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Multivariate Variable Deletion Methods: Don't Do Stepwise

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Abstract

This paper explains the theory and methodology behind the use of variable deletion in canonical correlational analysis (CCA). Both the Capraro and Capraro (2002) and the Cantrell (1997) data tables are evaluated and explained in order to clarify strategies utilized. Understanding of variable deletion strategies and their proper usages in a CCA can assist a researcher in reporting a more replicable study.

Variable Deletion Strategies in Canonical Correlation Analysis

Any study using the General Linear Model (GLM) focuses on explaining the explained in as few variables as possible (parsimoniously). CCA is the most general form of the GLM (Capraro & Capraro, 2002; French & Chess, 2002; Knapp, 1978; Thompson, 1984, 1991, 1998). Thompson (1991) also clarified the generality of the CCAs, explaining that they can perform all other parametric measures such as t-tests, ANOVAs, Regressions, Discriminant Analysis, and MANOVAs.

Fewer variables in a CCA produce results that are more generalizable, are more population driven than sample driven, and more replicable (Cantrell, 1999; Capraro & Capraro, 2002; Thompson, 1991; Thorndike, 1978). Furthermore, as with all strategies of variable deletion in GLM, stepwise is highly discouraged. Because stepwise methods present a false number of degrees of freedom they provide unscrupulous results that are usually nonreplicable and should not be employed in statistical analysis (Thompson, 1996).

In this paper, two studies were analyzed in order to explain and clarify the proper procedures used in variable deletion in CCA. Both the Capraro and Capraro (2002) and

the Cantrell (1997) data tables are evaluated and explained. The Capraro and Capraro (2002) data consisted of a real data set, testing 287 students with three different tests (criteria variables) on six subscales (predictor variables), while the Cantrell (1997) paper used the Holzinger and Swinford (1939) heuristic data set, testing three variables with eight subset variables.

This paper does not address the mathematical applications used in creation of these tables but clarifies the theory behind the strategies of variable deletion.

Strategy One: Delete the Canonical Communality Coefficients (h^2) while watching the Squared Canonical Coefficient (R_C^2)

1. Find the lowest h^2 and delete it
2. Check change to R_C^2 for each function
3. If there is little change to R_C^2 find the next lowest h^2
4. Delete it (repeat process until R_C^2 change is too big)

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INSERT TABLE 2 ABOUT HERE

INSERT TABLE 3 ABOUT HERE

In the Capraro and Capraro (2002) Table 1, the smallest h^2s were perceptions (6.34%) and success (9.08%). Perceptions was deleted first and the table was recalculated (see Table 2) and success next and the tables were again recalculated (see Table 3). The largest change in R_C^2 for each function was less than 1%.

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The Cantrell tables for strategy one produced similar results (see Table 4). T15 was dropped first (see Table 5) due to its low h^2 and similarly T16 was deleted because of its 32.83% h^2 (see table 6). The dropping of these two h^2s resulted in a very small change in any of the three functions.

Clearly, there is a negative aspect to this type of deletion strategy. By focusing decision making mostly on the h^2 without taking into account the function effect size (R_C^2) until after variable deletion, a misguided researcher could keep a large h^2 that in a function with a small

effect size. Therefore, you could be left with a less parsimonious solution (Capraro & Capraro, 2002).

Strategy two: Focus on functional contributions to total solution

1. Look at R_c^2
2. Omit function with small R_c^2
3. Recompute subset of h^2s
4. Find variable that has lowest h^2; drop it from the original solution
5. Stop when remaining variable are reasonably close in their subset h^2 values

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When looking at the Capraro and Capraro data Table 7, notice the lowest squared canonical coefficient (R_C^2) was Function III (1.9%). Therefore, by employing strategy 2 this is the function that should be dropped. Then, after recalculation of data (see Table 8), deletion of variables

commences. The first variable for deletion, due to low h^2 is perception (6.33%). Then table is recalculated (see Table 9). Next, the variable success is dropped because of low canonical communality coefficient (h^2 = 8.11%). And finally useful was dropped due to it not being close to the other h^2s.

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In the Cantrell data tables using strategy 2, Table 11 showed the recalculation of the variables after function 3 was dropped due to low R_C^2 (.90%) (see Table 4). Next, the correct procedure would require that the variable T17 be deleted due to lowest h^2 and obvious distance from the other canonical communality coefficient (26.93% being the next lowest). Finally, due to the perception of the researcher the iterations ended and the most parsimonious solution was found (see Table 12).

Clearly, an argument about the soundness of a strategy that ignores a function with a small squared canonical coefficient can be made. Furthermore, this strategy seems

to ignore variation as to where h^2 comes from (Capraro & Capraro, 2002).

