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Is a General Quality Model of Software Possible: Playability versus Usability?

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Abstract

This paper is very exploratory and addresses the issue 'Is a general quality model of software possible?'. If possible, how specific can/should it be?' ISO 25000 Series SQuaRE is generally regarded as a general quality model which can be applied to most kinds of software. Usability is one of the 8 characteristics of SQuaRE's Product Quality Model. It is the main issue associated with SQuaRE's Quality in Use Model too. it is the most important concept associated software quality since using is the only ultimate goal of software products.

Playability, however, is generally regarded as a special type of usability, which can be applied to game software. This common idea contradicts with the idea that SQuaRE is valid for most kinds, at least many kinds, of software. The empirical evidences of this paper show that SQuaRE is too specific to be a general quality model of software.

Keywords : Software Quality, Usability, Playability, ISO/IEC(The International Standard Organization) 25000 Series SQuaRE(Systems and software Quality Requirement and Evaluation)

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1. Introduction

This paper addresses the issue 'Is a general quality model of software possible? If possible, how specific can/should it be?' Koh and Koh [2018] define the quality and usability of a software product as '*how good or bad is a product*?[1]' and '*how good is a product for being used*,' respectively.

On the other hand, ISO/IEC's SQuaRE defines the quality and usability of a software-intensive computer system as '*the degree to which the system satisfies the stated and implied needs of its various stakeholders, and thus provides value*' and '*the degree to which a product or system can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*,' respectively [ISO/ IEC 25010:2011, pp.8, 12, 18; ISO/IEC 25022: 2016]. SQuaRE defines quality in use as '*the degree to which a product can be used by specific users to meet their needs to achieve specific goals with effectiveness, efficiency, freedom from risk and satisfaction in specific contexts of use*.' [ISO/IEC 25010:2011, p. 8, 12, 18; ISO/IEC 25022:2016]. The definition is almost the same as that of usability except that it includes "*freedom from risk and context coverage*".

SQuaRE defines usability as one of 8 characteristics of software product quality. It is noticeable, however, that SQuaRE provide no explicit and specific definition of the software quality and the software product quality. It is also noticeable that Koh and Koh's [2018] definitions are very simple and precise in sharp contrast with those of SQuaRE.

Software quality is a very confusing concept. Koh and his colleagues [Koh, 2016; 2017a, 2017b; Koh and Jiang, 2017; Koh and Koh, 2018, Koh, 2019] try to resolve the confusion associated with software quality by elaborating the views regarding software quality into a generic model of software quality view. According to the software quality view model, the playability of a game software product can be defined as '*how good is a product for being used*' *or, in short, 'goodness for playing*' [Koh and Koh, 2018; Koh, 2019]. Since playing can be classified as a special sub-type of using, according to the software quality view model, playability can be classified as a special sub-type of usability [Koh and Koh, 2018; Koh, 2019].

Gonzalez Sanchez et al. [2009a, 2009b] define playability as "*a set of properties that describe the player experience using a specific game system whose main objective is to provide enjoyment and entertainment*." They regard playability as the extension of ISO's usability or quality in use for the player centered video game. However, the sub-characteristics of their playability are quite different from those sub-characteristics of SQuaRE's usability. This paper addresses this contraction by analyzing the survey data under the Koh and his colleagues' [Koh, 2016, 2017a, 2017b; Koh and Jiang, 2017; Koh and Koh, 2018; Koh, 2019] software quality view model.

2. Usability versus Playability

There are diverse definitions of usability [Boehm et al., 1978; Foraker Labs, 2002; González Sánchez et al., 2009b; Grady, 1992; ISO 9126-1:2001, 9241-11, 25010:2011, 25021:2012, 25022:2016, 25023:2016; Koh, 2019; Koh and Jiang, 2017; Koh and Koh, 2018; Microsoft Corporation, 2000; McCall et al., 1977; Nielsen, 2012; Shuja and Krebs, 2008; U.S.

1) In this section and the following section, italic font emphasizes that corresponding part is quoted with no or only slight changes from the cited literature.

