A Comparative Study on Influencing Factors of Repurchase Intention in Internet Shopping Platforms in South Korea, China, and India: A Two-Stage SEM-Artificial Neural Network Analysis

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Abstract

In this study, we conducted a comparative study of Korea, China, and India on the influencing factors of internet shopping repurchase intention through SEM-ANN two-stage analysis, and analyzed changes in predictive performance and variable importance. As a result, through SEM analysis, it was confirmed that the factors influencing repurchase intention in internet shopping are different between Korea, China, and India. It has been proven that the R^2 of SEM is improved through ANN. And It has been proven that statistical-conclusion-validity was improved through which the size of the path coefficient in SEM remained similar to that of ANN's variable importance analysis.

Keywords : SEM-Artificial Neural Network Two-Stage Analysis, Internet Shopping Repurchase

1. Introduction

Currently, consumers are able to directly purchase products across international borders, establishing overseas internet purchasing as a standard consumer practice. For instance, in 2019, international consumers spent a total of $4.4 billion on South Korean internet shopping sites, with Chinese consumers alone contributing $3.8 billion, or 86% of the total sales [Lu and Kwon, 2021]. Furthermore, the expenditure by Chinese consumers on these platforms witnessed a significant surge, escalating from $234 million in 2014 to $4.4 billion in 2019, an increase exceeding sixteen times the amount spent five years earlier. This dramatic growth highlights the expanding scale and importance of cross-border e-commerce, particularly involving South Korean online marketplaces.

Until now, research into the global trend of direct internet purchasing has been somewhat constrained and typically biased towards specific areas of interest. For example, some studies have concentrated on South Korean consumers engaging with American or Japanese e-commerce giants such as Amazon and eBay [Lee and Rha, 2015; Lu and Kwon, 2021]. Conversely, there is a significant shortfall in scholarly attention given to Chinese or Japanese consumers who make purchases from South Korean online platforms. Likewise, there is a noticeable scarcity of research concerning Indian or Chinese customers buying from South Korean entities. This gap highlights a need for more comprehensive investigations into the buying patterns of these consumer groups within the context of South Korean e-commerce.

Given the marked rise in international online transactions, it is essential, from both academic and practical perspectives, to explore the factors that influence purchasing and repurchasing behaviours in e-commerce across different countries. This study investigates the key determinants of online shopping behaviours among consumers in South Korea, India, and China, recognising the significant influence these nations, particularly China and India, are projected to have on Korean commercial activities in both the near and long term. The research focuses on repurchase intentions on internet shopping platforms as the primary dependent variable, while considering Price, Quality, Service, and Information Search as independent variables. This approach allows for a detailed examination of the cross-national factors that affect repurchase intentions, offering insights into the diverse consumer dynamics in these significant markets.

In this study, a two-stage SEM-ANN analysis is adopted as the analytical method. These days, the field of Social Science and Management has integrated Deep Learning with SEM-ANN [Jiang and Kwon, 2023]. This methodology capitalises on SEM's capacity for delineating causal relationships and ANN's predictive accuracy to exploit the advantages of Explainable Artificial Intelligence (XAI). Structural Equation Modelling (SEM) focuses on relationships between variables based on linearity, while Artificial Neural Networks (ANN) utilise non-linearity to discern and model complex patterns [Kwon et al., 2024]. The two-stage SEM-ANN approach merges SEM's linear aspects with ANN's non-linear capabilities to deepen understanding of causal relationships and enhance predictive efficacy. This research employed the two-stage SEM-ANN framework to examine how SEM's explanatory power (R^2) is augmented

within ANN and to investigate changes in the impact of independent variables, informed by SEM's linearity, through ANN's non-linear analysis.

2. Research Model

Parasuraman et al. [1994] suggested a framework to assess consumer satisfaction through three critical dimensions: price, product quality, and service quality. Building on this foundation, Kim and Rhee [2004] highlighted these same factors as pivotal in influencing decisions for clothing purchases, while Bei and Chiao [2006] emphasized the importance of reasonable pricing, product quality, and service quality in fostering consumer satisfaction and loyalty. Drawing on these foundational studies and further research [Woo et al., 2023; Chen et al., 2018; Yunita et al., 2017], the current study examines price, quality, and service as essential determinants of repurchase intentions within online shopping environments. This approach seeks to deepen understanding of how these factors contribute to ongoing consumer engagement and loyalty on digital commerce platforms.