Strategy three: evaluate both h^2 and variables contribution to solution

1. Multiply R_c^2 times r_s^2
2. Add products together for each row
3. Drop lowest weighted h^2
4. Look at the change in R_c^2; if small, drop next lowest h^2
5. Remove as many variables as possible with comprising the R_c^2

This strategy is regarded by both researchers evaluated as the best strategy for variable deletion in CCA (Cantrell, 1999; Capraro & Capraro, 2002). Due to the design of this strategy, a weighted h^2, dependent on both the R_C^2 and the squared structure coefficients of each variable, a better idea of the variable's true contribution to the solution is found.

Obviously, the parallel here to other GLM analysis cannot be ignored. Thompson (1998) consistently stresses an importance of both weights and structure coefficients in GLMs for clearer picture. Of course, the most general form of the GLM (CCAs) should not be immune to this necessity.

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The Capraros' (2002) Table 13 shows the data with their newly calculated weighted h^2. With the weighted h^2 the lowest canonical communality coefficient is perception (1.54%). Perception is deleted and Table 14 shows recalculations, with success being the next lowest h^2 (2.02%). Success is deleted and worry is seen as being a candidate for deletion (see Table 15). Worry is deleted and the researcher decides to discontinue iterations (see table 16). Finally, the function with the lowest R_C^2 is dropped and the final solution is presented with two functions and three predictors (see Table 17).

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The Cantrell (1997) article uses 5 tables to get to final solution. Table 18 shows the weighted three functions with the weighted h^2s. T15 is deleted and the table 19 shows the recalculations. T12 is next and the recalculations are shown in table 20. It is observed that there are still small variations in the change of R_C^2 for each function. Because of low h^2, T10 was deleted (see table 21). And finally, T16 was dropped and the final table shows the final solution (see Table 22).

It is also observed that Cantrell chose not to delete a function. This is clearly due to the judgment of the researcher. Regardless, a deletion of four variables allows for a very parsimonious solution that barely changed the squared canonical coefficients of the functions.

Summary

In summary, the goal of any study done with the GLM is to explain the most variance with as few variables as possible. This paper explained the theory and methodology behind the use of variable deletion in canonical correlational analysis by using both the Capraro and Capraro (2002) and the Cantrell (1997) data tables. Hopefully, evaluation of these employed variable deletion strategies and their proper usages in a CCA will offer confidence and clarity in future use of any of these strategies.

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Table 1. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 1, Iteration 1)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
spacerel.	-0.5	-0.845	71.40%	0.556	0.162	2.62%	0.956	0.509	25.91%	99.94%
level10	-0.179	-0.604	36.48%	1.008	0.510	26.01%	-0.617	-0.613	37.58%	100.07%
gcksum	-0.521	-0.901	81.18%	-1.197	-0.331	10.96%	-0.843	-0.279	7.78%	99.92%
Adequacy			63.02%			13.20%			23.76%	
Rd			16.13%			0.49%			0.45%	
R_C^2			25.60%			3.70%			1.9%	
Rd			6.86%			0.68%			0.20%	
Adequacy			26.80%			18.35%			10.71%	
Useful	0.157	0.581	33.76%	0.153	-0.076	0.58%	-0.565	-0.463	21.44%	55.77%
Intrinsic	-0.096	0.426	18.15%	-0.579	-0.63	39.69%	-0.82	-0.571	32.60%	90.44%
Worry	-0.187	-0.081	0.66%	-0.829	-0.805	64.80%	0.531	0.292	8.53%	73.99%
Confid	0.932	0.972	94.48%	-0.023	-0.207	4.28%	0.787	0.083	0.695%	99.45%
Percep	0.046	0.244	5.95%	0.2	-0.061	0.37%	0.145	0.033	0.11%	6.43%
Success	0.061	0.279	7.78%	0.229	-0.061	0.37%	-0.222	-0.096	0.92%	9.08%

Table 2. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 1, Iteration 2)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
spacerel.	−0.503	−0.846	71.57%	0.522	0.142	2.02%	0.974	0.513	26.32%	99.90%
level10	−0.181	−0.605	36.60%	1.028	0.528	27.88%	−0.583	−0.596	35.52%	100.00%
gcksum	−0.516	−0.9	81.00%	−1.181	−0.324	10.50%	−0.524	−0.292	8.53%	100.02%
Adequacy			63.06%			13.46%			23.45%	
Rd			16.14%			0.48%			0.45%	
R_C^2			25.60%			3.6%			1.9%	
Rd			6.62%			0.67%			0.21%	
Adequacy			25.85%			18.60%			11.04%	
Useful	0.167	0.581	33.76%	0.211	−0.061	0.37%	−0.53	−0.467	21.81%	55.94%
Intrinsic	−0.093	0.427	18.23%	−0.56	−0.622	38.69%	−0.891	−0.603	36.30%	93.28%
Worry	−0.177	−0.08	0.64%	−0.817	−0.825	68.06%	0.525	0.255	6.50%	75.21%
Confid	0.934	0.973	94.67%	−0.03	−0.204	4.16%	0.802	0.079	0.62%	99.46%
Percep	0.00	0.00	0.00%	0.00	−0.00	0.00%	0.00	0.00	0.00%	0.00%
Success	0.072	0.279	7.78%	0.286	−0.057	0.32%	−0.176	−0.098	0.96%	9.07%

