Assessing the Necessary Skill Profiles for Playing Video Games

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ABSTRACT

It seems clear that different video games require different skills. However, there has been no systematic way of assessing what these skills are or for assessing the extent to which particular skills are required by a particular game. This study used a psychometric approach to help identify these skills and profile particular games and genres of video games. Experienced gamers generated a list of 32 skills and then a diverse sample of participants rated a number of games on the extent to which they required the skills. Factor analysis revealed seven general components: perceptual-motor, role-playing, numerical reasoning, problem solving, focus-persistence, acceptance of uncertainty, and player interaction. Different genres of games differed significantly on a number of these components. The resulting instrument can be used by the game industry to profile games for review and evaluation.

INTRODUCTION

It has been known since the inception of video games that each requires different skills to play the game. Often these skills involve perceptual speed, targeting and reaction time, but other games require strategic thinking and cognitive processing of information. While games require different skills, there is yet no definitive list of these skills or method to evaluate the skills required by a particular game. This study was conducted to develop an instrument that could be used by individuals familiar with a particular video game to assess the various skills required to play the game.

Review of the Literature

Previous research has identified some of the skills involved in playing different video games. For example, Dorval and Pepin (1986) found that subjects who played 8 sessions of *Zaxxon*, in which the player controls a spaceship in a three-dimensional space and attempts to shoot enemies and avoid obstacles and being hit, showed significantly higher spatial skill scores than the control group. A number of studies have been primarily interested in using video games to develop skills that would transfer to other contexts. For example, Mulligan, Dobson, and McCracken (2005) looked at visual processing skills developed by video game players and hockey players. The video game *ThinkHockey* was used to teach players the strategic and

tactical aspects of the game. The skills would then transfer over to real-life hockey. Other examples of video games that develop skills to transfer over would be the use of Madden video games by NFL athletes, as well as targeting and shooting games by the military. These studies identify a skill of interest and then attempt to find a video game that could be used to develop this skill.

Other studies have looked at the effect of videogame playing in general on the development of particular skills. Green and Bavelier (2004) summarize research on the effects of playing video games on reaction time and perceptual-motor coordination, spatial skills, and visual attention. Griffith et al. (1983) found that video game players far outperformed non-players on a rotary pursuit task, especially at high speeds. In a controlled study, Orosy-Fildes and Allan (1989) found that when half of the subjects underwent a 15-minute practice on an Atari 2600 video game system, they displayed a faster reaction time than the control group.

Recent research provides evidence for improved skills with more modern gaming systems as well. Strobach, Frensch, and Schubert (2012) found that video game play improved dual task and task switching skills in both regular gamers and non-gamers. Furthermore, Feng, Spence, and Pratt (2007) determined that spatial attention and mental rotation improved after playing 10 hours of an action game. When examining general attention skills, Dye, Green, and Bavelier (2009) found that action video gamers performed significantly better on the Attentional Network Test (ANT) than non-action video gamers. This reveals that action video game players have enhanced attention skills compared to their non-action video game player counterparts. We see that these effects extend even to younger children. In a study done by Masfety et al. (2016), high video game usage of more than five hours a week was significantly associated with higher intellectual functioning and increased academic achievement.

However, these studies have generally identified changes in skills as a function of either playing video games in general or specific games without first identifying the skills required. To identify all of the skills needed to play a particular video game, a different approach is required. One method is to perform a task analysis of a game and then relate the tasks to the skills. Human factors psychology has developed procedures for task analyses (e.g., Militello, Hutton, Pliske, Knight, & Klein; 1997). While this could be done for video games, it would be extremely laborious. Moreover, video games today can be extremely complex, making an exhaustive task analysis nearly impossible. Moreover, players play games in different ways using different skill sets, so the skills identified in the task analysis may not necessarily relate to the skill sets or abilities of all players.

Similar to task analyses, laboratory methods measuring specific skills developed following game play or correlated with game performance are also too time consuming and expensive to be of use considering the thousands of games that one would like to assess.