Department of Health and Humanity Services, 2017]. Among them, ISO/IEC traditionally regards usability concerning the product (refer 〈Table 1〉). Herrera et al. [2010], Nielsen [2012] regard it concerning the product itself too. On the other hand, Gonzalez Sanchez et al. [2009a, 2009b], Microsoft Corporation [2000] and U.S. Department of Health and Humanity Services [2017] regard it concerning user's experiences. Koh and his colleagues [Koh and Jiang, 2017; Koh and Koh, 2018; Koh, 2019] combine these two approaches by defining two types of usability: the usability instance as the goodness of an individual using instance, that is evaluated by the user him/herself, and the product usability as the goodness of the product for using as a type of software activity. The product usability is obtained by aggregating all usability instances associated with a product.

Most, or almost all, software products are developed to be used and should be good to use. So, if it is defined as the goodness for using, usability should be the principal characteristic with which every characteristic is related directly or indirectly in a software quality model. For an example, SQuaRE is the most extensive software quality model ever existed, which contains 2 quality models of software and system (product quality model and quality in use model), 13 characteristics, 40 sub-characteristics, and 123 measures for systems and software quality in total [Koh 2017]. Most of these elements of SQuaRE are related with usability directly or indirectly, especially in a hierarchy of cause-and-effect relationships [Koh, 2016, 2017, 2019; Koh and Jiang, 2017; Koh and Koh, 2018]. It is the natural result since SQuaRE's chief goal is to assist software engineers to develop software products with high quality [ISO/IEC 25010:2011], that is, software products good to use.

Playing is a special-type activity of using. Koh and his colleagues [Koh and Jiang, 2017; Koh and Koh, 2018; Koh, 2019] define the goodness of performing a special-type activity of using as a special(-type) sub-characteristics of usability. Koh [2019] suggests the following principle.

- **Principle of Inheritance**: Every aspect of usability should be able to be inherited by its special sub-characteristics, possibly, with proper specializations.

In other words, the principle of inheritance can be rephrased as the following principle. Both the principles conform the general principle of generalization-and-specialization.

- **Principle of Generalization**: Usability should be defined by the common aspects which its every special sub-characteristic, including playability, possesses.

However, 〈Table 1〉 shows Gonzalez Sanchez et al.'s [2009b] playability does not share some sub-characteristics with other authors' usability. This implies that something is wrong. In this regard, Koh and his colleagues [Koh and Jiang, 2017; Koh and Koh, 2018; Koh, 2019] argue that the parts related with SQuaRE's usability are relevant only for working in which a given set of prespecified tasks should be completed. In the remains of this paper, this issue is addressed.

Satisfaction is one of the characteristics most frequently cited as the sub-characteristic of usability (refer 〈Table 1〉). Koh and Jiang [2017] defines the satisfaction as *'the user's evaluation on how much he/she is satisfied (by the using instance).'* In this paper, the satisfaction as defined by them is used as the operational definition of usability, hence, of playability too.

〈Table 1〉 Entity evaluated and sub-characteristics of Usability

	Software Quality Models[2]									
	Hr	ISO			Ns	QiU	GS	MS	US	KO
		9126-1	9241-11	25000						
Entity Evaluated										○
Product or Interface	○	○	○	○	○	○				○
User experience							○	○	○	
Sub-Characteristics										
Accessibility				○						
AR[3]				○						
Attractiveness		○								
Data-input-ability										○
Data-prepare-ability										○
Discovery								○		
Ease of use	○									
Effectiveness	○		○			○	○			
Efficiency/Productivity[4]	○		○		○	○	○	○	○	
Emotion							○			
Error[5]				○	○	○			○	
Experience	○									
Flexibility						○	○			
Immersion							○			
Intuitive design									○	
Learnability[6]		○		○	○		○	○	○	
Memorability					○				○	
Motivation							○			
Navigate-ability										○
Operability		○		○						
Output-wait-ability										○
Output-utilize-ability										○
Perceived Interaction quality	○									
Perceived transaction quality	○									
Play-ability										○
Response-wait-ability										○
Safety						○	○			
Satisfaction	○		○		○	○	○		○	
Sense of community	○									
Socialization							○			
Study-ability										○
Understandability		○								
User interface aesthetics				○						
Work-ability										○

