linked to prior scale translation and validation projects (VGDS-E and VGDS-G) for comparative purposes.

2.1 Participants

We recruited participants from Chinese-language online discussion forums (such as gamer forums house in ptt.cc), as well as participants from a large public university in Taipei. All participants were invited to complete the survey in exchange for one of eight case process totaling \$5000 TWD (2x \$1000 and 6x \$500). Initially, our survey link was accessed 2,408 times, although only 1000 participants completed the entire survey—these responses were collected between April 5 and April 24, 2020. Median completion time for the survey was 948 seconds (just under 16 minutes), and we removed anyone who completed the survey in under five minutes (33% of the median, $n = 14$ cases) or who took longer than 45 minutes (300% of the median, $n = 105$ cases). We also removed $n = 18$ participants who self-reported being younger than 18 years old.

Our retained sample included $N = 863$ participants, 98% ($n = 847$) opted to provide at least some demographic data, and all demographic items were left as open responses so that participants could describe themselves using their own terms. About two-thirds of the sample self-identified as male ($n = 561$) and just under one-third identified as female ($n = 275$). The average age of our sample was 25.78 ($SD = 6.07$), ranging from 18 to 54 and with a modal score of 20. Ethnicity questions for Taiwan-based respondents are complicated due to larger sociocultural debates about race and ethnicity in Taiwan (for example, as compared to Chinese), but 43.7% of respondents ($n = 370$) explicitly reference Taiwan (“台”) in their own ethnic identity. Just over 66% of the sample ($n = 559$) were currently enrolled in college or university courses, with another 23% in post-graduate training ($n = 191$), and others had either high school education (or were still enrolled, $n = 38$) or undergraduate college degrees ($n = 55$).

With respect to video game experience, players named 240 different individual game titles/franchises on as many as eight different platforms, with only two games named by more than 5% of the sample (*Animal Crossing* and *League of Legends*). The most common gaming platform was mobile gaming at 37%, $n = 320$, and PC gaming at 33%, $n = 286$, with PlayStation consoles, $n = 130$, and the Nintendo Switch, $n = 107$, also mentioned by more than 10% of the sample). Players self-reported their most recent gameplay session being an average of 2:00 minutes ($SD = 2.53$), with a modal score of 2:00; these values ranged from :01 to over 30:00—unsurprising given the wide variety of games and platforms named (including the dominance of mobile gaming, which likely explains overall shorter gaming sessions). For nearly 70% of the responses, participants were playing solo or alone. Notably, these data are provided for sample descriptives and not used in analysis, although the diversity of game titles suggests our findings to generalize across various video games.

2.2 Measures

The focal measure for the current study was the Chinese-language translation of the 26-item VGDS [12], referred to as VGDS-C. The scale is comprised of 26 items on seven-point Likert scales from “strongly disagree” to “strongly agree,” with seven items for cognitive demands, five items for emotional demands, four items for controller-focused physical demands, four items for exertion-focused physical demands, and six items for social demands. Higher scores represent greater perceived demands. For all scales, we calculated McDonald’s ω as a more robust estimator of internal consistency than Cronbach’s α , given that ω accounts for variance in factor loadings for individual scale items [14, 28].