Internet e-commerce, conducted remotely, presents consumers with various uncertainties and risks throughout the shopping process. To mitigate these risks, consumers actively gather information about products, sellers, and delivery logistics, or seek out others' purchasing experiences for guidance [Hong and Jin, 2011; Liu and Noh, 2020]. Those who are more sensitive to risk tend to engage more thoroughly in information seeking [Blodgett and Hill, 1991], and as perceived risks increase, consumers broaden their search across a more diverse array of information channels [Castle and Murray,

1991]. This research focuses on non-face-to-face e-commerce environments and pinpoints these information-seeking behaviors as critical determinants shaping repurchase intentions. By understanding these behaviors, the study aims to enhance strategies for fostering consumer confidence and loyalty in online markets.

This research includes demographic and IT environmental variables to clearly delineate the impact of price, quality, service, and information search on repurchase intentions. It examined demographic variables such as gender, age, and expenditure on Internet shopping. Furthermore, the study evaluated IT environment variables, specifically Internet speed and associated costs, to assess their influence on consumer behaviour in online shopping contexts.

3. Research Methodologies

3.1 Analysis Methods

In the domain of Management Information Systems, the researches that integrate with Structural Equation Modelling (SEM) and Artificial Neural Networks (ANN) typically employs a method whereby PLS-SEM analysis results are inputted into ANN for additional scrutiny. This study similarly leveraged latent variable scores derived from SmartPLS as the input data for ANN analysis. The focus of the research was to undertake a detailed comparison of how the explanatory power, denoted by R^2, is enhanced between SEM and ANN outputs, and to examine the variations in the impact exerted by independent variables. This approach enables a thorough evaluation of the effectiveness of these combined methodologies, providing valuable in-

sights into their applicability and precision in contemporary research.

In this research, the Artificial Neural Network (ANN) analysis was executed using the Multi-Layer Perceptron (MLP) feature from the Neural Networks module in SPSS. Consistent with prevailing practices in SEM-ANN studies, this analysis employed the standard settings provided by the MLP [Alharbi and Sohaib, 2021; Nguyen et al., 2021]. This approach ensured a consistent framework for examining the models. The analysis began by feeding latent variable scores derived from Partial Least Squares (PLS) analysis into the MLP. After shuffling the data, training and validation datasets were distributed in a 9:1 ratio. This setup facilitated a rigorous ten-fold cross-validation process to thoroughly evaluate the model's robustness. Finally, this study compared the predictive (explanatory) performance of both PLS and ANN by calculating the coefficient of determination, R^2, thereby assessing their effectiveness in modelling complex relationships.

In PLS analysis, the coefficient of determination, R^2, serves as a critical measure to evaluate how effectively the independent variables can explain or predict the dependent variable. Here, the dependent variable is represented as y, and its predicted value is indicated as $\hat{y}$. The sum of squared errors (SSE) is calculated by taking the sum of the squared differences between y and $\hat{y}$. In contrast, the sum of squared deviations (SSD) is derived from the squared differences between the dependent variable y and its average value. The mean squared error (MSE) is then determined by dividing the SSE by the total number of samples, represented by 'n' in the associated mathematical expression.

$$\text{SSE (sum of squared error)} = \sum_1^n (y - \hat{y})^2$$

$$\text{SSD (sum of squared deviation)} = \sum_1^n (y - \overline{y})^2$$

$$\text{MSE} = \frac{\text{SSE}}{n}$$

R^2 calculation is carried out as follows:

$$R^2 = 1 - \frac{\text{SSE}}{\text{SSD}}$$

$$R^2 = 1 - \frac{\frac{\text{SSE}}{n}}{\frac{\text{SSD}}{n}}$$

$\frac{\text{SSD}}{n}$ is variance. In SmartPLS, data is standardized and analyzed. Therefore, variance becomes 1, so, the formula is as follows.

$$R^2 = 1 - \frac{\text{SSE}}{n}$$

$$R^2 = 1 - \text{MSE}$$

Therefore, in SmartPLS, once R^2 is determined, it is possible to directly infer MSE.