2) Included models are GS [Gonzalez Sanchez et al., 2009b], Hr [Herrera et al., 2010], ISO models, KO [Koh, 2019], MS [Microsoft Corporation, 2000], Ns [Nielsen, 2012], US [U.S. Department of Health and Humanity Services, 2017]. For GS, the sub-characteristics of 'playability' are included. The column QiU identifies those included in the quality in use models of Alnanih et al. [2013], Herrera et al. [2010], ISO 9126-1:2001, and ISO 25000 too. However, those included only as the sub-characteristics of usability in the Herrera et al. [2010] and not included in the other quality in use models are excluded. It is noticeable that every quality in use model is regarding the product, its interface, and etc.

3) Appropriateness recognizability

4) 'Productivity' for Q91

5) 'User error protection' for ISO25000, 'error frequency and severity' for US, and 'safety (error prevention and recovery from error)' for quality in use of Alnanih et al [2013].

6) 'Learning' for MS, and 'ease of learning' for US.

3. Empirical Evidences

During the period from 19 November to 3 December 2019, undergraduate students of Business Administration School of Chungbuk National University were asked how much time they had played software games during the last week. They were asked, if any, to evaluate the most impressive game among the games they had played, using 5-point rating scales (1-strongly disagree and 5-strongly agree). Among 253 responses, 142 responses were valid and used in the exploratory factor analysis with principal component method and varimax rotation using SPSS 24.0. (refer Appendix).

The characteristic *satisfaction* is included as its adjective form (*satisfactory*) as the measure of playability. The characteristics *usefulness, trust, pleasure*, and *comfort* and the sub-characteristics of *satisfaction* in SQuaRE's quality in use model, are included in their adjective forms. *Beautiful* is included as the adjective form of 'user interface aesthetics' which is a sub-characteristic of usability in SQuaRE's product quality model.

Effectiveness and *efficiency* are other important traditional characteristics of existing usability models and their adjective forms (*effective and efficient*) are included. The characteristic easy are included as the adjective form of 'ease of use.' The characteristics *appropriate, beneficial, convenient, educational*, and *practical* are included along with them. The characteristics *difficult* and *harmful* are included as the antonyms of *easy* and *beneficial*, respectively, to increase reliably. If the general wisdom that *effectiveness* and *efficiency* are important distinctive sub-characteristics is true, then they will be very closely correlated with the characteristics *efficient, effective, or useful*. At least, we had thought so.

Other characteristics are included on our individual judgement. Some of them are identified during the preliminary interviews of the survey.

All the characteristics except *satisfactory* are used in the factor analysis. 〈Table 2〉 shows the results. The factor analysis identified 10 factors. We named 3 factors as Joy, Stimulus, and Novelty, respectively. However, we failed to name the rest 7 factors. The characteristic *satisfactory* is excluded from the factor analysis. If it is included an exploratory factor analysis, it belongs to the factor Joy, leaving the results almost the same as those presented in this paper. 〈Table 2〉 shows that the 3 factors and the characteristics that belong to them, except original, are highly correlated with *satisfactory*. Beside them, only the characteristics *convenient, effective*, and relaxing are statistically significantly correlated with the characteristic *satisfactory* at the 1% significance level.

On the other hand, the characteristics *appropriate, beautiful, beneficial, comfortable, difficult, dynamic, easy, educational, efficient, emotional, harmful, intellectual, pleasant, practical, realistic, trustworthy*, and *useful*, are proven to be lowly correlated with the characteristic satisfactory. Especially, it is noticeable that the characteristics *beautiful, comfortable, efficient, pleasant, trustworthy*, and *useful* are lowly correlated with the characteristic *satisfactory*.