Table 3. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 1, Iteration 3)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
spacerel.	-0.504	-0.846	71.57%	0.583	0.171	2.92%	0.938	0.505	25.50%	100.00%
level10	-0.190	-0.610	37.21%	0.984	0.482	23.23%	-0.651	-0.628	39.44%	99.88%
gcksum	-0.509	-0.898	81.64%	-1.218	-0.349	12.18%	-0.441	-0.266	7.08%	99.90%
Adequacy			63.14%			12.78%			24.01%	
Rd			16.10%			0.43%			0.43%	
R_C^2			25.50%			3.40%			1.80%	
Rd			6.29%			0.67%			0.20%	
Adequacy			24.67%			19.78%			10.97%	
Useful	0.175	0.582	33.87%	0.229	-0.075	0.56%	-0.584	-0.475	22.56%	57.00%
Intrinsic	-0.093	0.43	18.49%	-0.629	-0.664	44.09%	-0.845	-0.557	31.02%	93.60%
Worry	-0.153	-0.078	0.61%	-0.732	-0.840	70.56%	0.549	0.339	11.49%	82.66%
Confid	0.950	0.975	95.06%	-0.82	-0.187	3.50%	0.764	0.087	0.76%	99.32%
Percep	0.00	0.00	0.00%	0.00	-0.00	0.00%	0.00	0.00	0.00%	0.00%
Success	0.00	0.00	0.00%	0.00	-0.00	0.00%	-0.00	-0.00	0.00%	0.00%

Table 4. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 1, Iteration 1)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
T5	-0.295	-0.848	71.91%	0.213	-0.059	0.35%	1.446	0.527	27.77%	100.03%
T6	-0.540	-0.937	87.80%	1.232	0.264	6.37%	-0.732	-0.320	5.29%	100.06%
T7	-0.276	-0.883	77.97%	-1.511	-0.455	20.70%	-0.612	-0.113	1.28%	99.95%
Adequacy			79.23%			9.34%			11.45%	
Rd			29.23%			0.47%			0.10%	
R_C^2			36.90%			5.00%			0.90%	
Rd			11.42%			0.54%			0.14%	
Adequacy			30.95%			10.73%			15.81%	
T29	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%	0.073	0.008	0.01%	76.08%
T12	0.123	-0.238	5.66%	-0.537	-0.190	3.61%	0.722	0.802	64.32%	73.59%
T18	-0.122	-0.286	3.18%	0.538	0.433	18.75%	0.349	0.670	44.89%	71.82%
T23	-0.241	-0.769	59.14%	0.481	0.261	6.81%	0.941	0.053	0.28%	66.23%
T24	-0.377	-0.752	56.55%	0.091	0.191	3.65%	-0.016	0.174	3.03%	63.23%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	0.96%	-0.466	-0.335	11.22%	48.42%
T16	0.017	-0.378	14.29%	0.280	0.383	14.67%	-0.196	-0.164	2.69%	31.65%
T15	0.112	-0.066	0.44%	0.418	0.533	28.41%	0.056	-0.011	0.01%	28.86%

Table 5. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 1, Iteration 2)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
T5	-0.300	-0.847	71.74%	0.190	-0.080	0.64%	1.449	0.525	27.56%	99.94%
T6	-0.560	-0.941	88.55%	1.231	0.251	6.30%	-0.717	-0.228	5.20%	100.05%
T7	-0.260	-0.875	76.56%	-1.507	-0.468	21.90%	-0.632	-0.120	1.44%	99.90%
Adequacy			78.95%			9.61%			11.40%	
Rd			28.52%			0.41%			0.10%	
R_C^2			36.50%			4.30%			0.90%	
Rd			11.41%			0.35%			0.14%	
Adequacy			31.26%			8.15%			15.92%	
T29	-0.462	-0.822	67.40%	-0.652	-0.367	13.47%	0.048	0.007	0.00%	80.88%
T12	0.116	-0.240	8.41%	0.619	0.452	20.43%	0.371	0.682	46.51%	75.35%
T18	-0.125	-0.238	5.66%	-0.591	0.222	4.93%	0.706	0.796	63.36%	73.95%
T23	-0.248	-0.775	60.06%	0.539	0.244	5.95%	0.058	0.056	0.31%	66.33%
T24	-0.180	-0.757	57.30%	0.051	0.168	2.82%	-0.020	0.175	3.06%	63.19%
T20	-0.148	-0.605	36.60%	-0.220	-0.134	1.80%	-0.466	-0.342	11.70%	50.09%
T16	0.048	-0.383	14.67%	0.453	0.397	15.76%	-0.167	-0.155	2.40%	32.83%
T15	0.00	-0.00	0.00%	0.00	0.00	0.00%	-0.00	-0.00	0.00%	0.00%