Survey Questionnaire and Data Collection

The key variables in this research are price, quality, service, and information search. Price means that the price offered by an internet shopping mall is cheaper than that of an offline store or other internet shopping mall, or that the overall price including shipping costs is lower. quality means the superior nature of the products on offer, which may include cutting-edge trends or uniquely designed items. service means that deliveries are not only swift and secure but also that the process for returns and exchanges is efficient, supported by multiple communication channels for addressing customer queries. Information search means the activity of in-

〈Table 1〉 Characteristics of Respondents

		Korea	China	India
Gender	Male	0.402	0.347	0.472
	Female	0.598	0.653	0.528
Age	Less than 20 years old	0.211	0.074	0.023
	Between 21~25 years old	0.318	0.341	0.093
	Between 26~30 years old	0.211	0.214	0.357
	Between 31~35 years old	0.100	0.232	0.328
	Between 36~40 years old	0.046	0.059	0.000
	More than 40 years old	0.115	0.080	0.200
Frequency of Purchase (Monthly)	1~2 times	0.487	0.288	0.765
	3~4 times	0.318	0.257	0.081
	5~6 times	0.096	0.198	0.067
	7~8 times	0.046	0.065	0.061
	More than 9 times	0.054	0.192	0.026

vestigating product specifications and reading through consumer reviews online. Lastly, repurchase intention indicates the likelihood of customers returning to the website for future purchases or choosing to buy again.

The dataset employed in this study comprises 929 responses, gathered through an online survey conducted in 2019. This survey targeted individuals from Korea, China, and India, aiming to analyze factors that influence the repurchase of clothing on internet shopping platforms. The distribution of the responses is as follows: Korea 261, India 345, and China 323. 〈Table 1〉 shows the key demographic and behavioral characteristics of the respondents.

4. Data Analysis

4.1 Reliability and Validity

This study utilised data from 929 responses to validate the reliability and validity of its measurement model. SmartPLS software, a tool frequently used for PLS-SEM analysis, facilitated this process. The findings, as detailed in 〈Table 2〉, demonstrate robust reliability; Average Variance Extracted (AVE) values exceeded 0.5, Composite Reliability (CR) surpassed 0.7, and Cronbach's alpha was above 0.6. Additionally, factor loadings for the constructs of the measurement items were consistently above 0.797, further affirming

〈Table 2〉 Reliability Test

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Price	0.911	0.912	0.944	0.849
Quality	0.913	0.913	0.939	0.792
Service	0.833	0.834	0.899	0.749
Information Search	0.816	0.834	0.890	0.731
Repurchase Intention	0.941	0.941	0.962	0.894

〈Table 3〉 Discriminant Validity

|	1	2	3	4	5	6	7	8	9	10
1. Price	0.921									
2. Quality	0.663	0.89								
3. Service	0.706	0.712	0.865							
4. Information Search	0.668	0.709	0.691	0.855						
5. Gender	0.036	0.091	0.077	0.095	1					
6. Age	0.143	0.087	0.113	0.084	-0.057	1				
7. Internet Speed	0.512	0.527	0.562	0.546	-0.024	0.1	1			
8. Internet Cost	0.547	0.52	0.515	0.517	0.021	0.091	0.472	1		
9. Expenditure	0.193	0.314	0.271	0.28	0.136	0.062	0.238	0.173	1	
10. Repurchase Intention	0.666	0.748	0.756	0.687	0.106	0.063	0.565	0.462	0.353	0.946

the model's reliability.

Following, the discriminant validity of the measurement model was analyzed, as detailed in 〈Table 3〉. The analysis confirmed discriminant validity, indicated by the square roots of AVE for each construct exceeding the corresponding correlation coefficients among the constructs. This result validates that the constructs are distinct and measure different dimensions as intended.
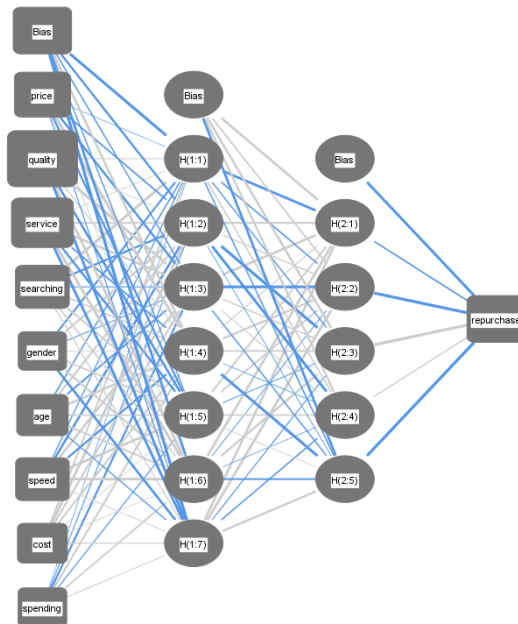
4.2 SEM and ANN Analysis

