Multivariate statistics: Assignment 1

Team 27: **Raïsa Carmen** *s0204278* **Marco Chi Chung Fong** *stnumber*
Wenting Jiang *s0204278* **Chin Wei Ma** *r0877202*

1 Task 1

1.1 CFA to construct a measurement model for the Attitude items

There are 9 attitude items that are scored on a five-point Likert scale.

1.1.1 A simple 3-factor model

We first conduct a simple confirmatory factor analysis, assuming each item only has a loading on the concept it aims to measure (organic, packaging, and cruelty free). We will assume the the three latent variables are correlated and the factor loading of the first indicator of each latent variable is fixed to 1. We fit the model on standardized data. Table 1 shows several performance measures for the model. It shows that the currently proposed 3-factor model is not a good fit. The chi-squared goodness of fit tests indicate that the constraints imposed by the model are not supported ($p < 0.001$). The cutoff for a good model for CFI and TLI (cutoff > 0.95) and for RMSEA and SRMR (cutoff < 0.08) are also not satisfied. Figure 1 shows a graphical representation of the model, including all loadings (which are equal to the covariance between the variable and the factor since the data was first standardized), correlations and variances.

In the standardized solution, the standardized loadings represent correlations between a variable and a factor (Table 2) and the error variances indicate the proportion of the variance in a variable that cannot be explained by the model (Table 2).

Table 1: Performance of the simple model for the attitudes.

Performance measure	Value
user model Chisq. (df)	120.89 (24)***
baseline model Chisq. (df)	906.01 (36) ***
comparative fit index (CFI)	0.889
Tucker-Lewis index (TLI)	0.833
Loglik user model (H0)	-1518.492
Loglik unrestricted model(H1)	-1458.049
Akaike (AIC)	3078.984
Bayesian (BIC)	3142.207
RMSEA (ll,ul)	0.16 (0.14, 0.19)***
Standardized root mean square residual	0.057

Table 2: The solution of the simple model for the attitudes.

loading	value
organic =~ A_organic1	0.87 (0.80, 0.94)***
organic =~ A_organic2	0.73 (0.63, 0.82)***
organic =~ A_organic3	0.72 (0.62, 0.81)***
packaging =~ A_packaging1	0.84 (0.78, 0.91)***
packaging =~ A_packaging2	0.79 (0.72, 0.87)***
packaging =~ A_packaging3	0.80 (0.73, 0.88)***
crueltyfree =~ A_crueltyfree1	0.91 (0.87, 0.96)***
crueltyfree =~ A_crueltyfree2	0.79 (0.72, 0.86)***
crueltyfree =~ A_crueltyfree3	0.86 (0.81, 0.92)***

	(co)variance	value
10	organic~~organic	0.75 ***
11	packaging~~packaging	0.71 ***
12	crueltyfree~~crueltyfree	0.83 ***
13	organic~~packaging	0.54 ***
14	organic~~crueltyfree	0.48 ***
15	packaging~~crueltyfree	0.55 ***
16	A_organic1~~A_organic1	0.24 ***
17	A_organic2~~A_organic2	0.47 ***
18	A_organic3~~A_organic3	0.48 ***
19	A_packaging1~~A_packaging1	0.29 ***
20	A_packaging2~~A_packaging2	0.37 ***
21	A_packaging3~~A_packaging3	0.35 ***
22	A_crueltyfree1~~A_crueltyfree1	0.17 ***
23	A_crueltyfree2~~A_crueltyfree2	0.37 ***
24	A_crueltyfree3~~A_crueltyfree3	0.25 ***

1.1.2 A 3-factor model with correlated error terms

Since the simple 3-factor model does not seem to perform well, we alter the model by including correlated error terms for all pairs of items that focus on the same aspect. We also impose equal residual correlations for all pairs of items that focus on the same aspect.

Table 3: Performance of the model for the attitudes with correlated error terms.