Table 6. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 1, Iteration 3)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
T5	-0.300	-0.846	71.57%	0.250	-0.063	0.40%	1.440	0.529	27.98%	99.95%
T6	-0.569	-0.943	88.92%	1.196	0.235	5.52%	-0.768	-0.237	5.62%	100.06%
T7	-0.240	-0.872	76.04%	-1.534	-0.479	22.94%	-0.566	-0.099	0.98%	99.96%
Adequacy			78.84%			9.62%			11.53%	
Rd			28.70%			0.35%			0.10%	
R_C^2			36.40%			3.60%			0.90%	
Rd			10.73%			0.27%			0.14%	
Adequacy			29.48%			7.50%			15.63%	
T29	-0.459	-0.821	67.40%	-0.704	-0.418	17.47%	0.108	0.035	0.12%	85.00%
T12	0.126	-0.238	5.66%	-0.627	0.231	5.34%	0.771	0.830	68.89%	79.89%
T18	-0.117	-0.291	8.47%	0.684	0.501	25.10%	0.317	0.650	42.25%	75.82%
T23	-0.268	-0.776	60.22%	-0.672	0.252	6.35%	-0.028	0.040	0.16%	66.73%
T24	-0.379	-0.759	57.46%	0.134	0.172	2.96%	-0.060	0.168	2.82%	63.24%
T20	-0.189	-0.605	36.60%	-0.157	-0.166	2.76%	-0.491	-0.329	10.82%	50.18%
T16	0.00	-0.00	0.00%	0.00	0.00	0.00%	-0.00	-0.00	0.00%	0.00%
T15	0.00	-0.00	0.00%	0.00	0.00	0.00%	-0.00	-0.00	0.00%	0.00%

Table 7. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 2, Iteration 1)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
spacerel.	-0.5	-0.845	71.40%	0.556	0.162	2.62%				74.03%
level10	-0.179	-0.604	36.48%	1.008	0.510	26.01%				62.49%
gcksum	-0.521	-0.901	81.18%	-1.197	-0.331	10.96%				92.14%
Adequacy			63.02%			13.20%				
Rd			16.13%			0.49%				
R_C^2			25.60%			3.70%				
Rd			6.86%			0.68%				
Adequacy			26.80%			18.35%				
Useful	0.157	0.581	33.76%	0.153	-0.076	0.58%				34.33%
Intrinsic	-0.096	0.426	18.15%	-0.579	-0.63	39.69%				57.84%
Worry	-0.187	-0.081	0.66%	-0.829	-0.805	64.80%				65.46%
Confid	0.932	0.972	94.48%	-0.023	-0.207	4.28%				98.76%
Percep	0.046	0.244	5.95%	0.2	-0.061	0.37%				6.33%
Success	0.061	0.279	7.78%	0.229	-0.061	0.37%				8.16%

Table 8. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 2, Iteration 2)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
spacerel.	-0.503	-0.846	71.57%	0.522	0.142	2.02%				73.59%
level10	-0.181	-0.605	36.60%	1.028	0.528	27.88%				64.48%
gcksum	-0.516	-0.9	81.00%	-1.181	-0.324	10.50%				91.50%
Adequacy			63.06%			13.46%				
Rd			16.14%			0.48%				
R_C^2			25.60%			3.60%				
Rd			6.62%			0.67%				
Adequacy			25.85%			18.60%				
Useful	0.167	0.581	33.76%	0.211	-0.061	0.37%				34.13%
Intrinsic	-0.093	0.427	18.23%	-0.56	-0.622	38.69%				56.92%
Worry	-0.177	-0.08	0.64%	-0.817	-0.825	68.06%				68.70%
Confid	0.934	0.973	94.67%	-0.03	-0.204	4.16%				98.83%
Percep	0.00	0.00	0.00%	0.00	-0.00	0.00%				0.00%
Success	0.072	0.279	7.78%	-0.286	-0.057	0.32%				8.11%

Table 8. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 2, Iteration 3)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
spacerel.	-0.504	-0.846	71.57%	0.583	0.171	2.92%				74.50%
level10	-0.190	-0.610	37.21%	0.984	0.482	23.23%				60.44%
gcksum	-0.509	-0.898	80.64%	-1.218	-0.349	12.18%				92.82%
Adequacy			63.14%			12.78%				
Rd			16.10%			0.43%				
R_C^2			25.50%			3.40%				
Rd			6.29%			0.67%				
Adequacy			24.67%			19.78%				
Useful	0.175	0.582	33.87%	0.229	-0.075	0.56%				34.43%
Intrinsic	-0.093	0.430	18.49%	-0.629	-0.664	44.09%				62.58%
Worry	-0.153	-0.078	0.61%	-0.732	-0.840	70.56%				71.17%
Confid	0.950	0.975	95.06%	0.082	-0.187	3.50%				98.56%
Percep	0.00	0.00	0.00%	0.00	-0.00	0.00%				0.00%
Success	0.00	0.00	0.00%	0.00	-0.00	0.00%				0.00%