In this study, the structural equation model was analyzed using SmartPLS, and the resulting latent variable scores were input into SPSS MLP as input data for analysis. Figure 1 is the result of analyzing Korean data using SmartPLS. 〈Figure 2〉 is an ANN analysis model composed of two hidden layers. The first hidden layer consisted of 7 nodes, the second hidden layer consisted of 5 nodes, and the rest were set to the default SPSS MLP. In the ANN analysis, as in the SEM analysis, 90% of the total data was separated as training data and 10% as testing data, and 10 folds cross validation was performed.
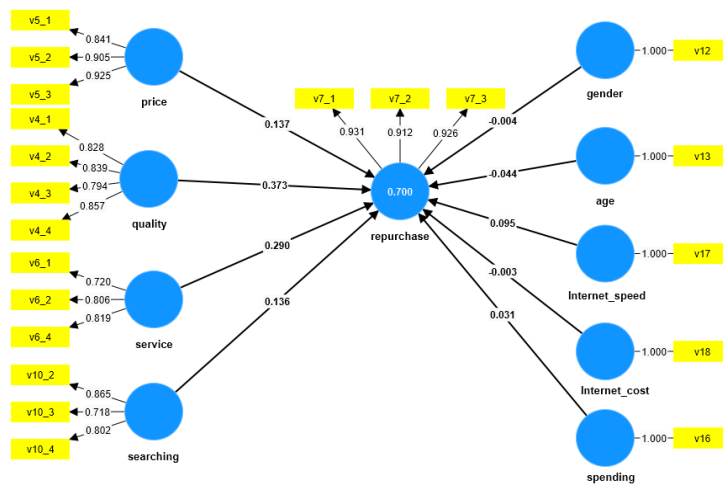
〈Figure 1〉 Results of SEM Analysis by SmartPLS

〈Figure 2〉 Results of ANN Analysis by SPSS MLP

4.3 SEM Analysis Results

The outcomes of the comparative analysis investigating the impact of price, quality, service, and information search for repurchase intention in online shopping across South Korea, China, and India, while accounting for control variables, are summarized in 〈Table 4〉.

The explanatory power of the independent variables on the dependent variable, measured by R^2, was highest in South Korea (70%) and India (70.3%), followed by China (49.9%).[1] This proved that the influencing factors on repurchase intention differ by country.

As a result of verifying the path coefficient at the 5% significance level, price, quality, service, and information search were all significant in Korea, price, quality, and service were significant in China, and service and information search were significant in India. It appeared significant. This proved that the influencing factors on repurchase intention differ by country.

As a result of examining the control variables at the 5% significance level, internet speed was significant in Korea, internet speed and age were significant in China, and gender was significant in India. As a result, it was confirmed that in Korea and China, the faster the internet speed, the higher the repurchase intention for internet shopping. In China, the younger the customer, the higher the repurchase intention, and in India, the female, the higher the repurchase intention.

Next, looking at the relative power of influence on repurchase intention up to 3rd place, Korea came in the order of quality, service, and price, China came in the order of service, quality, and price, and India came in the order of service, information search, Appeared in

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[1] MSE (Mean Squared Error) of Korea, China, and India by SmartPLS analysis is 0.3, 0.501, and 0.297, respectively.

⟨Table 4⟩ Comparison of SEM and ANN Analysis Results

		Korea		China		India	
		SEM	ANN	SEM	ANN	SEM	ANN
Variable Importance	Price	0.137**	0.139	0.113*	0.086	0.115	0.107
	Quality	0.373***	0.310	0.166***	0.174	0.118	0.094
	Service	0.290***	0.214	0.322***	0.264	0.455**	0.289
	Information search	0.136*	0.106	0.093	0.104	0.209*	0.176
	Gender	−0.004	0.024	0.011	0.030	0.085***	0.063
	Age	−0.044	0.037	−0.141***	0.058	0.051	0.055
	Internet speed	0.095*	0.083	0.166**	0.121	0.014	0.094
	Internet cost	−0.003	0.049	−0.082*	0.061	−0.036	0.065
	Expenditure	0.031	0.039	0.145**	0.103	0.033	0.056
R²	Train_R²	0.700	0.738	0.499	0.501	0.703	0.735
	Test_R²		0.724		0.532		0.721

*0.05 < p, ** 0.01 < p, ***0.001 < p

order of quality. As a result, it was confirmed that the influence of factors on repurchase intention also differs depending on the country.