Following the protocol of prior VGDS work [12, 35], convergent validity was tested by correlating VGDS-C dimensions with perceptions of task load from the NASA-Task Load Index [27] ($M = 5.57$ (on a 10-point scale; $SD = 1.65$, $\omega = .770$). Predictive validity was examined using single-item assessments for perceived mental ($M = 5.89$, $SD = 2.60$), emotional ($M = 5.59$, $SD = 2.56$), physical ($M = 3.76$, $SD = 2.64$), and social ($M = 3.31$, $SD = 2.75$) effort (separate items, 10-point scales) [46]. Concurrent validity was assessed using players’ perceptions of enjoyment ($M = 6.00$, $SD = .862$, $\omega = .879$, three items) and appreciation ($M = 4.68$, $SD = 1.15$, $\omega = .889$, six items), both seven-point scales [42], and need satisfaction was assessed using the player need satisfaction scale (three item, seven-point scales [48]) for felt autonomy ($M = 5.18$, $SD = 1.14$, $\omega = .762$), competence ($M = 5.24$, $SD = 1.03$, $\omega = .777$) and relatedness ($M = 3.93$, $SD = 1.59$, $\omega = .890$). Finally, we used a video game rating scheme that asked players to rate gameplay ($M = 81.57$, $SD = 16.78$), narrative ($M = 61.82$, $SD = 30.43$), controls ($M = 77.79$, $SD = 19.30$), sound ($M = 76.49$, $SD = 20.74$), graphics ($M = 79.01$, $SD = 17.88$), and overall experience ($M = 81.89$, $SD = 12.65$) [42]. Table 1 summarizes our scale descriptives.

3 RESULTS

Assessment of VGDS-C is presented in three steps: (a) confirmatory factor analysis against the *a priori* five-factor structure, (b) *post hoc* assessment of items leading to a possible lack of fit, and (c) construct validity through analyzing associations between VGDS-C dimensions and common gaming entertainment outcomes.

3.1 Confirmatory Factor Analysis

Confirmatory factor analysis was performed using structural equation modeling based on maximum likelihood estimation (which filters out missing data listwise for each parameter estimate) using the *lavaan* package for R statistical package [51]. Our data did not fit the specified model using commonly accepted thresholds for model fit [9], $\chi^2(289) = 1741.44$, $p < .001$, CFI = .852, TLI = .833, RMSEA = .076 (90% CI = .073, .080), SRMR = .088—here, CFI and TLI scores fell below a suggested .950 and SRMR was greater than a suggested .080, while RMSEA did fall within acceptable parameters (below .080). Closer inspection of the squared multiple correlations of all 26 items suggested two items (the only two reverse-coded items) with comparatively weak loadings (below .300): one item from the “controller demand” dimension (“這個遊戲操作讓我感到挫折” as a translation from “The game controls tripped me up”) and one recoded item from the (“這個遊戲不需要投入太多的心力” as a

Table 1: Descriptive statistics for measured variables.

Measure	Source	Scale range	<i>M</i>	<i>SD</i>	ω
Task Load Index	Hart & Staveland (1988)	0-10, six items	5.57	1.65	.770
Mental effort	Paas (1992)	0-10, single item	5.89	2.60	n/a
Emotional effort	"	"	5.59	2.56	n/a
Physical effort	"	"	3.76	2.64	n/a
Social effort	"	"	3.31	2.75	n/a
Enjoyment	Oliver et al. (2015)	1-7, three items	6.00	.862	.879
Appreciation	"	1-7, six items	4.68	1.15	.889
Autonomy	Przybylski et al. (2010)	1-7, three items	5.18	1.14	.762
Competence	"	"	5.24	1.03	.777
Relatedness	"	"	3.93	1.59	.890
Gameplay	Oliver et al. (2015)	0-100, single item	81.47	16.78	n/a
Narrative	"	"	61.82	30.43	n/a
Controls	"	"	77.79	19.30	n/a
Sound	"	"	76.49	20.74	n/a
Graphics	"	"	79.01	17.88	n/a
Overall experience	"	"	81.89	12.65	n/a

translation from “This game doesn’t require a lot of mental effort.”). Removal of these items did not improve model fit and thus, the *a priori* VGDS-C could not be confirmed. Comparison to a univariate solution did suggest that a multivariate solution would be a better fit for observed data (five-factor model AIC = 77340, BIC = 77635; univariate model AIC = 81258, BIC = 81506) and thus, we further examined the scale’s underlying factor structure.