Performance measure	Value
user model Chisq. (df)	58.94 (21)***
baseline model Chisq. (df)	906.01 (36) ***
comparative fit index (CFI)	0.956
Tucker-Lewis index (TLI)	0.925
Loglik user model (H0)	-1487.518
Loglik unrestricted model(H1)	-1458.049
Akaike (AIC)	3023.036
Bayesian (BIC)	3095.292
RMSEA (ll,ul)	0.11 (0.08, 0.14)**
Standardized root mean square residual	0.041

1.1.3 Conclusion

An anova test between the two models shows that the model with correlated error terms is significantly better (p-value < 0.001).

Since, however, the performance measures (Table 3) shows less-than-perfect fit, we look at the residual correlations and notice that 7 (19.44%) of all correlations are larger than 0.05 or smaller than -0.05. Three of the largest residual correlations involved the correlations between A_organic3, A_packaging3, and A_crueltyfree3 which leads us to believe that the assumption that these correlations are equal does not hold. Indeed, a model that relaxes this assumption has a good TLI (0.966), CFI (0.982), RMSEA (0.074), and SRMR (0.03). The Chi-square goodness of fit test still has a p-value of 0.016

Table 4: The standardized solution of the model with correlated error terms for the attitudes.

loading	value
organic =~ A_organic1	0.88 (0.81, 0.96)***
organic =~ A_organic2	0.73 (0.64, 0.82)***
organic =~ A_organic3	0.72 (0.63, 0.81)***
packaging =~ A_packaging1	0.87 (0.80, 0.93)***
packaging =~ A_packaging2	0.80 (0.73, 0.87)***
packaging =~ A_packaging3	0.80 (0.73, 0.87)***
crueltyfree =~ A_crueltyfree1	0.93 (0.87, 0.98)***
crueltyfree =~ A_crueltyfree2	0.77 (0.69, 0.84)***
crueltyfree =~ A_crueltyfree3	0.83 (0.77, 0.90)***

	(co)variance	value
10	A_organic1~~A_packaging1	0.01
11	A_organic1~~A_crueltyfree1	0.01
12	A_packaging1~~A_crueltyfree1	0.01
13	A_organic2~~A_packaging2	0.13 ***
14	A_organic2~~A_crueltyfree2	0.13 ***
15	A_packaging2~~A_crueltyfree2	0.13 ***
16	A_organic3~~A_packaging3	0.12 ***
17	A_organic3~~A_crueltyfree3	0.12 ***
18	A_packaging3~~A_crueltyfree3	0.12 ***
19	organic~~organic	0.78 ***
20	packaging~~packaging	0.74 ***
21	crueltyfree~~crueltyfree	0.85 ***
22	organic~~packaging	0.53 ***
23	organic~~crueltyfree	0.46 ***
24	packaging~~crueltyfree	0.55 ***
25	A_organic1~~A_organic1	0.22 ***
26	A_organic2~~A_organic2	0.47 ***
27	A_organic3~~A_organic3	0.44 ***
28	A_packaging1~~A_packaging1	0.25 ***
29	A_packaging2~~A_packaging2	0.35 ***
30	A_packaging3~~A_packaging3	0.36 ***
31	A_crueltyfree1~~A_crueltyfree1	0.14 **
32	A_crueltyfree2~~A_crueltyfree2	0.41 ***
33	A_crueltyfree3~~A_crueltyfree3	0.32 ***

1.2 CFA to construct a measurement model for the Behavior-Intention items

There are 9 behavior-intention items that are scored on a five-point Likert scale.

1.2.1 A simple 3-factor model

Table 5: Performance of the simple model for the behavior-intent items.

Performance measure	Value
user model Chisq. (df)	147.81 (24)***
baseline model Chisq. (df)	1478.43 (36) ***
comparative fit index (CFI)	0.914
Tucker-Lewis index (TLI)	0.871
Loglik user model (H0)	-1245.746
Loglik unrestricted model(H1)	-1171.838
Akaike (AIC)	2533.491
Bayesian (BIC)	2596.714
RMSEA (ll,ul)	0.19 (0.16, 0.21)***
Standardized root mean square residual	0.033

1.2.2 A 3-factor model with correlated error terms

Since the simple 3-factor model does not seem to perform well, we alter the model by including correlated error terms for all pairs of items that focus on the same aspect. We also impose equal residual residual correlations for all pairs of items that focus on the same aspect.