4.4 ANN Analysis Results

The ANN analysis results are displayed in the ANN column of ⟨Table 4⟩, which is the average of 10 folds cross validation. Detailed results of 10 folds cross validation are included in the appendix.

The difference between Train R² and Test R² in Korea, China, and India is not significant, so it is judged that there is no overfitting. When compared based on Test R², Korea and India were very similar at 72.4% and 72.1%, respectively, while China's was relatively low at 53.2%.

SPSS MLP presents the relative importance of independent variables to dependent variables through sensitivity analysis. Variable importance is interpreted similarly to the path coefficient of SEM. Sensitivity analysis is a method to check whether there is any difference in the R² or MSE of the model when

one independent variable is removed from the original model or mixed randomly.

Looking at the three rankings of variable importance averaged through 10 folds cross validation, Korea was ranked in the order of quality, service, and price, China was ranked in the order of service, quality, and information search, and India was ranked in the order of service, information search, and price.

4.4.1 Comparison of Effect Sizes of R²

In the SEM model, the degree of change in R² is presented as the effect size (Hair et al., 2016). If the effect size is 0.35 or more, it is called a large effect, if it is between 0.15 and 0.35, it is called a moderate effect, and if it is between 0.02 and 0.15, it is called a small effect. When the R² of the research model is called and the R² due to changes in this research model is called , the effect size f^2 calculation formula is as follows.

$$f^2 = \frac{R^2A - R^2B}{1 - R^2A}$$

When the latent variable values calculated as a result of PLS analysis were inputted and analyzed in the ANN model, the effect size f^2 was small at 0.087 in Korea, 0.071 in China, and 0.065 in India. Previous studies have shown that ANN has higher prediction performance than PLS (Sohaib et al., 2019; Duc et al., 2023). As a result of examining the degree of improvement in prediction performance in terms of f^2, the ANN analysis results showed a smaller effect size than the PLS analysis results.

4.4.2 Comparison of SEM's path coefficient and ANN's variable importance

The results of a comparative analysis of the path coefficient of SEM and variable importance of ANN are in Table 4. In subsequent studies, the name of the path coefficient and variable importance was expressed as variable importance.

The first and second places in variable importance for SEM and ANN were the same in Korea, China, and India. As a result, SEM′s research results on the analysis of factors influencing repurchase were reconfirmed through ANN analysis. Therefore, the statistical conclusion validity of this study was proven to be more valid.

Next, some changes were found in variable importance. In the SEM analysis, China′s 3rd and 4th places were price and information search, but in the ANN analysis, it changed to information search and price. In the SEM analysis, the variable importance of service, which ranked first in India, decreased from 0.455 to 0.289. It is believed that the importance of variables has increased as ANN′s non-linear weights are reflected in the analysis process.

5. Conclusion: Implications and Limitations

In this study, the influencing factors of internet shopping repurchase intention were analyzed through SEM-ANN two-stage analysis, and changes in predictive performance and variable importance were identified. The conclusions and implications of this study are as follows.

First, through SEM analysis, it was verified that there are differences between countries in the factors influencing internet shopping repurchase intention. Therefore, in order for companies to effectively respond to the rapidly increasing trend of overseas Internet purchases, they need to understand these differences and establish management strategies based on them.

Second, the analysis performance was improved by inputting the SEM analysis results into ANN for further analysis. It is meaningful in that the degree of R^2 improvement resulting from the SEM-ANN second-stage analysis was analyzed according to Cohen′s effect size, confirming that the results of the PLS analysis were improved by a small effect size through ANN. However, in this study, ANN model optimization was performed limitedly using a heuristic method while changing the SPSS MLP option. Therefore, the limitation is that we were unable to examine in depth the extent to which the effect size could be improved.

Third, changes in variable importance were compared in the second stage of SEM-ANN analysis. It is significant in that it increases statistical-conclusion-validity through generalization of variable influence by confirming that what is high in SEM is also high in ANN.