3.2 Exploratory Factor Analysis

Given the lack of model fit for the specified VGDS-C, we chose an exploratory factor analysis technique capable of exploring the potential for (a) there to be more or fewer underlying factors than those found in prior work and/or (b) for items to correlate more strongly with other factors than those presumed. This is especially plausible when scale items created in one language might contain phrasing that does not connote the same meaning (for example, “tripped me up” or “gave me the feels” are idioms that might not cross-cultural boundaries). As with the CFA, four participants were removed from analysis for having missing data on at least one scale item. Our observed data was adequate for factor analysis, KMO = .892, Bartlett’s $\chi^2(325) = 10003.80$, $p < .001$.

For our EFA, we used principal axis factoring with oblique factor rotations (oblimin) to allow for underlying factors to be correlated with each other. We established *a priori* that items should have primary factor loadings $\geq .500$ with cross-loadings $\leq .300$ [9, 31]. The first iteration demonstrated both recoded items to have poor primary loadings and problematic cross loadings, and they were removed. Our second iteration reported a factor solution that nearly entirely replicated both VGDS-E [12] and VGDS-G [35], with one peculiarity: an item from the cognitive demand scale “這款遊戲讓我在精神上消耗殆盡” intended as a translation of “This game exhausted me mentally” (a) loaded strongly with other exertional-physical demand items and seemed to diminish the contribution of an item intended *a priori* for exertional-physical demand “遊玩後, 我感覺很緊繃” as a translation of “I felt strained after playing.”

Here, it is likely that the semantic meaning of “exhausted” might have primed participants to think of physical rather than mental (re: cognitive effort). Removal of that item resulted in an exact replication of the five dimensions from prior research, although the “strained” item fell below the .500 threshold for primary factor loading. This final iteration resulted in a 22-item VGDS-C that replicated the five expected demand dimensions, retains all but four of the original scale items (losing two cognitive demand, one controller demand, and one exertion demand item), with primary loadings greater than .500 and no cross-loadings above .300 per our *a priori* parameters. Table 2 represents the final items and primary factor loadings, along with eigenvalues for each factor and calculated internal consistency (ω) and calculated means and standard deviations (see OSF for comprehensive EFA results). Table 3 reports observed bivariate correlations between VGDS-C factors.

3.3 Supplemental Split-Half Factor Analysis

As an additional test of our factor structure, we did additional split-half analysis of the VGDS-C scale by creating two randomly generated subsets of our data: $n = 434$ for EFA and $n = 429$ for CFA (a slight imbalance due to removal of underage participants after randomization), using the latter as confirmatory evidence of the former [2]. As expected, the EFA data was adequate for factor analysis, KMO = .841, Bartlett’s $\chi^2(231) = 3937.63$, $p < .001$ and the factor loadings closely replicated the initial EFA (see supplemental OSF for complete results). The subsequent CFA confirmed overall measurement model fit, CFI = .916, TLI = .902, RMSEA = .065 (.059, .072), SRMR = .071. This analysis lends additional support for the VGDS-C factor structure.

3.4 Construct Validity Analyses

Convergent, predictive, and concurrent validity tests were calculated in three separate structural equation models, designed as direct replications of past work, using previously published analysis code [35] Notably, controller demands are reported in inverse

Table 2: Factor loadings, descriptive statistics, and final solution for VGDS-C items