Table 7: Performance of the model for the behavior-intent items with correlated error terms.

Performance measure	Value
user model Chisq. (df)	25.72 (21)
baseline model Chisq. (df)	1478.43 (36) ***
comparative fit index (CFI)	0.997
Tucker-Lewis index (TLI)	0.994
Loglik user model (H0)	-1184.699
Loglik unrestricted model(H1)	-1171.838
Akaike (AIC)	2417.397
Bayesian (BIC)	2489.653
RMSEA (ll,ul)	0.04 (0.00, 0.08)
Standardized root mean square residual	0.02

Table 6: The standardized solution of the simple model for the behavior-intent items.

loading	value
organic =~ BI_organic1	0.89 (0.84, 0.93)***
organic =~ BI_organic2	0.90 (0.85, 0.94)***
organic =~ BI_organic3	0.84 (0.79, 0.90)***
packaging =~ BI_packaging1	0.88 (0.83, 0.92)***
packaging =~ BI_packaging2	0.89 (0.85, 0.93)***
packaging =~ BI_packaging3	0.87 (0.82, 0.91)***
crueltyfree =~ BI_crueltyfree1	0.92 (0.88, 0.95)***
crueltyfree =~ BI_crueltyfree2	0.92 (0.89, 0.95)***
crueltyfree =~ BI_crueltyfree3	0.94 (0.91, 0.97)***

	error.variance	value
16	BI_organic1	0.22 (0.14, 0.29)***
17	BI_organic2	0.20 (0.12, 0.27)***
18	BI_organic3	0.29 (0.20, 0.38)***
19	BI_packaging1	0.23 (0.15, 0.31)***
20	BI_packaging2	0.21 (0.13, 0.28)***
21	BI_packaging3	0.25 (0.17, 0.33)***
22	BI_crueltyfree1	0.16 (0.10, 0.22)***
23	BI_crueltyfree2	0.16 (0.10, 0.22)***
24	BI_crueltyfree3	0.12 (0.07, 0.17)***

Table 8: The standardized solution of the model with correlated error terms for the behavior-intent items.

loading	value
organic =~ BI_organic1	0.88 (0.84, 0.93)***
organic =~ BI_organic2	0.89 (0.84, 0.93)***
organic =~ BI_organic3	0.85 (0.80, 0.91)***
packaging =~ BI_packaging1	0.88 (0.83, 0.92)***
packaging =~ BI_packaging2	0.90 (0.86, 0.94)***
packaging =~ BI_packaging3	0.85 (0.80, 0.91)***
crueltyfree =~ BI_crueltyfree1	0.92 (0.89, 0.95)***
crueltyfree =~ BI_crueltyfree2	0.91 (0.88, 0.95)***
crueltyfree =~ BI_crueltyfree3	0.94 (0.91, 0.97)***

	error.variance	value
22	organic	0.84 (0.78, 0.90)***
23	organic	0.75 (0.67, 0.83)***
24	packaging	0.81 (0.74, 0.87)***
25	BI_organic1	0.22 (0.14, 0.30)***
26	BI_organic2	0.21 (0.14, 0.29)***
27	BI_organic3	0.27 (0.18, 0.36)***
28	BI_packaging1	0.23 (0.15, 0.31)***
29	BI_packaging2	0.19 (0.12, 0.27)***
30	BI_packaging3	0.27 (0.18, 0.36)***
31	BI_crueltyfree1	0.15 (0.10, 0.21)***
32	BI_crueltyfree2	0.16 (0.11, 0.22)***
33	BI_crueltyfree3	0.12 (0.06, 0.17)***