Table 9. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 2, Iteration 4)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
spacerel.	-0.491	-0.837	70.06%	0.692	0.225	5.06%				75.12%
level10	-0.216	-0.629	39.56%	0.892	0.393	15.44%				55.01%
gcksum	-0.503	-0.9	81.00%	-1.268	-0.389	15.13%				96.13%
Adequacy			63.54%			11.88%				
Rd			16.20%			0.40%				
R_C^2			25.50%			3.40%				
Rd			4.96%			0.68%				
Adequacy			19.46%			19.90%				
Useful	0.00	0.00	0.00%	0.00	-0.00	0.00%				0.00%
Intrinsic	-0.065	0.434	18.84%	-0.682	-0.709	50.27%				69.10%
Worry	-0.139	-0.073	0.53%	-0.68	-0.817	66.75%				67.28%
Confid	1.031	0.987	97.42%	0.249	-0.154	2.37%				99.79%
Percep	0.00	0.00	0.00%	0.00	-0.00	0.00%				0.00%
Success	0.00	0.00	0.00%	0.00	-0.00	0.00%				0.00%

Table 10. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 2, Iteration 1)

Variable Statistic	Function 1			Function II			Function III			h^2
	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	
T5	-0.295	-0.848	71.91%	0.213	-0.059	0.35%				72.26%
T6	-0.540	-0.937	87.80%	1.232	0.264	6.37%				94.77%
T7	-0.276	-0.883	77.97%	-1.511	-0.455	20.70%				98.67%
Adequacy			79.23%			9.34%				
Rd			29.23%			0.47%				
R_C^2			36.90%			5.00%				
Rd			11.42%			0.54%				
Adequacy			30.95%			10.73%				
T29	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%				76.08%
T12	0.123	-0.238	5.66%	-0.537	-0.190	3.61%				65.95%
T18	-0.122	-0.286	3.18%	0.538	0.433	18.75%				60.20%
T23	-0.241	-0.769	59.14%	0.481	0.261	6.81%				37.20%
T24	-0.377	-0.752	56.55%	0.091	0.191	3.65%				28.96%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	0.96%				28.84%
T16	0.017	-0.378	14.29%	0.280	0.383	14.67%				26.93%
T15	0.112	-0.066	0.44%	0.418	0.533	28.41%				9.27%

Table 11. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 2, Iteration 2)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
T5	-0.305	-0.854	72.93%	0.456	0.045	0.20%				73.13%
T6	-0.508	-0.929	86.30%	1.103	0.239	5.71%				92.02%
T7	-0.300	-0.891	79.39%	-1.586	-0.451	20.34%				99.73%
Adequacy			79.54%			8.75%				
Rd			29.03%			0.36%				
R_C^2			36.50%			4.10%				
Rd			11.13%			0.56%				
Adequacy			30.49%			13.61%				
T29	-0.456	-0.825	68.06%	-0.591	-0.284	8.07%				76.13%
T12	-0.278	-0.771	59.44%	0.497	0.331	10.96%				70.40%
T18	-0.371	-0.755	57.00%	0.088	0.263	6.92%				63.92%
T23	-0.207	-0.606	36.72%	0.351	-0.100	1.00%				37.72%
T24	-0.067	-0.285	8.12%	0.384	0.541	29.27%				37.39%
T20	0.114	-0.062	0.38%	0.466	0.587	34.46%				34.84%
T16	0.021	-0.377	14.21%	0.298	0.427	18.23%				32.45%
T15	0.00	-0.00	0.00%	0.00	0.00	0.00%				0.00%

Table 12. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 3, Iteration 1)

Variable Statistic	Function 1			Function II			Function III			Weighted h^2
	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	
spacerel.	-0.5	-0.845	71.40%	0.556	0.162	2.62%	0.956	0.509	25.91%	18.87%
level10	-0.179	-0.604	36.48%	1.008	0.510	26.01%	-0.617	-0.613	37.58%	11.02%
gcksum	-0.521	-0.901	81.18%	-1.197	-0.331	10.96%	-0.843	-0.279	7.78%	21.34%
Adequacy			63.02%			13.20%			23.76%	
Rd			16.13%			0.49%			0.45%	
R_C^2			25.60%			3.70%			1.9%	
Rd			6.86%			0.68%			0.20%	
Adequacy			26.80%			18.35%			10.71%	
Useful	0.157	0.581	33.76%	0.153	-0.076	0.58%	-0.565	-0.463	21.44%	9.07%
Intrinsic	-0.096	0.426	18.15%	-0.579	-0.63	39.69%	-0.82	-0.571	32.60%	6.37%
Worry	-0.187	-0.081	0.66%	-0.829	-0.805	64.80%	0.531	0.292	8.53%	2.73%
Confid	0.932	0.972	94.48%	-0.023	-0.207	4.28%	0.787	0.083	0.695%	24.36%
Percep	0.046	0.244	5.95%	0.2	-0.061	0.37%	0.145	0.033	0.11%	1.54%
Success	0.061	0.279	7.78%	0.229	-0.061	0.37%	-0.222	-0.096	0.92%	2.02%

