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ABSTRACT

When approximately the same amount of variance can be reproduced with a larger variable set and a smaller variable set, researchers should generally choose the smaller variable set. The smaller set is a more parsimonious solution, and is therefore more likely to be true and replicable. Since true stepwise methods are not useful for variable deletion, analogs have been developed for use in multivariate methods such as canonical correlation analysis. Three strategies are described and illustrated. These analyses focus on deleting variables that have low canonical correlation communality coefficients. Empirical research suggests that such strategies may yield results that are more replicable across samples. (Contains 10 tables and 6 references.) (Author/SLD)

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Acceptable Variable Deletion Methods in Canonical Correlation Analysis

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Abstract

Since true stepwise methods are not useful for variable deletion, analogs have been developed for use in multivariate methods such as canonical correlation analysis. These analyses focus on deleting variables that have low canonical communality coefficients. Empirical research suggests that such strategies may yield results that are more replicable across samples.

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Acceptable Variable Deletion Methods in Canonical Correlation Analysis

Researchers may wonder why variables should be deleted in canonical correlation analysis. Perhaps they feel that bigger is better. The reason to delete variables in canonical correlation analysis is to simplify the analysis. There are many reasons to simplify the analysis. The most important reason is that the simpler the explanation, the more likely it is to be true, therefore the more likely it is that the result is replicable. In fact, Thorndike (1978) explains,

> as the number of variables increases, the probable effect of these sources of [error] variation on canonical correlation increases. Therefore, the fewer the variables there are in a canonical analysis which yields a correlation of a given magnitude, the greater the likelihood that that correlation is due to real, population-wide sources of covariation, rather than sample-specific sources. (p. 188)

As Rim (1972) noted, variable deletion would result in more parsimonious solutions, and consequently the solutions would be more invariant and generalizable.

Given the importance of parsimony in solutions, this paper presents three variable deletion strategies for use in canonical correlation analysis. Conventional stepwise

methods are inherently flawed, and cannot be used for this or other purposes (Thompson, 1996).

Deletion Strategy #1

The first strategy involves looking at the canonical communality coefficients (Thompson, 1980). Because the squared canonical structure coefficient shows how much variance the variable linearly shares with the canonical variable, and given that canonical functions are perfectly uncorrelated, then the sum of all the squared canonical structure coefficients across all the functions shows how much of the variance in a given observed variable is reproduced by the complete canonical solution (Thompson, 1984).

Not only should the canonical communality coefficient (h^2) be considered in variable deletion, but also the squared canonical coefficient (Rc^2). The Rc^2 represents how much each function is contributing to the overall canonical solution. When a variable is deleted and the Rc^2 for a given function stays relatively the same, the result is a more parsimonious canonical solution.

The column labeled h^2 (canonical communality coefficient squared) in Table 1 presents the sum of the squared structure coefficients, labeled "$stru^2$," across all the functions. Notice that only two of these sums, those for variables T16 and T15, are remarkably lower than the other variable sums. The Rc^2s for each of the three functions were, respectively: 36.9%, 5%, and 0.9%. Thus, the

functions varied considerably as regards to their noteworthiness.

INSERT TABLE 1 ABOUT HERE

Because in the preceding strategy only the h^2 is utilized for choosing which variables to delete, the variable with the lowest h^2, T15, was the first variable dropped. Table 2 presents the complete canonical solution after variable T15 was dropped. Dropping variable T15 resulted in very little change in the Rc^2 for each function, less than 1% for each function. There was also very little change in the function, structure, and communality coefficients. Therefore, dropping variable T15 resulted in a more parsimonious model.

INSERT TABLE 2 ABOUT HERE

But, the resulting solution still left variable T16 with an h^2 remarkably lower than the others. Table 3 presents the next iteration in the variable deletion process with variable T16 dropped. Dropping T16 resulted in very little change in Rc^2 for each function. There was also again very little change in the function, structure, and communality coefficients. Therefore, the deletion resulted in a more parsimonious model.

INSERT TABLE 3 ABOUT HERE

Deletion Strategy #2

The limitations of this strategy are that the contribution of each function is not evaluated until the variable is dropped. Another strategy, which considers the contribution of each function to the total canonical solution, would involve looking at a subset of the h^2s. In the preceding example, the third function was contributing very little to the overall solution, $Rc^2 = 0.9\%$. Therefore, looking at the subset of *just the first two functions* may be more valuable to a researcher.