Another method is to conduct a conceptual analysis of skills learned. Smith (2008) proposes a method for identifying the skills developed in video games in a manner similar to identifying the skills involved in college courses, such as

rhetorical and compositional skills. She bases this on Johnson's (2005) discussion in *Everything Bad is Good for You* on how students think and write critically about their experiences playing video games. This conceptual approach of using player assessments from their experiences playing games seems more viable than either task analyses or performance assessments.

Consequently, the approach taken by Norman (2010) was to use psychometric methods to develop a set of scales that could be used to evaluate games. To develop the scale, experienced gamers created a pool of questions. These and other gamers served as coders to rate games that they were familiar with on the extent to which the game required each of these skills or abilities.

The current study expands upon this work by including a larger pool of participants and video games. The previous scale was modified to include two more items to better capture the diverse skills required in games.

METHOD

Participants

Four different sets of coders participated in this study. The first group consisted of upper level undergraduate students in a course on the "Psychology of Video Games and Entertainment" from 2011-2015 at the University of Maryland. Each student rated 5 games that they were familiar resulting in n = 929. Only a portion of the coders provided demographics information. About 44% of these identified as female.

The second group (n = 236) consisted of undergraduate student participants recruited through the psychology department SONA system. The participants' racial self-identifications are as follows: 55% Caucasian, 21% Asian, 14% African, 9% Hispanic, 5% Other or Multiracial. Approximately 56% of participants self-identified as male and 44% self-identified as female. Approximately 39% of participants identified as "casual" gamers, 20% as moderate plus, 19% as moderate, 8% as non-gamers, 7.5% as heavy gamers, and 1% as hardcore gamers.

The final group (n = 195) consisted of a "convenience sample" who found and took the skills questionnaire through links to the laboratory website. Demographics were not available for this group.

Rating Scale

The items used for this questionnaire were originally discussed and generated by students participating in a one day a week Summer Video Game Internship on the psychology of video games, held from June 2nd to July 28th, 2010. The rating form consisted of 24 items (Norman, 2010). After the scale was piloted, 8 additional items were added. The current set is shown in Appendix A. The items consisted of a stem listing the skill or ability required of player for the game and a 9-point scale with endpoints "Not necessary" and "Very necessary." The name of the game being rated, and any additional comments that they had about the game were also recorded. The ratings were submitted on the Web and stored in a FileMaker Pro database.

RESULTS

A total of 1360 ratings of various games were generated by the participants. Of these, 1320 where complete enough to be used in the data analysis. In all, 293 series of games were rated.

Factor Analysis

An exploratory factor analysis (principal components with a Varimax orthogonal rotation) was conducted on the data. Seven factors were identified. Appendix B shows the table of factor loadings for the 32 items. The seven factors were be labeled as follows: Factor 1: *Perceptual-Motor*, Factor 2: *Role-Playing*, Factor 3: *Numerical Reasoning*, Factor 4: *Problem Solving*, Factor 5: *Focus-Persistence*, Factor 6: *Acceptance of Uncertainty*, and Factor 7: *Player Interaction*.

Reliability

Cronbach's Alpha was .895 for all 32 items collectively. The Cronbach's Alpha for each subscale were: *Perceptual-Motor*, .826; *Role-Playing*, .844; *Numerical Reasoning*, .858; *Problem-Solving*, .610; *Focus-Persistence*, .739; *Acceptance of Uncertainty*, .411; and *Player Interaction* .490. Cumulatively, the scale is in the respectable range. Compared to Alpha = .7, the subscales of *Perceptual-Motor*, *Role-Playing*, *Numerical Reasoning*, and *Focus-Persistence* are deemed to be acceptable. *Problem Solving*, *Acceptance of Uncertainty*, and *Player Interaction* may be less than acceptable.