Dimension	Item	Factor Loadings
Cognitive Demand – Eigenvalue = 5.62, ω = .846, M = 4.35, SD = 1.28		
	The game was cognitive demanding / 這款遊戲相當耗費腦力。	.809
	I had to think very hard when playing the game. / 我玩這款遊戲時我需要非常認真思考	.788
	The game required a lot of mental gymnastics. / 這款遊戲需要大量的心智鍛鍊。	.702
	The game stimulated my brain. / 這款遊戲刺激了我的大腦。	.631
	The mental challenges in this game had an impact on how I played. / 這個遊戲中的心智挑戰影響了我怎麼玩這個遊戲。	.563
Emotional Demand – Eigenvalue = 3.09, ω = .851, M = 4.84, SD = 1.23		
	The game gave me the feels. / 這款遊戲讓我很有感觸。	.839
	I was moved by the game. / 我被這個遊戲感動了。	.821
	I had a strong emotional bond with the game content. / 我對這款遊戲的內容有很強的情感連結。	.785
	The game tugged at my heartstrings. / 這款遊戲牽動了我的心緒。	.573
	I had a lot of unexpected feelings during gameplay. / 我在遊玩過程中產生了許多意想不到的感受。	.558
Controller Demand – Eigenvalue = 2.52, ω = .749, M = 5.36, SD = 1.10		
	The controls were very natural to me. / 遊戲控制方式對我來說是非常自然的。	.855
	The game's controls were like second nature to me. / 這款遊戲的操作方式對我來說近乎直覺。	.666
	The game controls were easy to handle for me. / 這款遊戲的操作對我來說很容易上手。	.618
Exertional Demand – Eigenvalue = 1.56, ω = .861, M = 3.39, SD = 1.50		
	I was physically exhausted after playing. / 玩了這個遊戲後我筋疲力盡。	.902
	My body felt drained after gameplay. / 遊玩後我覺得全身力氣放盡。	.795
	The game was physically demanding. / 這個遊戲非常耗費體力。	.700
Social Demand – Eigenvalue = 1.41, ω = .845, M = 3.71, SD = 1.41		
	Socializing was an important part of playing this game. / 社交是這個遊戲中很重要的一部份。	.833
	Being around others in the game had an impact on how I played. / 在遊戲中與他人互動影響了我怎麼玩這個遊戲。	.786
	While playing, I was aware of others in the game. / 遊玩時，我意識到有其他人同時在這個遊戲中。	.681
	This game was socially demanding. / 這款遊戲相當耗費社交精力。	.661
	I felt obligated to others, while playing. / 我在遊玩時我覺得自己對他人有義務。	.573
	I was compelled to interact with others in the game. / 我被迫與遊戲中的其他人互動。	.567

Table 3: Observed bivariate correlations between latent VGDS-C dimensions

	Cognitive demand	Emotional demand	Controller demand	Exertional demand	Social demand
Cognitive demand	–				
Emotional demand	.301 (<.001)	–			
Controller demand	.125 (<.001)	.164 (<.001)	–		
Exertional demand	.463 (<.001)	.151 (<.001)	.156 (<.001)	–	
Social demand	.311 (<.001)	.135 (<.001)	-.011 (.745)	.331 (<.001)	–

to ease interpretation (so that higher scores represent decreased intuitiveness and thus, more demanding). Given the larger sample size for this study, we used a more conservative $p < .001$ value to protect against Type I (false-positive) errors [4].

For convergent validity (associations with perceived task load), cognitive demand ($B = .475, p < .001$) and exertional demand ($B = .363, p < .001$) were the only two VGDS dimensions associated with increased perceptions of task demand—replicating findings from prior VGDS-E and VGDS-G results. The overall model was a marginal fit (not surprising, given that three dimensions did not

correlated with TLX scores), CFI = .869, TLI = .853, RMSEA = .063 (90% CI .060, .066), SRMR = .075.

For predictive validity (associations with participants' perceptions of effort expenditure), we largely replicated past work on the VGDS-E and VGDS-G in that (a) cognitive demand was most strongly associated with cognitive effort ($B = .911, p < .001$), exertional demand was most strongly associated with physical effort ($B = 1.06, p < .001$), and social demand was most strongly associated with social effort ($B = 1.85, p < .001$). Where our data broke from prior work was the unexpected association between cognitive demand and emotional effort ($B = 1.05, p < .001$). The data was an

Table 4: Unstandardized beta weights from multivariate multiple regression of construct validity tests on VGDS-C dimensions. Bolded data represent statistically significant results at the $p < .001$ level or greater. Marked values indication replications of prior work (* for VGDS-E, + for VGDS-G).