Table 4 presents the complete canonical solution excluding the third function. Notice the subset h^2s. Instead of variables T15 and T16 having the lowest of the h^2s, T12 contributed the least amount of variance to the overall canonical solution. Therefore, in the new analysis, presented in Table 5, variable T12 was dropped from the solution. The result was variables that were very close in their subset h^2s. Therefore, the iterative deletion of variables with low communalities was terminated.

INSERT TABLES 4 AND 5 ABOUT HERE

Although this strategy considers looking at each function's contribution to the overall canonical solution, it does not consider each variables contribution to its respective function. For example, the Rc^2 for Function I was equal to 36.9%. The greatest contributor to that function was variable T22. But, variable T22 was not the

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greatest contributor to Function II. Variable T10 was the greatest contributor to Function II. Neither variable T22 nor variable T10 was the greatest contributor to function III, T12 was. As shown previously, Function III contributed very little to the overall solution. Therefore, although variable T12 was a great contributor to Function III, it is a very small contributor when looking at the aggregate.

Deletion Strategy #3

This brings about the third strategy in variable deletion, a *weighted* h^2. A weighted h^2 reflects not only the variable's contribution to the function, but also the function's contribution to the complete canonical solution. This gives a clearer picture of what a variable's total contribution is to the complete canonical solution. The weighted h^2 for a given variable consists of multiplying the Rc^2 for each function times the squared structure coefficient for each function and then adding these products together for each measured variable or row. This gives a better idea of what each variable is contributing.

Table 6 presents the weighted h^2 for each variable in the complete canonical solution. Notice that only four of the variables appear remarkably lower than the others, variables T10, T12, T15, and T16. Because it had the lowest weighted h^2, T15 was dropped from the solution first. Table 7 presents the results of dropping variable T15. Notice that the Rc^2 changed very little from the first iteration to the second.

INSERT TABLES 6 AND 7 ABOUT HERE

In the next iteration, presented in Table 8, the next smallest contributor to the solution is dropped, variable T12. Notice again the very small drop in the Rc^2 for each function. Table 9 presents the next iteration, which involves dropping variable T10 from the solution. Again, there was a very small drop in Rc^2 for each function. The final iteration, presented in Table 10, involves dropping variable T16 from the overall function. Likewise, there was very little change in the Rc^2. This final strategy for dropping variables deleted four variables considering their contribution to the overall solution. Dropping these four variables lowers the Rc^2 only 0.6% for the first function, 2.9% on the second function, and 0.7% on the third function. These are negligible differences considering the overall canonical solution, and the result is a much more parsimonious model, with four less variables than initial model.

INSERT TABLES 8, 9, AND 10 ABOUT HERE

Summary

When approximately the same amount of variance can be reproduced with a larger variable set and a smaller variable set, researchers should generally choose the smaller variable set. The smaller set is a more parsimonious

solution, and therefore is more likely to be true and replicable (Thompson, 1984). For canonical correlation analysis, bigger is not necessarily better. Three strategies for creating more parsimonious results were illustrated using a well-known data set to make the discussion concrete.

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References

Holzinger, K. J., & Swineford, F. (1939). A study in factor analysis: The stability of a bi-factor solution. Chicago: University of Chicago.

Rim, E. (1972). A stepwise canonical approach to the selection of `kernel' variables from two sets of variables. Dissertation Abstracts International, 34, 623A. (University Microfilms No. 73-17,386)

Thompson, B. (1980). Canonical correlation: Recent extensions for modeling educational processes. Paper presented at the annual meeting of the American Educational Research Association, Boston. (ERIC Document Reproduction Service No. 199 269)

Thompson, B. (1984). Canonical correlation analysis: Uses and interpretation. Newbury Park, CA: SAGE.

Thompson, B. (1995). Stepwise regression and stepwise discriminant analysis need not apply here: A guidelines editorial. Educational and Psychological Measurement, 55, 525-534.

Thorndike, R. M. (1978). Correlation procedures for research. New York: Gardner.

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Table 1. Final Canonical Solution with Canonical Communality Coefficients

(Deletion Strategy #1, Iteration #1)

	Function I			Function II			Function III			
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
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	6.97%	-0.732	-0.230	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%	
Rc2			36.90%			5.00%			0.90%	
Rd			11.42%			0.54%			0.14%	
Adequacy			30.95%			10.73%			15.81%	
T22	-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%
T10	-0.122	-0.286	8.18%	0.538	0.433	18.75%	0.349	0.670	44.89%	71.82%
T23	-0.291	-0.769	59.14%	0.481	0.261	6.81%	0.041	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%	0.290	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%

Note. The data in Table 1 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago.