	resid.correlation	value
10	BI_organic1 ~~ BI_packaging1	0.31 (0.17, 0.44)***
11	BI_organic1 ~~ BI_crueltyfree1	0.38 (0.22, 0.54)***
12	BI_packaging1 ~~ BI_crueltyfree1	0.37 (0.21, 0.52)***
13	BI_organic2 ~~ BI_packaging2	0.47 (0.34, 0.61)***
14	BI_organic2 ~~ BI_crueltyfree2	0.51 (0.37, 0.66)***
15	BI_packaging2 ~~ BI_crueltyfree2	0.54 (0.40, 0.69)***
16	BI_organic3 ~~ BI_packaging3	0.21 (0.09, 0.33)***
17	BI_organic3 ~~ BI_crueltyfree3	0.33 (0.16, 0.50)***
18	BI_packaging3 ~~ BI_crueltyfree3	0.32 (0.15, 0.49)***

1.2.3 Conclusion

An anova test between the two models shows that the model with correlated error terms is significantly better (p-value < 0.001).

The performance measures (Table 7) show a good fit and most residual correlations are between -0.05 and 0.05 (only 0 have an absolute value that is slightly higher with a maximum of 0.047). We shall thus keep this model as the final model.

1.3 Structural equation model to evaluate the impact of attitude on behavior intention

With a test statistics of 145.74 with 120 degrees of freedom, the chi-square p-value is 0.0550075 which means we cannot reject the null hypothesis that the model fits well.

```
## lavaan 0.6-12 ended normally after 63 iterations
##
##   Estimator                                         ML
##   Optimization method                           NLMINB
##   Number of model parameters                        63
##   Number of equality constraints                    12
##
##   Number of observations                           150
##
## Model Test User Model:
##
##   Test statistic                               145.742
##   Degrees of freedom                               120
##   P-value (Chi-square)                           0.055
##
## Parameter Estimates:
##
##   Standard errors                             Standard
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   BI_organic =~
##     BI_organic1       1.000
##     BI_organic2       1.009    0.065   15.469    0.000
##     BI_organic3       0.946    0.068   13.819    0.000
##   BI_packaging =~
##     BI_packaging1     1.000
```

```
##     BI_packaging2      1.010    0.064   15.764    0.000
##     BI_packaging3      0.959    0.070   13.706    0.000
##   BI_crueltyfree =~
##     BI_crueltyfre1     1.000
##     BI_crueltyfre2     0.982    0.052   19.068    0.000
##     BI_crueltyfre3     1.008    0.050   19.966    0.000
##   A_organic =~
##     A_organic1         0.842    0.071   11.907    0.000
##     A_organic2         0.738    0.073   10.076    0.000
##     A_organic3         0.692    0.072    9.641    0.000
##   A_packaging =~
##     A_packaging1       0.831    0.068   12.301    0.000
##     A_packaging2       0.792    0.069   11.468    0.000
##     A_packaging3       0.818    0.068   11.993    0.000
##   A_crueltyfree =~
##     A_crueltyfree1     0.895    0.066   13.580    0.000
##     A_crueltyfree2     0.798    0.068   11.658    0.000
##     A_crueltyfree3     0.881    0.066   13.450    0.000
##
## Regressions:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   BI_organic ~
##     A_organic         0.582    0.063    9.260    0.000
##   BI_packaging ~
##     A_packaging       0.574    0.060    9.536    0.000
##   BI_crueltyfree ~
##     A_crueltyfree     0.614    0.059   10.450    0.000
##
## Covariances:
##                    Estimate  Std.Err  z-value  P(>|z|)
##  .BI_organic1 ~~
##    .BI_pckgng1 (c)    0.058    0.015    3.791    0.000
##    .BI_crltyf1 (c)    0.058    0.015    3.791    0.000
##  .BI_packaging1 ~~
##    .BI_crltyf1 (c)    0.058    0.015    3.791    0.000
##  .BI_organic2 ~~
##    .BI_pckgng2 (d)    0.104    0.018    5.918    0.000
##    .BI_crltyf2 (d)    0.104    0.018    5.918    0.000
##  .BI_packaging2 ~~
##    .BI_crltyf2 (d)    0.104    0.018    5.918    0.000
##  .BI_organic3 ~~
##    .BI_pckgng3 (e)    0.056    0.018    3.008    0.003
```