Factor Variates as a Function of Game

The following 12 game series were profiled due to the number of ratings and to represent a diverse sample: *Angry Birds* ($n_{ratings}$ = 9), *Call of Duty* ($n_{ratings}$ = 38), *Candy Crush Saga* ($n_{ratings}$ = 9), *Dance Central* ($n_{ratings}$ = 20), *Fallout: New Vegas* ($n_{ratings}$ = 18), *FIFA* ($n_{ratings}$ = 40), *Halo* ($n_{ratings}$ = 34), *Final Fantasy* ($n_{ratings}$ = 19), *Grand Theft Auto* ($n_{ratings}$ = 39), *Pokémon* (n_{raters} = 22), *Mario Kart* ($n_{ratings}$ = 70), and *Super Mario Brothers* ($n_{ratings}$ = 68). The factor values for skills for each game are shown in Figures 1 through 12.

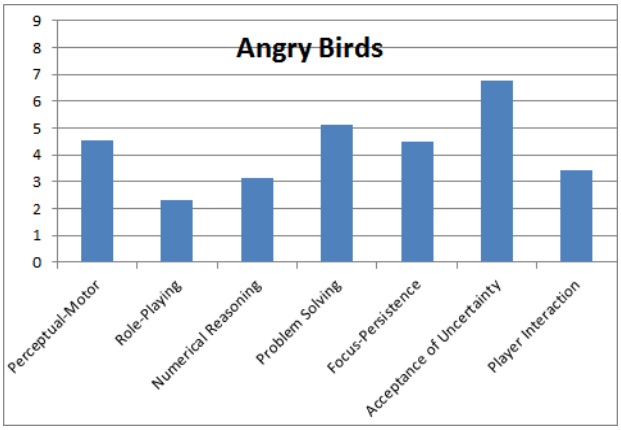

Figure 1. Factor values for Angry Birds.