Table 13. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 3, Iteration 2)

Variable Statistic	Function 1			Function II			Function III			Weighted h^2
	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	
spacerel.	-0.503	-0.846	71.57%	0.522	0.142	2.02%	0.974	0.513	26.32%	18.89%
level10	-0.181	-0.605	36.60%	1.028	0.528	27.88%	-0.583	-0.596	35.52%	11.05%
gcksum	-0.516	-0.900	81.00%	-1.181	-0.324	10.50%	-0.524	-0.292	8.53%	21.28%
Adequacy			63.06%			13.46%			23.45%	
Rd			16.14%			0.48%			0.45%	
R_C^2			25.60%			3.60%			1.90%	
Rd			6.62%			0.67%			0.21%	
Adequacy			25.85%			18.60%			11.04%	
Useful	0.167	0.581	33.76%	0.211	-0.061	0.37%	-0.530	-0.467	21.81%	9.07%
Intrinsic	-0.093	0.427	18.23%	-0.560	-0.622	38.69%	-0.891	-0.603	36.36%	6.75%
Worry	-0.177	-0.080	0.64%	-0.817	-0.825	68.06%	0.525	0.255	6.50%	2.74%
Confid	0.934	0.973	94.67%	-0.030	-0.204	4.16%	0.802	0.079	0.62%	24.40%
Percep	0.00	0.00	0.00%	0.00	-0.00	0.00%	0.00	0.00	0.00%	0.00%
Success	0.072	0.279	7.78%	0.286	-0.057	0.32%	-0.176	-0.098	0.96%	2.02%

Table 14. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 3, Iteration 3)

Variable Statistic	Function 1			Function II			Function III			Weighted h^2
	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	
spacerel.	-0.504	-0.846	71.57%	0.583	0.171	2.92%	0.938	0.505	25.50%	18.91%
level10	-0.190	-0.610	37.21%	0.984	0.482	23.23%	-0.651	-0.628	39.44%	11.11%
gcksum	-0.509	-0.898	80.64%	-1.218	-0.349	12.18%	-0.441	-0.266	7.08%	21.22%
Adequacy			63.14%			12.78%			24.01%	
Rd			16.16%			0.46%			0.46%	
R_C^2			25.60%			3.60%			1.90%	
Rd			6.32%			0.71%			0.21%	
Adequacy			24.67%			19.78%			10.97%	
Useful	0.175	0.582	33.87%	0.229	-0.075	0.56%	-0.584	-0.475	22.56%	9.12%
Intrinsic	-0.093	0.43	18.49%	-0.629	-0.664	44.09%	-0.845	-0.557	31.02%	6.91%
Worry	-0.153	-0.078	0.61%	-0.732	-0.840	70.56%	0.549	0.339	11.49%	2.91%
Confid	0.950	0.975	95.06%	0.082	-0.187	3.50%	0.764	0.087	0.76%	24.48%
Percep	0.00	0.00	0.00%	0.00	-0.00	0.00%	0.00	0.00	0.00%	0.00%
Success	0.00	0.00	0.00%	0.00	-0.00	0.00%	-0.00	-0.00	0.00%	0.00%

Table 15. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 3, Iteration 4)

Variable Statistic	Function 1			Function II			Function III			Weighted h^2
	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	
spacerel.	-0.508	-0.841	70.73%	-1.038	0.439	19.27%	0.371	0.316	9.99%	18.12%
level10	-0.244	-0.643	41.34%	0.338	-0.041	0.17%	-1.12	-0.765	58.52%	10.59%
gcksum	-0.468	-0.889	79.03%	-1.228	-0.455	20.70%	0.459	0.056	0.31%	20.18%
Adequacy			63.70%			13.38%			22.94%	
Rd			15.86%			0.32%			0.11%	
R_C^2			24.90%			2.40%			0.50%	
Rd			6.27%			0.35%			0.05%	
Adequacy			25.19%			14.50%			10.27%	
Useful	0.159	0.586	34.34%	0.129	-0.294	8.64%	-1.15	-0.755	57.00%	9.04%
Intrinsic	-0.124	0.44	19.36%	-1.131	-0.883	77.97%	0.345	0.16	2.56%	6.70%
Worry	-0.00	-0.00	0.00%	-0.00	-0.00	0.00%	0.00	0.00	0.00%	0.00%
Confid	0.973	0.987	97.42%	-0.581	-0.064	0.41%	0.529	0.144	2.07%	24.28%
Percep	0.00	0.00	0.00%	0.00	-0.00	0.00%	0.00	0.00	0.00%	0.00%
Success	0.00	0.00	0.00%	0.00	-0.00	0.00%	-0.00	-0.00	0.00%	0.00%