The mean values of the characteristic *satisfactory* and the characteristics that belong to the factor Joy are especially large: those of the characteristics *satisfactory, enjoyable, fun, exciting, interesting*, and *attractive* are 3.585, 3.683, 3.838, 3.465, 3.592, and 3.303, respectively. The mean values of the characteristics that belong to the factors Stimulus and Novelty are larger than 3.0 with the only

〈Table 2〉 The Game was …

Characteristics				Factors			
Name	Mean	Std. Deviation	Correlation with Satisfactory	Name	Mean	Std. Deviation	Correlation with Satisfactory
satisfactory	3.585	0.955	1	--	--	--	--
enjoyable	3.683	1.126	0.378**	Joy	3.756	0.780	.400**
fun	3.838	0.987	0.327**				
exciting	3.465	1.153	0.312**				
interesting	3.592	0.931	0.254**				
attractive	3.303	1.078	0.199*				
stimulating	3.162	1.177	0.389**	Stimulus	3.122	0.864	.391**
splendid	3.120	1.176	0.304**				
curious	3.070	1.109	0.256**				
fantastic	3.134	1.162	0.217**				
creative	3.254	1.120	0.285**	Novelty	3.056	0.933	.250**
novel	3.042	1.110	0.231**				
original	2.873	1.135	0.108				
dynamic	2.979	1.223	0.102	Factor 4	3.150	0.579	0.118
easy	3.225	1.013	0.046				
difficult	2.754	1.046	-0.032				
convenient	3.275	1.066	0.217**	Factor 5	2.967	0.671	0.111
comfortable	3.028	1.024	0.048				
intellectual	2.817	1.247	-0.041				
harmful	2.923	1.227	-0.034				
effective	2.958	1.116	0.210**	Factor 6	2.789	0.907	0.108
efficient	2.894	1.122	0.157				
educational	2.514	1.189	-0.098				
relaxing	3.070	1.177	0.392**	Factor 7	2.842	0.842	0.103
practical	2.747	1.145	-0.097				
pleasant	2.725	1.105	-0.042				
realistic	2.824	1.181	0.035				
useful	2.747	1.120	0.06	Factor 8	2.747	1.120	0.060
emotional	2.732	1.097	0.103	Factor 9	2.817	0.884	0.052
trustworthy	2.901	1.106	-0.019				
appropriate	3.063	1.099	0.14	Factor 10	2.923	0.671	0.023
beautiful	2.859	1.069	0.095				
beneficial	2.782	1.066	-0.062				

**p 〈 0.01, *p 〈 0.05.

exception of 2.873 of the characteristic *original*.

On the other hand, the mean values of most characteristics that belong to the other factors are smaller than 3.0. The exceptions are the characteristics easy, *convenient*, *comfortable*, *relaxing*, and *appropriate*: their mean values are 3.225, 3.275, 3.028, 3.070, and 3.063, respectively. It is especially noticeable that those of the characteristics *effective*, *efficient*, *useful*, and *beautiful* are smaller than 3.0.

4. Discussions

The empirical evidences clearly show that Joy is the utmost important driving factor of software game while the characteristics *effectiveness, efficiency*, and *usefulness* are not important to software games. It conforms to the common sense that people play software games to get joy, but not to accomplish some practical tasks, for example, that are assigned to the workers of corporations as their jobs in their work places.

The empirical evidences also show that the factors Stimulus and Novelty are important too. People may play a software game to get stimulated when they feel dull. A cause-and-effect relationship may exist among the factors Joy, Stimulus, and Novelty. Especially, the factor Novelty may influence both the factors Joy and Stimulus as a cause. This issue should be investigated further.

Mean values of the characteristics *convenient* and *relaxing* are larger than 3.0 and they are statistically significantly correlated with the characteristic *satisfactory*. The characteristic *relaxing* may represent a factor that contrasts with the factor Stimulus. Some people may play a software game to get stimulated while others may play a (another kind of) game to feel relaxed. It shares the same factor, however, with the characteristics *practical* and *pleasant*. We had expected the characteristic *practical* to constitute the same factor with the characteristics *effective, efficient*, and *useful*. This seemingly incongruity should be resolved by further researches.