Table 2. Final Canonical Solution After Dropping T15 with Subset Canonical Communality Coefficients (Deletion Strategy #1, Iteration #2)

	Function I			Function II			Function III			
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
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	-0.250	-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			28.82%			0.41%			0.10%	
Rc2			36.50%			4.30%			0.90%	
Rd			11.41%			0.35%			0.14%	
Adequacy			31.26%			8.15%			15.92%	
T22	-0.462	-0.821	67.40%	-0.652	-0.367	13.47%	0.048	-0.007	0.00%	80.88%
T12	-0.116	-0.290	8.41%	0.619	0.452	20.43%	0.371	0.682	46.51%	75.35%
T10	0.125	-0.238	5.66%	-0.591	-0.222	4.93%	0.706	0.796	63.36%	73.95%
T23	-0.288	-0.775	60.06%	0.539	0.244	5.95%	0.058	0.056	0.31%	66.33%
T24	-0.386	-0.757	57.30%	0.051	0.168	2.82%	-0.020	0.175	3.06%	63.19%
T20	-0.198	-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%

Note. The data in Table 2 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago.

Table 3. Final Canonical Solution After dropping T15 and T16 with Canonical Communality Coefficients (Deletion Strategy #1, Iteration #3)

	Functio n I			Function II			Function III			
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
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%	
Rc2			36.40%			3.60%			0.90%	
Rd			10.73%			0.27%			0.14%	
Adequacy			29.48%			7.50%			15.63%	
T22	-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%
T10	-0.117	-0.291	8.47%	0.684	0.501	25.10%	0.317	0.650	42.25%	75.82%
T23	-0.280	-0.776	60.22%	-0.672	0.252	6.35%	-0.028	0.040	0.16%	66.73%
T24	-0.378	-0.758	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%
T15			0.00%			0.00%			0.00%	0.00%

Note. The data in Table 3 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago.

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Table 4. Final Canonical Solution with Subset Canonical Communality Coefficients

(Deletion Strategy #2, Iteration #1)

	Functio n I			Function II			Function III			
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
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	6.97%				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%				
Rc2			36.90%			5.00%				
Rd			11.42%			0.54%				
Adequacy			30.95%			10.73%				
T22	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%				76.08%
T23	-0.291	-0.769	59.14%	0.481	0.261	6.81%				65.95%
T24	-0.377	-0.752	56.55%	0.091	0.191	3.65%				60.20%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	0.96%				37.20%
T16	0.017	-0.378	14.29%	0.290	0.383	14.67%				28.96%
T15	0.112	-0.066	0.44%	0.418	0.533	28.41%				28.84%
T10	-0.122	-0.286	8.18%	0.538	0.433	18.75%				26.93%
T12	0.123	-0.238	5.66%	-0.537	-0.190	3.61%				9.27%

Note. The data in Table 4 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago.

Table 5. Final Canonical Solution After Dropping T12 with Subset Canonical Communality Coefficients (Deletion Strategy #2, Iteration #2)

	Function I			Function II			Function III			
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
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%				
Rc2			36.50%			4.10%				
Rd			11.13%			0.56%				
Adequacy			30.49%			13.61%				
T22	-0.456	-0.825	68.06%	-0.591	-0.284	8.07%				76.13%
T23	-0.278	-0.771	59.44%	0.497	0.331	10.96%				70.40%
T24	-0.371	-0.755	57.00%	0.088	0.263	6.92%				63.92%
T20	-0.207	-0.606	36.72%	-0.351	-0.100	1.00%				37.72%
T10	-0.067	-0.285	8.12%	0.384	0.541	29.27%				37.39%
T15	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%
T12			0.00%			0.00%				0.00%

Note. The data in Table 5 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago

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Table 6. Final Canonical Solution With Canonical Communality Coefficients and Weighted Canonical Communality Coefficients

(Deletion Strategy #3, Iteration #1)