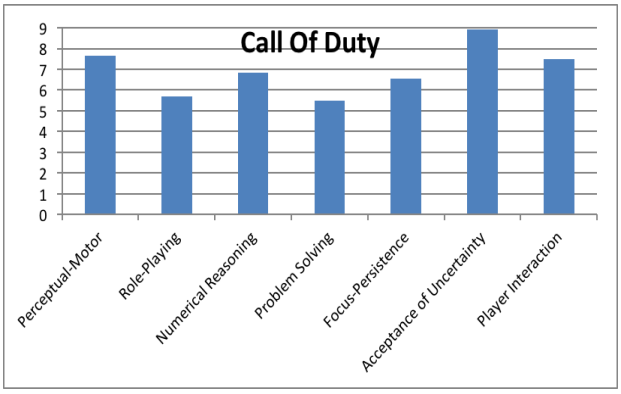

Figure 2. Factor values for Call of Duty

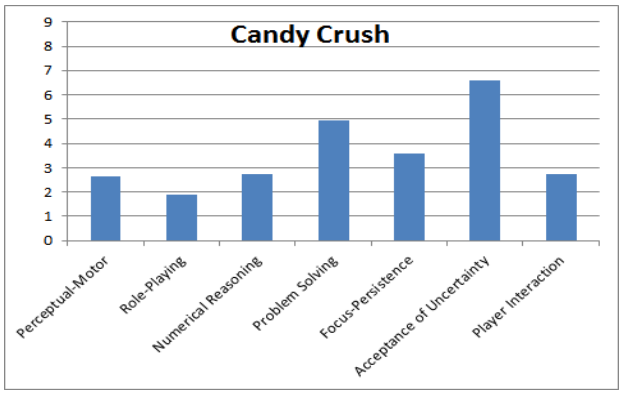

Figure 3. Factor values for Candy Crush

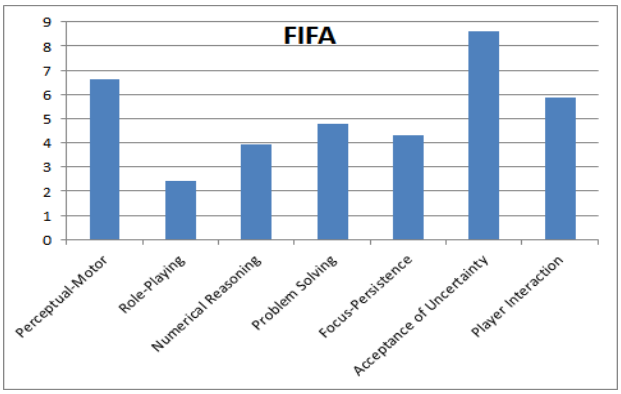

Figure 6. Factor values for FIFA

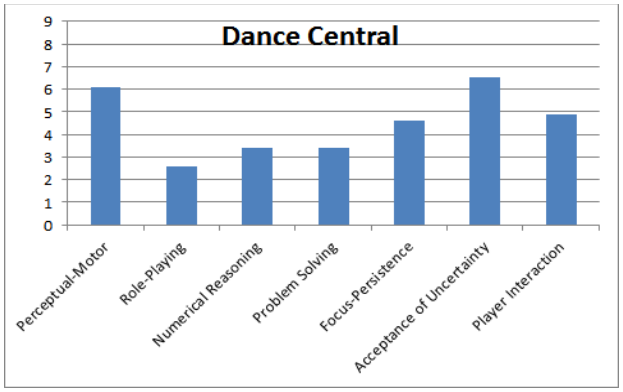

Figure 4. Factor values for Dance Central

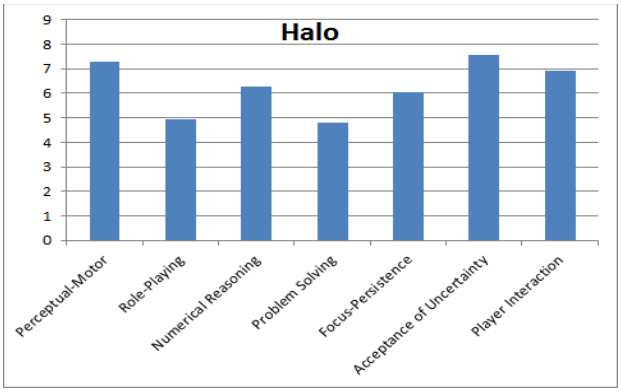

Figure 7. Factor values for Halo

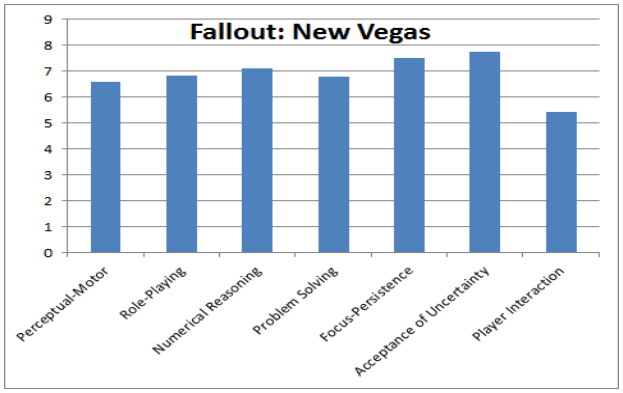

Figure 5. Factor values for Fallout: New Vegas

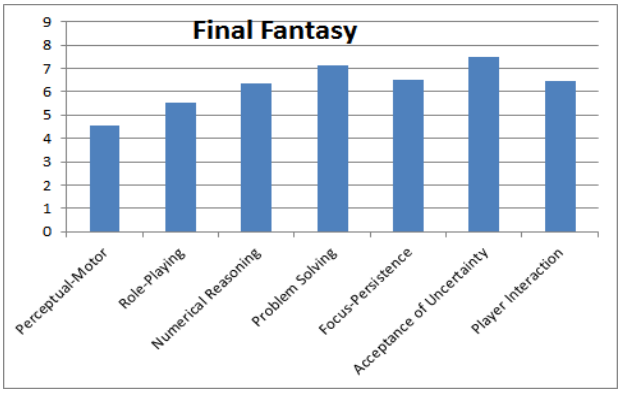

Figure 8. Factor values for Final Fantasy

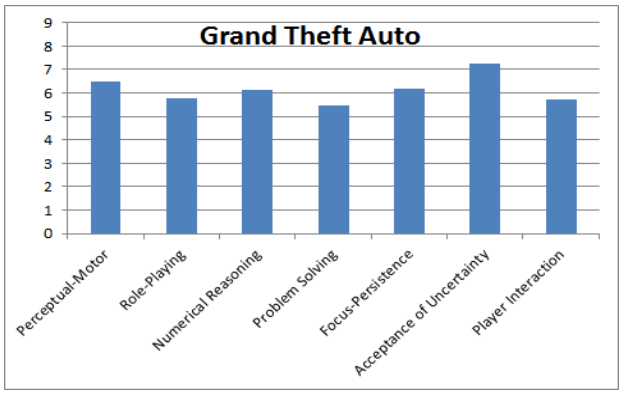

Figure 9. Factor values for Grand Theft Auto

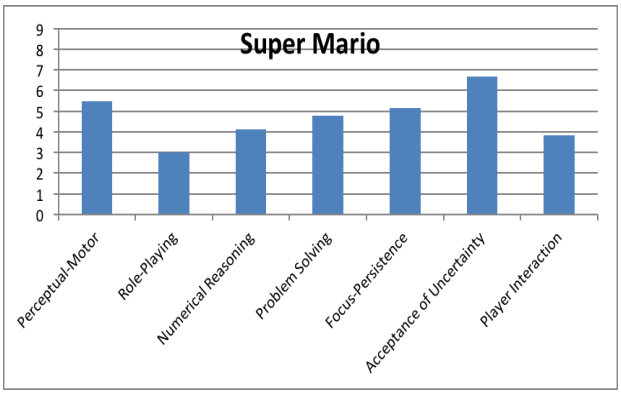

Figure 12. Factor values for Super Mario

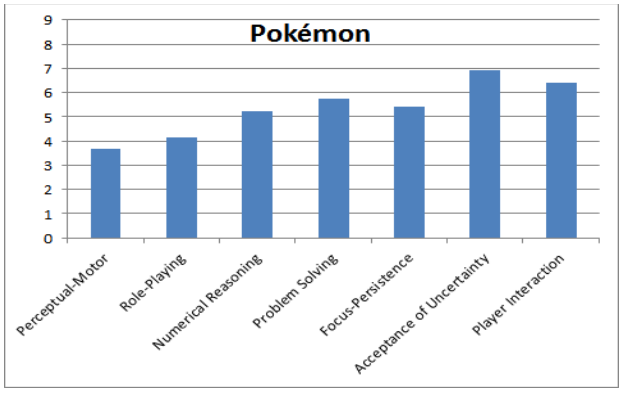

Figure 10. Factor values for Pokémon

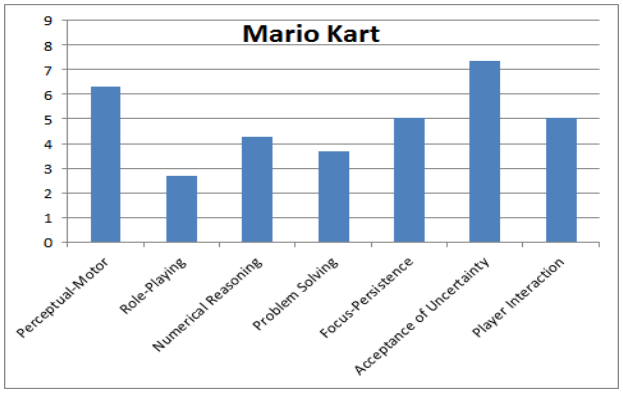

Figure 11. Factor values for Mario Kart

Profiles of Different Genres of Games

It is expected that different genres of games in general will require different sets of abilities. Consequently, an attempt was made to identify the genres of the 293 games series. Rather than independently defining the genres, existing genres of games listed in Wikipedia were used. An inspection of the discussion pages of articles on games reveals considerable interaction and consensus among a number of contributors to the classification. The only problem is that often games fit into several genres such as *First Person Shooter* (FPS) and *Role-Playing* games (RPG). Also, some genre tended to be too specific to the narrative and not the game play such as *Survival Horror* and *Sci-Fi*. These were ignored. Table 1 lists ten genres of games and the number of games classified within that genre along with the total number of ratings for those games. Figure 13 shows the factor profiles for each genre.