	Cognitive Demand	Emotional Demand	Controller Demand(reversed)	Exertional Demand	Social Demand
Task Load	.475*+ <.001	.085 .107	.011 .797	.363*+ <.001	.013 .700
Mental effort	.911*+ <.001	.188 .083	.035 .726	.603 <.001	.029 .714
Emotional effort	1.05 <.001	.420*+ <.001	.076 .455	.334 <.001	.136 .095
Physical effort	-.314 .010	.377 .001	-.040 .352	1.06*+ <.001	.154 .083
Social effort	-.017 .858	.164 .124	.018 .859	-.079 .278	1.85*+ <.001
Enjoyment	.117 .008	.489*+ <.001	.183*+ <.001	-.065 .023	-.020 .475
Appreciation	.192*+ <.001	1.14*+ <.001	-.047 .229	-.052 .057	.007 .818
Autonomy	.089 .074	.703*+ <.001	-.140 .003	-.090 .005	.138 <.001
Competence	.140 .011	.380+ <.001	-.426*+ <.001	-.111 .003	.093 .016
Relatedness	-.040 .500	.371*+ <.001	-.099 .065	-.098 .006	.984*+ <.001
Narrative	-4.22 .001	22.01*+ <.001	4.28 .001	-1.56 .065	-2.17 .018
Gameplay	4.29*+ <.001	1.94 .032	-1.94 .023	-.843 .145	.324 .572
Controls	4.74* <.001	-1.95 .052	-6.17*+ <.001	.312 .625	.272 .693
Sound	-2.44 .031	8.94*+ <.001	-.127 .898	.615 .345	.082 .119
Graphics	-.540 .553	4.64*+ <.001	-1.47 .113	-.472 .397	-.534 .382
Overall	.703 .328	5.77*+ <.001	-1.24 .046	-.739 .065	-.526 .194

overall strong fit for the specified model, CFI = .930, TFI = .915, RMSEA = .052 (90% CI .049, .056), SRMR = .061.

For concurrent validity tests (associations with media entertainment constructs), we again replicated prior work on the VGDS-E and VGDS-G with robust overall model fit, CFI = .916, TLI = .901, RMSEA = .045 (90% CI = .043, .057), SRMR = .056. Given the large number of regression weights, we present all results in Table 4 (also see supplemental OSF files for complete analyses). Those associations replicating prior work are also marked with an asterisk (for VGDS-E) and/or a cross (for VGDS-G). We interpret these patterns in Section 4.

4 DISCUSSION

Our Chinese-language translation of the Video Game Demand Scale replicated the same five-factor measurement model found in prior usage of the scale in English [10, 11, 65] and German [35]. The scale reliably and distinctly measured video gamers' perceptions

of the cognitive, emotional, physical (in terms of game controls and energy exertion), and social demands of their most recent gaming experiences. Moreover, those individual demands showed predictable patterns with other measures of task demand, effort expenditure, and entertainment outcomes. That these patterns held from a sample engaging several hundred different properties across myriad mobile and console platforms is strong evidence that these demands are broadly applicable to gaming experiences of gamers of many backgrounds.

4.1 Stability of VGDS when Translating to Chinese

As shown, the VGDS-C mostly replicated prior scale-validation efforts and passed established markers of measurement validity [9]. Four items from the original scale (VGDS-E) were lost, although one exertional demand item associated with feeling "strained" has

proven problematic in prior work: in Chinese, “遊玩後，我感覺很緊繃”；in German, “Nach dem Spiel fühlte ich mich angespannt.” Future work should revisit the connotation of this item, perhaps through more direct analysis of player’s own language regarding exertional demand. Likewise given that both exertional demand and controller demand have comparatively few items (three each, as they are considered sub-dimensions of physical demand broadly) and consistently emerge as unique factors, future work should focus on expanding the conceptual scheme of these two dimensions by identifying candidate items for inclusion on both factors.