	Function I			Function II			Function III				Weighted
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2	h2
T5	-0.295	-0.848	71.91%	0.213	-0.059	0.35%	1.446	0.527	27.77%	100.03%	26.80%
T6	-0.540	-0.937	87.80%	1.232	0.264	6.97%	-0.732	-0.230	5.29%	100.06%	32.79%
T7	-0.276	-0.883	77.97%	-1.511	-0.455	20.70%	-0.612	-0.113	1.28%	99.95%	29.82%
Adequacy			79.23%			9.34%			11.45%		
Rd			29.23%			0.47%			0.10%		
Rc2			36.90%			5.00%			0.90%		
Rd			11.42%			0.54%			0.14%		
Adequacy			30.95%			10.73%			15.81%		
T22	-0.454	-0.819	67.08%	-0.546	-0.300	9.00%	0.073	0.008	0.01%	76.08%	25.20%
T23	-0.291	-0.769	59.14%	0.481	0.261	6.81%	0.041	0.053	0.28%	66.23%	22.16%
T24	-0.377	-0.752	56.55%	0.091	0.191	3.65%	-0.016	0.174	3.03%	63.23%	21.08%
T20	-0.215	-0.602	36.24%	-0.257	-0.098	0.96%	-0.466	-0.335	11.22%	48.42%	13.52%
T16	0.017	-0.378	14.29%	0.290	0.383	14.67%	-0.196	-0.164	2.69%	31.65%	6.03%
T10	-0.122	-0.286	8.18%	0.538	0.433	18.75%	0.349	0.670	44.89%	71.82%	4.36%
T12	0.123	-0.238	5.66%	-0.537	-0.190	3.61%	0.722	0.802	64.32%	73.59%	2.85%
T15	0.112	-0.066	0.44%	0.418	0.533	28.41%	0.056	-0.011	0.01%	28.86%	1.58%

Note. The data in Table 6 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago

Table 7. Final Canonical Solution After Deleting Variable T15 With Weighted Canonical Communality Coefficients (Deletion Strategy #3, Iteration #2)

	Function I			Function II			Function III			Weighted
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
T5	-0.300	-0.847	71.74%	0.943	-0.080	0.64%	0.281	0.525	27.56%	26.46%
T6	-0.560	-0.941	88.55%	0.040	0.251	6.30%	-0.840	-0.228	5.20%	32.64%
T7	-0.250	-0.875	76.56%	-0.381	-0.468	21.90%	0.912	-0.120	1.44%	28.90%
Adequacy			78.95%			9.61%			11.40%	
Rd			28.82%			0.41%			0.10%	
Rc2			36.50%			4.30%			0.90%	
Rd			11.41%			0.35%			0.14%	
Adequacy			31.26%			8.15%			15.92%	
T22	-0.462	-0.821	67.40%	-0.652	-0.367	13.47%	0.048	-0.007	0.00%	25.18%
T23	-0.288	-0.775	60.06%	0.539	0.244	5.95%	0.058	0.056	0.31%	22.18%
T24	-0.386	-0.757	57.30%	0.051	0.168	2.82%	-0.020	0.175	3.06%	21.07%
T20	-0.198	-0.605	36.60%	-0.220	-0.134	1.80%	-0.466	-0.342	11.70%	13.54%
T16	0.048	-0.383	14.67%	0.453	0.397	15.76%	-0.167	-0.155	2.40%	6.05%
T10	-0.116	-0.290	8.41%	0.619	0.452	20.43%	0.371	0.682	46.51%	4.37%
T12	0.125	-0.238	5.66%	-0.591	-0.222	4.93%	0.706	0.796	63.36%	2.85%
T15			0.00%			0.00%			0.00%	0.00%

Note. The data in Table 7 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago

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Table 8. Final Canonical Solution After Deleting Variables T15 and T12 With Weighted Canonical Communality Coefficients (Deletion Strategy #3, Iteration #3)

	Function I			Function II			Function III			Weighted
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
T5	-0.310	-0.854	72.93%	0.494	0.047	0.22%	1.373	0.519	26.94%	26.44%
T6	-0.529	-0.933	87.05%	1.064	0.215	4.62%	-0.966	-0.288	8.29%	31.61%
T7	-0.274	-0.883	77.97%	-0.306	-0.467	21.81%	-1.601	-0.031	0.10%	28.87%
Adequacy			79.32%			8.88%			11.78%	
Rd			28.63%			0.29%			0.05%	
Rc2			36.10%			3.30%			0.40%	
Rd			11.13%			0.36%			0.05%	
Adequacy			30.83%			10.87%			11.54%	
T22	-0.464	-0.828	68.56%	-0.718	-0.361	13.03%	0.499	0.128	1.64%	25.19%
T23	-0.275	-0.777	60.37%	0.570	0.322	10.37%	-0.187	-0.181	3.28%	22.15%
T24	-0.381	-0.760	57.76%	0.042	0.250	6.25%	-0.028	0.038	0.14%	21.06%
T20	-0.190	-0.608	36.97%	-0.331	-0.151	2.28%	-0.415	-0.465	21.62%	13.51%
T16	0.052	-0.382	14.59%	0.482	0.447	19.98%	-0.523	-0.526	27.67%	6.04%
T10	-0.060	-0.290	8.41%	0.476	0.592	35.05%	0.707	0.616	37.95%	4.34%
T12			0.00%			0.00%			0.00%	0.00%
T15			0.00%			0.00%			0.00%	0.00%