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〈Table Appendix〉 10 Folds Cross validation Results of ANN Analysis by SPSS MLP

Korea

ANN	price	quality	service	Search	gender	age	speed	cost	spending	Train R^2	Test R^2
1	0.147	0.285	0.225	0.082	0.023	0.031	0.097	0.062	0.047	0.758	0.794
2	0.154	0.361	0.217	0.058	0.024	0.041	0.075	0.042	0.028	0.775	0.601
3	0.108	0.336	0.196	0.171	0.011	0.023	0.097	0.021	0.038	0.660	0.697
4	0.091	0.278	0.239	0.139	0.024	0.050	0.092	0.045	0.043	0.736	0.666
5	0.200	0.272	0.180	0.133	0.024	0.051	0.045	0.054	0.041	0.747	0.661
6	0.131	0.320	0.206	0.091	0.030	0.036	0.100	0.047	0.040	0.754	0.926
7	0.114	0.290	0.231	0.109	0.024	0.041	0.086	0.061	0.044	0.742	0.725
8	0.153	0.270	0.197	0.097	0.040	0.024	0.096	0.067	0.056	0.760	0.679
9	0.145	0.313	0.270	0.080	0.022	0.047	0.053	0.051	0.019	0.726	0.856
10	0.149	0.377	0.177	0.098	0.014	0.027	0.092	0.036	0.030	0.726	0.631
mean	0.139	0.310	0.214	0.106	0.024	0.037	0.083	0.049	0.039	0.738	0.724
std	0.029	0.036	0.027	0.032	0.008	0.010	0.019	0.013	0.010	0.030	0.098
SEM	0.137	0.373	0.290	0.136	−0.004	−0.044	0.095	−0.003	0.031	0.700	

China

ANN	price	quality	service	search	gender	age	speed	cost	spending	Train R^2	Test R^2
1	0.080	0.148	0.247	0.116	0.016	0.061	0.112	0.092	0.127	0.404	0.541
2	0.074	0.189	0.258	0.093	0.036	0.054	0.139	0.066	0.090	0.530	0.435
3	0.077	0.169	0.274	0.120	0.023	0.051	0.119	0.055	0.112	0.507	0.455
4	0.102	0.169	0.317	0.066	0.040	0.066	0.140	0.022	0.079	0.510	0.648
5	0.098	0.197	0.244	0.103	0.027	0.037	0.133	0.032	0.129	0.525	0.515
6	0.116	0.160	0.273	0.120	0.018	0.065	0.084	0.070	0.094	0.514	0.530
7	0.064	0.189	0.314	0.108	0.038	0.083	0.073	0.065	0.068	0.491	0.494
8	0.079	0.198	0.250	0.144	0.022	0.052	0.123	0.044	0.088	0.524	0.439
9	0.091	0.158	0.254	0.088	0.040	0.060	0.122	0.064	0.123	0.520	0.585
10	0.083	0.161	0.210	0.082	0.036	0.050	0.162	0.094	0.122	0.482	0.678
mean	0.086	0.174	0.264	0.104	0.030	0.058	0.121	0.061	0.103	0.501	0.532
std	0.015	0.017	0.031	0.021	0.009	0.012	0.025	0.022	0.021	0.035	0.080
SEM	0.113	0.166	0.322	0.093	0.011	−0.141	0.166	−0.082	0.145	0.499	

India

ANN	price	quality	service	search	gender	age	speed	cost	spending	Train R^2	Test R^2
1	0.100	0.122	0.203	0.181	0.099	0.059	0.114	0.061	0.062	0.847	0.678
2	0.072	0.120	0.388	0.113	0.031	0.086	0.076	0.071	0.044	0.720	0.668
3	0.061	0.050	0.124	0.323	0.056	0.053	0.094	0.082	0.156	0.579	0.620
4	0.051	0.143	0.361	0.166	0.074	0.091	0.045	0.022	0.048	0.712	0.593
5	0.187	0.053	0.302	0.122	0.064	0.054	0.098	0.078	0.042	0.742	0.776
6	0.068	0.120	0.276	0.207	0.095	0.044	0.120	0.033	0.037	0.803	0.824
7	0.094	0.125	0.370	0.104	0.053	0.052	0.069	0.079	0.053	0.737	0.754
8	0.171	0.066	0.361	0.216	0.025	0.049	0.037	0.039	0.037	0.681	0.783
9	0.144	0.082	0.290	0.155	0.051	0.028	0.133	0.076	0.041	0.702	0.657
10	0.125	0.060	0.219	0.169	0.082	0.039	0.154	0.108	0.045	0.827	0.858
mean	0.107	0.094	0.289	0.176	0.063	0.055	0.094	0.065	0.056	0.735	0.721
std	0.045	0.033	0.082	0.061	0.024	0.018	0.036	0.025	0.034	0.074	0.085
SEM	0.115	0.118	0.455	0.209	0.085	0.051	0.014	−0.036	0.033	0.703	

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