Table 1. Number of Games and Ratings in Each Genre

Genre	Number of Games	Number of Ratings
Action-Adventure	38	149
Fighting	12	97
FPS (First-Person Shooter)	20	134
Platform	25	98
Puzzle	9	45
RPG (Role Playing)	21	63
Sports	14	114
Racing	6	83
Simulation	7	23
Rhythm	4	33

A MANOVA was conducted to see if genre differed significantly on the factor means. Overall, the difference was significant ($p < .001$). All of the univariate factors were also significant ($p < .01$), except *Problem Solving* ($p > .50$). Specific comparison tests between genres could be conducted but this goes beyond the purpose of this paper, but will be discussed later.

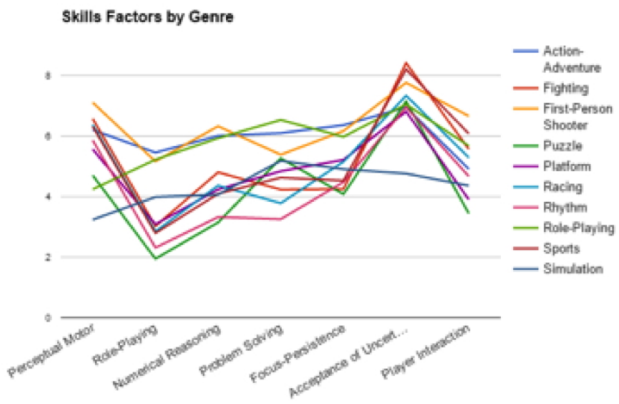

Figure 13. Factor values for ten genres of video games.

DISCUSSION

This study identifies seven factors of player abilities necessary for playing a variety of video games based on an exploratory factor analysis of 32 items pertaining to skills or abilities required to play a particular game being rated. The factors were as follows:

Perceptual-Motor Abilities

Role-Playing

Numerical Reasoning

Problem Solving

Focus-Persistence

Acceptance of Uncertainty

Player Interaction

Perceptual-Motor Abilities. It is well known that many video games require advanced perceptual-motor abilities. These involve a number of components pertaining to perceptual speed, pattern recognition, object identification, simple and choice reaction time, tracking, targeting,

timing, rhythm, and response mapping. Some games obviously require this more than others. *Dance Central* (Figure 4) and other rhythm games require this ability, while turn based games such as *Pokémon* would not (Figure 10). In addition, *Perceptual-Motor* abilities are also required in fast-paced fighting games such as *Call of Duty* (Figure 2) and sports games such as *FIFA* (Figure 6).

Role-Playing. This factor involves the ability to process or interpret written and spoken information and deal with the moral issues of the game and relate to the characters. Games such as *Fallout: New Vegas* (Figure 5) and *Final Fantasy* (Figure 8) require role-playing while *Candy Crush* (Figure 3) does not.

Numerical Reasoning. Many games require the player to manage resources such as guns and ammo, health packs and potions, and attend to numeric information about status of self and opponents. This factor essentially represents an ability optimize these resources, maintain balance and do this under pressure. *Call of Duty* (Figure 2) and *Fallout: New Vegas* (Figure 5) require this whereas *Angry Birds* (Figure 1) and *Candy Crush* (Figure 3) do not.

Problem Solving Abilities. Many games either require the player to directly solve puzzles or require players to solve problematic situations in the game play. In particular, *Candy Crush* (Figure 3) uses puzzle combinations and *Pokémon* (Figure 8) requires problem solving in the narrative. On the other hand, rhythm games such as *Dance Central* (Figure 4) require no problem solving. Interestingly, the ability to assess and use probabilities loads on this factor, probably due to the occurrence of probability in brainteasers and its importance in strategy games.