The characteristic *convenient* seems to be more related with the environment in which a software game is played rather than the game itself, for example, with the process through which the user gets to be able to play the game. The mean value of the characteristic *comfortable* is larger than 3.0 too, although it is only very slightly correlated with the characteristic *satisfactory*. It seems to be more related with the environment in which a software game is played rather than the game itself too. It is very odd that these two characteristics form a factor together with the characteristic *intelligent*. It is one of the deficiencies of this research not to distinguish the characteristics associated with the software game itself and those chiefly associated with the system or environment in which the game is played. This shortcoming should be resolved by further researches too.

The characteristics with mean value under 3.0 and statistically insignificant correlation with the characteristic *satisfactory* (the characteristics *appropriate, beautiful, beneficial, comfortable, dynamic, difficult, easy, educational, efficient, emotional, harmful, intelligent, original, pleasant, practical, realistic, trustworthy, useful*) can be interpreted that they are not important or relevant to the game software. Such characteristics encompass most traditional characteristics of existing usability models including SQuaRE. For an example, the empirical evidences show that the characteristic *appropriate* is not important. The characteristic *appropriate* recognizability of SQuaRE cannot be important or relevant for the game software.

The only exceptions are the characteristics *satisfactory* and *effective*. This fact supports Koh and his colleagues' colleagues' [Koh and Jiang, 2017; Koh and Koh, 2018; Koh, 2019] argument that the characteristic *satisfactory* can be used as an operational definition of usability, at least, for the game software. It is especially noticeable that the characteristic *satisfactory* reflects the user's overall evaluation of the instance of his/her playing a software game while the other characte-

ristics reflect the user's evaluation of specific aspects of his/her playing instance or the software game that he/she played itself.

It is noticeable that the characteristic *effective* turned out to be statically correlated with the characteristic *satisfactory* even though its mean value is under 3.0. 'Effective' can have various meanings according to the goals of the users of software. For example, 'effective' may mean 'being joyful' for a game player, 'completing some tasks' for a worker, or 'getting knowledge' for a student. It is especially noticeable that the characteristics *appropriate, educational, easy*, or *trustworthy* may turn out to be important for educational software games.

In summary, the empirical evidences clearly show that the factors Joy, Stimulus, and Novelty are important for the game software and that most traditional characteristics of existing usability models including SQuaRE are neither important nor relevant for the game software. This conclusion also supports Koh and his colleagues' [Koh and Jiang, 2017; Koh and Koh, 2018; Koh, 2019] argument that usability should be variously and specifically defined for each type of software. Most existing usability models are too specific to be a generic model that can be applied to the general software.

5. Conclusions

This paper addresses the issue 'Is a general quality model of software possible? If possible, how specific can/should it be?' In this paper, adopting the definitions of Koh and Koh [2018] and Koh [2019], the quality and usability of a software product, and the playability of a game software product are defined as 'how good or bad is a product', 'goodness for using,' and 'goodness for playing,' respectively. According to the definitions, playability is a special type of usability, conforming to the existing general conception.

To fined find the factors of playability empirically, 142 responses were collected from undergraduate students of Business Administration School of Chungbuk National University during the period from 19 November to 3 December 2019 and used in an exploratory factor analysis with principal component method and varimax rotation using SPSS 24.0. The students were asked to evaluate the most impressive game among the games they had played, if any, using 5-point rating scales (1-strongly disagree and 5-strongly agree). The satisfaction which the player evaluated on her/his experience of playing a game is used as the operational definition of playability. It is noticeable that characteristic *satisfaction (satisfactory)* reflects the user's overall evaluation of the instance of his/her playing a software game. The other characteristics included reflect the user's evaluation of specific aspects of his/her playing experience instance or the software game that he/she played. The characteristics *usefulness, trust, pleasure*, and *comfort* and the subcharacteristics of *satisfaction* in the quality in use model of SQuaRE, are included in their adjective forms. The characteristic *beautiful* is included as the adjective form of user interface aesthetics which is a sub-characteristic of usability in the product quality model of SQuaRE. The characteristics *effectiveness and efficiency* are other important traditional characteristics of usability and their adjective forms (*effective* and *efficient*) are included. The characteristic *easy* are included as the adjective form of ease of use. The characteristics *appropriate, beneficial, convenient, educational,* and *practical* are included along with them. The characteristics *difficult*