Note. The data in Table 8 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago

Table 9. Final Canonical Solution After Deleting Variables T15, T12, and T10 With Weighted Canonical Communality Coefficients (Deletion Strategy #3, Iteration #4)

	Function I			Function II			Function III			Weighted
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
T5	-0.301	-0.851	72.42%	0.306	-0.018	0.03%	1.428	0.524	27.46%	26.13%
T6	-0.524	-0.933	87.05%	1.189	0.258	6.66%	-0.810	-0.252	6.35%	31.53%
T7	-0.287	-0.887	78.68%	-0.519	-0.453	20.52%	-1.543	-0.090	0.81%	28.88%
Adequacy			79.38%			9.07%			11.54%	
Rd			28.58%			0.24%			0.02%	
Rc2			36.00%			2.70%			0.20%	
Rd			10.75%			0.22%			0.02%	
Adequacy			29.86%			8.33%			10.11%	
T22	-0.459	-0.830	68.89%	-0.854	-0.379	14.36%	0.213	0.042	0.18%	25.19%
T23	-0.280	-0.777	60.37%	0.691	0.382	14.59%	0.198	-0.034	0.12%	22.13%
T24	-0.405	-0.761	57.91%	0.250	0.291	8.47%	0.522	0.240	5.76%	21.09%
T20	-0.186	-0.610	37.21%	-0.380	-0.123	1.51%	-0.888	-0.713	50.84%	13.54%
T16	0.053	-0.381	14.52%	0.556	0.526	27.67%	-0.487	-0.490	24.01%	6.02%
T12			0.00%			0.00%			0.00%	0.00%
T10			0.00%			0.00%			0.00%	0.00%
T15			0.00%			0.00%			0.00%	0.00%

Note. The data in Table 9 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago

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Table 10. Final Canonical Solution After Deleting Variables T15, T12, T10, and T16 With Weighted Canonical Communality Coefficients (Deletion Strategy #3, Iteration #5)

	Functio n I			Function II			Function III			Weighted
	Func	Struc	Stru2	Func	Struc	Stru2	Func	Struc	Stru2	h2
T5	-0.301	-0.850	72.25%	0.423	0.021	0.04%	1.398	0.526	27.67%	25.99%
T6	-0.533	-0.935	87.42%	1.113	0.230	5.29%	-0.906	-0.271	7.34%	31.51%
T7	-0.278	-0.884	78.15%	-0.387	-0.464	21.53%	-1.583	-0.050	0.25%	28.51%
Adequacy			79.27%			8.95%			11.75%	
Rd			28.46%			0.19%			0.02%	
Rc2			35.90%			2.10%			0.20%	
Rd			10.09%			0.13%			0.02%	
Adequacy			28.11%			6.40%			8.54%	
T22	-0.456	-0.830	68.89%	-0.964	-0.455	20.70%	0.541	0.210	4.41%	25.18%
T23	-0.272	-0.779	60.68%	0.901	0.415	17.22%	-0.146	-0.150	2.25%	22.15%
T24	-0.396	-0.762	58.06%	0.401	0.318	10.11%	0.390	0.198	3.92%	21.07%
T20	-0.175	-0.610	37.21%	-0.340	-0.177	3.13%	-1.035	-0.760	57.76%	13.54%
T12			0.00%			0.00%			0.00%	0.00%
T10			0.00%			0.00%			0.00%	0.00%
T16			0.00%			0.00%			0.00%	0.00%
T15			0.00%			0.00%			0.00%	0.00%

Note. The data in Table 10 are from A study in factor analysis: The stability of a bi-factor solution (pp. 81-91), by K. J. Holzinger and F. Swineford, 1939, Chicago; University of Chicago

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