Focus-Persistence. This factor is primarily patience getting through difficult or boring parts of the game and avoiding distractions. Most video games require this ability, but *Fallout: New Vegas* (Figure 5) is particularly high on this requirement. The genre *Action-Adventure*, *First-Person Shooter*, and *Role-Playing* are also high compared to other genre (Figure 13).

Acceptance of Uncertainty. Games by their nature are filled with chance and uncertainty as seen in Figures 1-12. "Dumb luck" loads highly on this factor as well as the ability to assess and use probabilities. However, games that involve simulations can constructions such as *Civilization* and *Minecraft* do not require this, as seen for the genre of simulations in Figure 13.

Player Interaction. This last factor is primarily the ability to deal with other players in a competitive or communicative manner. Essentially, it is the interaction with other people playing the game as either team members or opponents. Consequently, *Call of Duty* (Figure 2) and *Halo* (Figure 7) require this ability since they are often played with competing players. Single player games such as *Candy Crush* (Figure 3) do not by nature not require this ability.

Rater Bias

For a number of the games, a fairly large number of players evaluated the games. However, there may be an issue with representativeness, because

most of the raters were undergraduate students taking a psychology of video games course. However, having many different ratings will decrease the likelihood of bias due to any one person's game-playing abilities and the types of games they like to play. This particularly calls into question the reviews of games in many periodicals that are based on the opinions of one critic rather than those based on psychometric methods and a statistical sample of game players.

Reliability and Validity of Factors

The reliability of the skills questionnaire is established by the value of Cronbach's Alpha. Overall, Alpha was .894. Each subscale also yielded acceptable values of Alpha, except for the factors of *Acceptance of Uncertainty*, and *Player Interaction*. Additional work is needed on these two scales to increase their reliability.

The validity of the factors can be established by looking at the correspondence of their actual values with the expected values for particular games as indicated in a previous section. Games that one would expect to be high on perceptual-motor skills also score high (e.g. *Call of Duty*) and games that one would expect not to require perceptual-motor skills, score low (e.g., *Candy Crush*). The same is true for each factor, arguing that the factors have external validity. The same holds true for the factor scores for different genre as seen in the next section.

Profiles of Different Genres of Games

Grouping of games by genre helps to establish the reliability of the factors. The fact that all of the skills factors differed significantly among genre, except *Problem Solving* helps to establish the validity of the scales.

Moreover, the profiles of *Action-Adventure* and *Fighting* games are very similar (Figure 13) except that *Fighting* games require competitive *Player Interaction Abilities*. The profiles of *Action-Adventure* and *Role-Playing* games are very similar partly owing to the fact that games are often classified in the same genre. Finally, *Puzzle* and *Platform* games are also similar.

Conclusions

A coding instrument for assessing skill required for playing particular video games was developed. A factor analysis revealed seven skill factors requiring: *Perceptual-Motor Abilities*, *Role-Playing, Numerical Reasoning. Focus-Persistence, Problem Solving, Acceptance of Uncertainty, and Player Interaction.*

The data on 293 games series from a variety of coders indicates that the instrument has sufficient reliability and validity to be used as a standardized measure for assessing skills required by a video game. The instrument can be used to profile both individual games and game genres and can be used in future research on video games and by the video game developers and by the media for evaluation of video games.

ACKNOWLEDGEMENTS

This study was partially funded through a teaching grant from the Center for Teaching Excellence, University of Maryland. Special thanks are given to the students in Psyc 445, "The Psychology of Video Games and Entertainment" for their assistance in this study and the students that participated in the 2010

Summer Video Game Internship especially Rowan Blackmon, Zhong Lu, and Johnny Wu.