and *harmful* are included as the antonyms of the characteristics *easy* and *beneficial*, respectively, to increase reliably. Other characteristics are included on the authors' individual judgement. Some of them are identified during the preliminary interviews of the survey.

The empirical evidences show that the factors Stimulus, Novelty, and, especially, Joy are the utmost important driving factors for the game software while most traditional characteristics of existing usability models including SQuaRE (for example, the characteristics *appropriate recognizability, ease of use, comfort, effectiveness, efficiency, pleasure, trust, usefulness*) are neither important nor relevant for the game software. the empirical evidences also support Koh and his colleagues' [Koh and Jiang, 2017; Koh and Koh, 2018, Koh, 2019] argument that usability should be variously and specifically defined for each specific type of software. Most existing usability models are too specific to be a generic model that can be applied to the general software. The empirical evidences also imply that 'effective' can have various meaning depending on the goals of using a software product and, hence, lacks validity and reliability. The empirical evidences also show that it is necessary for the characteristics included in this paper to be defined more rigorously.

The empirical evidences show that the structure including the major sub-characteristics, of playability does not coincide with that of the parts related with usability, implying that ISO's SQuaRE, especially the parts related with usability, that is believed to be valid for general types of software may be invalid for various types of software. The parts related with usability of ISO's SQuaRE seems to be valid only for the application software products to support some practical tasks or jobs.

The analysis in this research is never meant to be confirmatory nor conclusive. It is very exploratory. Although data, analysis, and interpretation of the research are reasonably valid, reliable, and meaningful, the conclusions should be confirmed and elaborated by further researches. Especially, the characteristics associated with the software game itself and those chiefly associated with the system or environment in which the game is played are not rigorously distinguished. This shortcoming should be resolved by further researches. A cause-and-effect relationship among the factors of usability may exist. This issue should be investigated by the further researches too.

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〈Appendix〉 The Results of Exploratory Factor Analysis