A finding unique to VGDS-C was that one item intended to measure cognitive demand (“這款遊戲讓我在精神上消耗殆盡,” emphasis added here, as a translation of “This game exhausted me mentally”) loaded strongly with other exertional demand items. On reflection, it is likely the case that the Chinese characters “精神” connote “energy” (精力) and more conceptually aligned with exertional demand. This unexpected translation error coupled with poorly-loading “strained” item above and two problematic reverse-coded items introduced just enough error into our *a priori* measurement model to reject the confirmatory factor analysis. However, removal of these items did not affect the expected underlying dimensionality of the scale itself, as our exploratory factor analysis reproduced the same five-factor structure found in prior work. However, the overall reduction in items prevented us from conducting measurement invariance tests with data from prior scales.

Nearly every one of our convergent and predictive validity tests replicated past work, with a single exception: cognitive demands were associated with emotional effort expenditure. One reason for this finding might also be due to a translation issue in that the Chinese characters “心理上” that were intended to measure “emotional effort” translate more directly to “psychological effort”—the latter connotation suggesting more of a mental than emotional process. Again here, removal of this item did not distort the underlying factor structure of VGDS-C.

4.2 Demands Differentiate Entertainment Outcomes

Replicating prior work, video game demand dimensions were useful in discriminating various focal entertainment outcomes from gameplay. For example, players rated games as more hedonically enjoyable when those games had increased emotional demands, and decreased controller demands. The former is likely a function of more basic emotional reactions to gameplay, and the latter is a function of intuitive controller interfaces facilitating gameplay [38, 50]. This latter finding is bolstered by the strong negative association between controller demands and perceptions of both in-game competence and ratings of game controls. More intuitive controller interfaces facilitate on-screen performance, which boosts enjoyment [62]. Related to these findings was the influence of increased cognitive demands on how players’ positive ratings of game controls and gameplay (aligning with the ludic dimensions of problem-solving and cognitive engagement).

Feelings of eudaimonic appreciation were primarily (and quite strongly) driven by increased emotional demands, likely reflecting players feeling an intense-yet-pleasurable emotional strain while playing games with more serious content [29, 42]. These

findings are also reflected in the very strong association between more positive ratings of the game’s narrative and increased emotional demand—here, players are reporting on more prominent “above-the-neck” experiences (dealing with more complex psychological processes, contrasted with “below-the-neck” experiences more aligned with action [55]) in which their gameplay is considered through more personal, reflective, and pensive. Further, increased emotional demands corresponded with higher ratings of autonomy, as well as players rating the games as having superior sound, graphics, and being overall better games. These findings comport research reporting that players’ subjective quality assessments of a video game were highly aligned with how they felt about the game’s physical and narrative world, as well as the consequences for the player’s in-game decision making [56]. Altogether, these findings continue to support arguments that while video game can and do provide basic hedonic pleasure, gaming experiences are also evolving in ways that invoke deeper and more eudaimonic emotional connections [29, 42].

Although not specifically tied to an entertainment outcome, players’ feelings of relatedness—of social connection with others—was largely and predictably driven by higher social demand scores, with a smaller relationship between relatedness and emotional demands. These findings replicate past VGDS work, but also prior work causally modeling the associations between game ratings, need satisfaction, and entertainment outcomes [42, 62]. In that work, players social and emotional connections to in-game others was a strong predictor of appreciation outcomes.

Taken together, these findings suggest that player perceptions of game’s cognitive, emotional, physical, and social demands are useful in helping explain players assessments of unique gaming outcomes.

4.3 Implications for HCI

Understanding how video game players perceive in-game challenges has been a core area of scholarship among HCI scholars. Broadly, the attainment of flow states is largely dependent on a precarious and dynamic balance between player skill and game challenge [15]. While not contradicting this research, recent developments have moved toward multidimensional approaches to conceptualizing game challenges, perhaps in recognition of the medium’s evolution from technological demonstrations and simple puzzles to encompass a wide variety of user experiences [8, 59]. For example, recent work [63] has presented empirical evidence for distinct dimensions of player challenge preferences to include analytical challenges (cognitive effort and reasoning), physical challenges (such as reaction times and other kinesthetic effort), insight challenges (creative thinking and problem solving), and socioemotional challenges (interpersonal reflections)—demonstrating their predictive validity in explaining discrete play motivations and video game genre preferences. With respect to VGDS, future research would greatly benefit from exploring the causal relationship between challenge preferences prior to gameplay and resultant demand perceptions during and following gameplay. Recent work on an integrated model of challenge originating from recent gameplay interaction scale (CORGIS [18]) might also provide a compelling avenue to understand how players balance and cope with in-game