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Appendix A: Video Games Skills Survey

Video Game Skills Profile

For each of the following items, indicate the extent to which the skill or ability is necessary in the game:

1.	Creativity and innovative thinking	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
2.	Problem solving strategies	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
3.	Persistence and patience getting through difficult or boring parts	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
4.	Ability to tune out irrelevant stimuli	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
5.	Spatial navigation	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
6.	Ability to control the camera angle	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
7.	A competitive nature	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
8.	Ability to adapt to movement, orientations, and physics	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
9.	Quickly adapt to new rules, levels, and opponents	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
10.	Operate in secrecy, stealth, and deception	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
11.	Rapid, ballistic motor movements	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
12.	Fine, controlled motor movements	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9

13. Good eye-hand coordination	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
14. Ability to detect hidden figures	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
15. Ability to manage resources (e.g., weapons, possessions, health)	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
16. Ability to attend to graphical information in the game (e.g., arrows, lights, signs)	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
17. Ability to understand and follow written information in the game	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
18. Ability to understand and follow spoken instructions in the game.	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
19. Ability to use numeric information in the game (e.g., health bars, ammo counters, damage dealt)	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
20. Ability to communicate with other (human) players in order to succeed at in-game tasks	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
21. Ability to master the buttons on the controller or keyboard	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
22. Dumb luck	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
23. Ability to assess and use probabilities	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
24. Ability to remember events, names, and places in the game	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
25. Careful timing	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9
26. Ability to function under pressure and handle surprises	Not necessary Very necessary ○1 ○2 ○3 ○4 ○5 ○6 ○7 ○8 ○9

27. Desensitization to violence and horror	Not necessary ◯1 ◯2 ◯3 ◯4 ◯5 ◯6 ◯7 ◯8 ◯9	Very necessary
28. Ability to relate to and/or identify with a character	Not necessary ◯1 ◯2 ◯3 ◯4 ◯5 ◯6 ◯7 ◯8 ◯9	Very necessary
29. Ability to optimize things	Not necessary ◯1 ◯2 ◯3 ◯4 ◯5 ◯6 ◯7 ◯8 ◯9	Very necessary
30. Good balance between reckless abandon and cautiousness	Not necessary ◯1 ◯2 ◯3 ◯4 ◯5 ◯6 ◯7 ◯8 ◯9	Very necessary
31. Ability to set aside one's own moral values and code of ethics	Not necessary ◯1 ◯2 ◯3 ◯4 ◯5 ◯6 ◯7 ◯8 ◯9	Very necessary
32. Compassion and empathy for others	Not necessary ◯1 ◯2 ◯3 ◯4 ◯5 ◯6 ◯7 ◯8 ◯9	Very necessary

Appendix B: Rotated Component Matrix with Factor Loadings for Each Item

Rotated Component Matrix[a]

	Component						
	1 Perceptual-Motor	2 Role-Playing	3 Numerical Reasoning	4 Problem Solving	5 Focus-Persistence	6 Acceptance of Uncertainty	7 Player Interaction
Coordination	.760				.107		.100
Orientation	.760				.165		
Fine	.744						
Rapid	.649			-.203			
Timing	.636	-.132		.237			
Buttons	.609		.247				
Pressure	.564		.518	.158		.152	
Spatial	.499				.486	-.217	
Moral	.178	.764	.225			.164	-.158
Relate		.753	.148	.130			
Compassion		.747		.165			
Desensitizatio	.247	.658	.440				

n							
Spoken		.656	.221	.134	.309		.192
Memory		.541	.356	.256	.198		.173
Written	-.264	.472	.295	.245	.396		.242
Camera	.261	.426	.185		.349	-.285	.130
Resources		.328	.752	.111	.129		
Numeric		.268	.738				.211
Balance	.254	.274	.639			.162	
Optimize		.258	.583	.231			.215
Stealth	.224	.429	.542	.110			
Rules	.263		.500	.130	.224		
Detection	.107	.404	.423		.390	.102	-.120
Creativity		.151	.140	.825			
Problem		.121	.229	.801	.138		
Irrelevant	.380				.589	.320	
Persistence	-.177	.150		.464	.505	.144	-.218
Graphical	.130	.142	.446		.504		.128
Luck						.836	.109

Probabilities		.219	.174	.485		.545	.218
Communicate	.169	.116	.130			.106	.767
Competitive	.422	-.262	.162	-.116	-.161	.287	.523