Table 16. Canonical Solution with Canonical Communality Coefficients

(Capraros' Strategy 3, Final Iteration)

Variable Statistic	Function 1			Function II			Function III			Weighted h^2
	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	
spacerel.	-0.5	-0.845	71.40%	0.556	0.162	2.62%				18.07%
level10	-0.179	-0.604	36.48%	1.008	0.510	26.01%				10.30%
gcksum	-0.521	-0.901	81.18%	-1.197	-0.331	10.96%				20.18%
Adequacy			63.02%			13.20%				
Rd			16.13%			0.49%				
R_C^2			25.60%			3.70%				
Rd			6.86%			0.68%				
Adequacy			26.80%			18.35%				
Useful	0.157	0.581	33.76%	0.153	-0.076	0.58%				8.76%
Intrinsic	-0.096	0.426	18.15%	-0.579	-0.63	39.69%				6.69%
Worry	-0.187	-0.081	0.66%	-0.829	-0.805	64.80%				0.00%
Confid	0.932	0.972	94.48%	-0.023	-0.207	4.28%				24.27%
Percep	0.046	0.244	5.95%	0.2	-0.061	0.37%				0.00%
Success	0.061	0.279	7.78%	0.229	-0.061	0.37%				0.00%

Table 17. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 3, Iteration 1)

Variable Statistic	Function 1			Function II			Function III			Weighted h^2
	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	
T5	-0.295	-0.848	71.91%	0.213	-0.059	0.35%	1.446	0.527	27.77%	26.80%
T6	-0.540	-0.937	87.80%	1.232	0.264	6.37%	-0.732	-0.230	5.29%	32.79%
T7	-0.276	-0.883	77.97%	-1.511	-0.455	20.70%	-0.612	-0.113	1.28%	29.82%
Adequacy			79.23%			9.34%			11.45%	
Rd			29.23%			0.47%			0.10%	
R_C^2			36.90%			5.00%			0.90%	
Rd			11.42%			0.54%			0.14%	
Adequacy			30.95%			10.73%			15.81%	
T29	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%	0.073	0.006	0.01%	25.20%
T12	0.123	-0.238	5.66%	-0.537	-0.190	6.81%	0.041	0.053	0.28%	22.16%
T18	-0.122	-0.286	3.18%	0.538	0.433	3.65%	-0.016	0.174	3.03%	21.08%
T23	-0.241	-0.769	59.14%	0.481	0.261	0.96%	-0.466	-0.335	11.22%	13.52%
T24	-0.377	-0.752	56.55%	0.091	0.191	14.67%	-0.196	-0.164	2.69%	6.03%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	18.75%	0.349	0.670	44.89%	4.36%
T16	0.017	-0.378	14.29%	0.280	0.383	3.61%	0.722	0.802	64.32%	2.85%
T15	0.112	-0.066	0.44%	0.418	0.533	8.41%	0.056	-0.011	0.01%	1.58%

Table 4. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 3, Iteration 2)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
T5	-0.295	-0.848	71.91%	0.213	-0.059	0.35%	1.446	0.527	27.77%	100.03%
T6	-0.540	-0.937	87.80%	1.232	0.264	6.37%	-0.732	-0.320	5.29%	100.06%
T7	-0.276	-0.883	77.97%	-1.511	-0.455	20.70%	-0.612	-0.113	1.28%	99.95%
Adequacy			79.23%			9.34%			11.45%	
Rd			29.23%			0.47%			0.10%	
R_C^2			36.90%			5.00%			0.90%	
Rd			11.42%			0.54%			0.14%	
Adequacy			30.95%			10.73%			15.81%	
T29	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%	0.073	0.008	0.01%	76.08%
T12	0.123	-0.238	5.66%	-0.537	-0.190	3.61%	0.722	0.802	64.32%	73.59%
T18	-0.122	-0.286	3.18%	0.538	0.433	18.75%	0.349	0.670	44.89%	71.82%
T23	-0.241	-0.769	59.14%	0.481	0.261	6.81%	0.941	0.053	0.28%	66.23%
T24	-0.377	-0.752	56.55%	0.091	0.191	3.65%	-0.016	0.174	3.03%	63.23%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	0.96%	-0.466	-0.335	11.22%	48.42%
T16	0.017	-0.378	14.29%	0.280	0.383	14.67%	-0.196	-0.164	2.69%	31.65%
T15	0.112	-0.066	0.44%	0.418	0.533	28.41%	0.056	-0.011	0.01%	28.86%