Table 5: Conceptual dimensions of recent player experience scales in HCI, with proposed affinity groupings.

Video game demand scale(Bowman et al., 2018)	Player preference for challenge(Vahlo & Karhulahti, 2020)	CORGIS(Denisova et al., 2020)
Cognitive demands (e.g., problem-solving)	Analytical challenges (e.g., mental effort) Insight challenges (e.g., creative thinking)	Cognitive challenge (e.g., problem-solving)
Emotional demands (e.g., unexpected feelings)	Socioemotional challenges (e.g., self-exploration)	Emotional challenges (e.g., narrative tensions) Decision-making challenges (e.g., tension and consequences)
Controller demands (e.g., device mapping)	–	–
Exertional demands (e.g., reaction times)	Physical challenges (e.g., reaction times)	Performative challenge (e.g., reaction times)
Social demands (e.g., relationships with others)	–	–

and out-of-game sources of challenge and demand. CORGIS provides compelling evidence that players experience challenge as variably performative, emotional, cognitive, and consequential—players must tangibly engage a video game, sort through and settle narrative tensions inside that game, solve puzzles and problems while playing, and cope with the consequences of in-game decisions. Replications of the current study would be well-served from integrating both HCI approaches—perhaps game challenge preferences as predictive of demand perceptions, and/or CORGIS and VGDS scores showing concurrent validity with one another. One notable distinction between CORGIS and VGUD is that the former is more focused towards challenges from the on-screen experience, while the latter incorporates sources of attention (such as social others) external to the screen itself. Broadly, there is considerable conceptual overlap between both approaches and the interactivity-as-demand model engaged in the current study, summarized in Table 5

Examples offered in parentheses are simplified explications of each respective dimension; see source materials for more information.

Notably, the dominance of emotional demands as associated with and predictive of so many different entertainment outcomes and game evaluations closely aligns with HCI research exploring gaming experience often described by players as emotionally moving [5], challenging [6], reflective [39, 67], and even uncomfortable [24]. The growth of scholarship into the eudaimonic reactions to video game content and thus the rich emotional impacts of gaming tracks with the overall evolution of the medium to include more complex and humanistic experiences [8, 59] and scholarship into the rich narrative experiences of gaming [16, 53].

5 CONCLUSION

In the face of globalized gaming economies and increasingly international gaming communities, it is critical that we develop methods and measures for understanding players perceptions of their gaming experiences that are broadly applicable. Along with this, video

games themselves are constantly evolving and maturing, encompassing a broad range of cognitive, emotional, physical, and social experiences.

Our data suggest that these discrete demand perceptions generalize both (a) across broad segments of gamers to include English, German, and (now) Chinese-speaking players and (b) across hundreds of different game titles and gaming formats. More critically is that VGDS-C provides a useful metric for understanding how these demands help us discriminate between different focal gaming outcomes, which enables research to understand *how* players come to feel various forms of entertainment. Future work can use these measures to better assess how players are engaging with a variety of game experiences (e.g., user experience testing or game development cycles), while also helping to explain variance in players reactions to game content (e.g., enjoyment, appreciation, purchasing behaviors, or other outcomes). Moreover, future research might also consider regional dialects or language families. For example, Chinese language has myriad formal and informal dialects [64, 68] that might require adjustments to scale items presented here. That said, the current state of evidence suggests that player perceptions of demand seem to transcend broad cultural contexts and thus, might be useful for both local and global game design.

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