〈Table A1〉 Results of the Exploratory Factor Analysis

Characteristics	Factors									
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
fun	0.823	0.220	-0.009	-0.061	-0.017	0.037	0.030	-0.068	0.167	-0.037
enjoyable	0.749	0.196	0.173	0.070	-0.027	0.027	-0.015	0.282	-0.096	0.159
attractive	0.614	0.041	0.228	-0.060	0.030	0.002	0.515	-0.114	-0.115	-0.241
exciting	0.584	0.477	0.068	-0.063	-0.001	0.090	0.009	0.274	0.035	-0.065
interesting	0.568	-0.051	0.244	0.419	-0.174	0.007	0.024	-0.039	-0.183	0.059
splendid	0.071	0.760	0.190	0.015	-0.221	-0.042	-0.025	-0.006	-0.080	0.155
stimulating	0.110	0.759	-0.048	0.005	-0.059	0.037	0.027	-0.065	-0.090	-0.021
fantastic	0.302	0.647	0.093	-0.081	0.127	0.271	-0.011	0.003	0.155	-0.170
curious	0.088	0.563	0.422	-0.138	0.010	0.181	0.152	0.039	0.180	-0.017
original	0.076	0.082	0.854	0.060	0.107	-0.126	0.131	0.033	0.011	0.048
novel	0.227	0.116	0.818	0.150	0.043	-0.037	-0.041	-0.203	-0.024	0.080
creative	0.104	0.468	0.582	0.113	-0.083	0.214	0.191	0.155	0.109	-0.003
effective	0.171	0.025	0.175	0.781	0.123	-0.130	0.023	0.023	-0.033	0.000
efficient	0.081	0.001	0.015	0.780	0.145	-0.177	0.007	0.034	0.054	-0.069
educational	-0.288	-0.108	-0.047	0.617	0.149	-0.004	0.066	-0.096	0.192	0.115
realistic	-0.078	-0.050	-0.155	0.158	0.770	-0.008	-0.061	-0.018	-0.064	0.099
practical	0.071	-0.135	-0.003	0.123	0.736	0.010	0.178	-0.244	0.236	0.064
pleasant	-0.034	-0.112	0.347	0.134	0.725	0.065	0.045	0.114	0.052	0.170
relaxing	-0.051	0.179	0.236	0.064	0.495	-0.156	0.208	0.281	0.213	-0.146
easy	0.020	-0.105	0.127	0.085	0.085	-0.820	-0.104	0.104	0.086	0.032
difficult	0.035	0.130	-0.014	-0.117	0.031	0.804	-0.100	-0.156	0.087	0.135
dynamic	0.120	-0.001	0.315	-0.124	0.129	0.545	0.052	0.163	0.417	-0.127
beautiful	0.060	0.142	0.104	-0.008	0.066	0.068	0.817	-0.031	-0.073	0.136
beneficial	-0.107	-0.016	-0.029	0.486	0.107	0.059	0.577	0.116	0.173	0.114
appropriate	0.448	-0.156	0.087	0.114	0.097	-0.209	0.532	-0.098	0.241	-0.113
harmful	-0.073	0.186	0.151	-0.009	-0.031	0.265	0.011	-0.711	-0.005	-0.098
intellectual	-0.038	-0.173	0.097	0.448	0.173	0.069	0.153	-0.573	0.089	0.257
convenient	0.193	0.247	0.286	0.378	0.044	0.230	-0.023	0.508	-0.057	0.073
comfortable	-0.024	0.013	0.147	0.395	-0.014	-0.092	0.264	0.402	0.389	-0.004
useful	-0.012	0.018	-0.009	0.194	0.182	0.087	-0.009	-0.072	0.829	0.236
trustworthy	0.034	-0.112	0.055	-0.003	0.126	0.053	0.017	0.003	0.327	0.820
emotional	-0.113	0.369	0.153	0.126	0.247	-0.021	0.272	0.039	-0.251	0.582
Eigen value	5.439	4.172	1.899	2.569	1.717	1.562	1.396	1.309	1.514	1.033
% of Variance	16.988	13.038	5.934	8.029	5.366	4.882	4.362	4.092	3.607	3.229
Cumulative %	16.998	30.035	43.998	38.065	49.365	54.247	58.609	62.700	66.308	69.537
Cronbach's alpha	0.789	0.736	0.777	0.705	0.709	-.300	0.568	0.242	0.829	0.447

KMO = 0.692, X^2 = 1922.951, df = 496, Sig = .000.

〈Table A2〉 Correlations between Factors

Factors	Joy	Stimulus	Novelty	F4	F5	F6	F7	F8	F9	F10
Joy	1									
Stimulus	.440**	1								
Novelty	.407**	.456**	1							
F4	0.032	-0.107	.169*	1						
F5	-0.025	-0.058	.175*	.308**	1					
F6	0.102	-0.122	.199*	.189*	.218**	1				
F7	.200*	0.100	.249**	.290**	.247**	0.032	1			
F8	0.124	0.063	.328**	.529**	.410**	0.114	.383**	1		
F9	-0.054	0.028	0.079	.282**	.322**	0.096	.197*	.654**	1	
F19	-0.003	0.133	.219**	.173*	.311**	-0.031	0.135	.351**	.282*	1

〈Table A1〉 and 〈Table A2〉 show the result of a factor analysis discussed in this paper. The analysis is never meant to be confirmatory nor conclusive. It is very exploratory, and its details are not presented in this paper. The data, analysis, results, however, are reasonably valid, reliable, and meaningful. We named the first 3 factors as Joy, Stimulus, and Novelty, respectively. However, we failed to name the other factors properly.

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