Table 4. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 3, Iteration 3)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
T5	-0.295	-0.848	71.91%	0.213	-0.059	0.35%	1.446	0.527	27.77%	100.03%
T6	-0.540	-0.937	87.80%	1.232	0.264	6.37%	-0.732	-0.320	5.29%	100.06%
T7	-0.276	-0.883	77.97%	-1.511	-0.455	20.70%	-0.612	-0.113	1.28%	99.95%
Adequacy			79.23%			9.34%			11.45%	
Rd			29.23%			0.47%			0.10%	
R_C^2			36.90%			5.00%			0.90%	
Rd			11.42%			0.54%			0.14%	
Adequacy			30.95%			10.73%			15.81%	
T29	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%	0.073	0.008	0.01%	76.08%
T12	0.123	-0.238	5.66%	-0.537	-0.190	3.61%	0.722	0.802	64.32%	73.59%
T18	-0.122	-0.286	3.18%	0.538	0.433	18.75%	0.349	0.670	44.89%	71.82%
T23	-0.241	-0.769	59.14%	0.481	0.261	6.81%	0.941	0.053	0.28%	66.23%
T24	-0.377	-0.752	56.55%	0.091	0.191	3.65%	-0.016	0.174	3.03%	63.23%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	0.96%	-0.466	-0.335	11.22%	48.42%
T16	0.017	-0.378	14.29%	0.280	0.383	14.67%	-0.196	-0.164	2.69%	31.65%
T15	0.112	-0.066	0.44%	0.418	0.533	28.41%	0.056	-0.011	0.01%	28.86%

Table 4. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 3, Iteration 4)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
T5	-0.295	-0.848	71.91%	0.213	-0.059	0.35%	1.446	0.527	27.77%	100.03%
T6	-0.540	-0.937	87.80%	1.232	0.264	6.37%	-0.732	-0.320	5.29%	100.06%
T7	-0.276	-0.883	77.97%	-1.511	-0.455	20.70%	-0.612	-0.113	1.28%	99.95%
Adequacy			79.23%			9.34%			11.45%	
Rd			29.23%			0.47%			0.10%	
R_C^2			36.90%			5.00%			0.90%	
Rd			11.42%			0.54%			0.14%	
Adequacy			30.95%			10.73%			15.81%	
T29	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%	0.073	0.008	0.01%	76.08%
T12	0.123	-0.238	5.66%	-0.537	-0.190	3.61%	0.722	0.802	64.32%	73.59%
T18	-0.122	-0.286	3.18%	0.538	0.433	18.75%	0.349	0.670	44.89%	71.82%
T23	-0.241	-0.769	59.14%	0.481	0.261	6.81%	0.941	0.053	0.28%	66.23%
T24	-0.377	-0.752	56.55%	0.091	0.191	3.65%	-0.016	0.174	3.03%	63.23%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	0.96%	-0.466	-0.335	11.22%	48.42%
T16	0.017	-0.378	14.29%	0.280	0.383	14.67%	-0.196	-0.164	2.69%	31.65%
T15	0.112	-0.066	0.44%	0.418	0.533	28.41%	0.056	-0.011	0.01%	28.86%

Table 4. Canonical Solution with Canonical Communality Coefficients

(Cantrell's Strategy 3, Iteration 5)

Variable	Function 1			Function II			Function III			
Statistic	Func.	r_s	r_s^2	Func.	r_s	r_s^2	Func.	r_s	r_s^2	h^2
T5	-0.295	-0.848	71.91%	0.213	-0.059	0.35%	1.446	0.527	27.77%	100.03%
T6	-0.540	-0.937	87.80%	1.232	0.264	6.37%	-0.732	-0.320	5.29%	100.06%
T7	-0.276	-0.883	77.97%	-1.511	-0.455	20.70%	-0.612	-0.113	1.28%	99.95%
Adequacy			79.23%			9.34%			11.45%	
Rd			29.23%			0.47%			0.10%	
R_C^2			36.90%			5.00%			0.90%	
Rd			11.42%			0.54%			0.14%	
Adequacy			30.95%			10.73%			15.81%	
T29	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%	0.073	0.008	0.01%	76.08%
T12	0.123	-0.238	5.66%	-0.537	-0.190	3.61%	0.722	0.802	64.32%	73.59%
T18	-0.122	-0.286	3.18%	0.538	0.433	18.75%	0.349	0.670	44.89%	71.82%
T23	-0.241	-0.769	59.14%	0.481	0.261	6.81%	0.941	0.053	0.28%	66.23%
T24	-0.377	-0.752	56.55%	0.091	0.191	3.65%	-0.016	0.174	3.03%	63.23%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	0.96%	-0.466	-0.335	11.22%	48.42%
T16	0.017	-0.378	14.29%	0.280	0.383	14.67%	-0.196	-0.164	2.69%	31.65%
T15	0.112	-0.066	0.44%	0.418	0.533	28.41%	0.056	-0.011	0.01%	28.86%