```
##    .BI_crltyf3 (e)    0.056    0.018    3.008    0.003
##  .BI_packaging3 ~~
##    .BI_crltyf3 (e)    0.056    0.018    3.008    0.003
##  .BI_organic ~~
##    .BI_packgng        0.323    0.054    5.931    0.000
##    .BI_crltyfr        0.267    0.048    5.545    0.000
##  .BI_packaging ~~
##    .BI_crltyfr        0.295    0.049    6.032    0.000
##  .A_organic1 ~~
##    .A_packgng1 (c)    0.058    0.015    3.791    0.000
##    .A_crltyfr1 (c)    0.058    0.015    3.791    0.000
##  .A_packaging1 ~~
##    .A_crltyfr1 (c)    0.058    0.015    3.791    0.000
##  .A_organic2 ~~
##    .A_packgng2 (d)    0.104    0.018    5.918    0.000
##    .A_crltyfr2 (d)    0.104    0.018    5.918    0.000
##  .A_packaging2 ~~
##    .A_crltyfr2 (d)    0.104    0.018    5.918    0.000
##  .A_organic3 ~~
##    .A_packgng3        0.238    0.048    5.001    0.000
##    .A_crltyfr3        0.089    0.037    2.411    0.016
##  .A_packaging3 ~~
##    .A_crltyfr3        0.034    0.032    1.060    0.289
##   A_organic ~~
##     A_packagng        0.737    0.047   15.699    0.000
##     A_crultyfr        0.634    0.058   10.834    0.000
##   A_packaging ~~
##     A_crultyfr        0.709    0.049   14.571    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .BI_organic        0.382    0.067    5.674    0.000
##    .BI_packaging      0.376    0.064    5.877    0.000
##    .BI_crueltyfree    0.349    0.054    6.421    0.000
##     A_organic         1.000
##     A_packaging       1.000
##     A_crueltyfree     1.000
##    .BI_organic1       0.216    0.033    6.570    0.000
##    .BI_organic2       0.214    0.031    6.996    0.000
##    .BI_organic3       0.267    0.038    7.034    0.000
##    .BI_packaging1     0.212    0.031    6.762    0.000
##    .BI_packaging2     0.198    0.028    6.999    0.000
```

```
##    .BI_packaging3     0.279    0.039    7.239    0.000
##    .BI_crueltyfre1    0.136    0.022    6.226    0.000
##    .BI_crueltyfre2    0.173    0.023    7.461    0.000
##    .BI_crueltyfre3    0.121    0.022    5.432    0.000
##    .A_organic1        0.307    0.052    5.882    0.000
##    .A_organic2        0.456    0.059    7.702    0.000
##    .A_organic3        0.497    0.069    7.258    0.000
##    .A_packaging1      0.290    0.043    6.679    0.000
##    .A_packaging2      0.361    0.047    7.604    0.000
##    .A_packaging3      0.341    0.053    6.411    0.000
##    .A_crueltyfree1    0.218    0.036    6.049    0.000
##    .A_crueltyfree2    0.360    0.045    7.961    0.000
##    .A_crueltyfree3    0.221    0.040    5.604    0.000
```

```
##                lhs op             rhs label est.std    se      z pvalue
## 1       BI_organic =~     BI_organic1         0.877 0.023 38.571  0.000
## 2       BI_organic =~     BI_organic2         0.880 0.021 41.636  0.000
## 3       BI_organic =~     BI_organic3         0.841 0.027 30.622  0.000
## 4     BI_packaging =~   BI_packaging1         0.877 0.022 39.491  0.000
## 5     BI_packaging =~   BI_packaging2         0.886 0.020 44.199  0.000
## 6     BI_packaging =~   BI_packaging3         0.836 0.028 30.332  0.000
## 7   BI_crueltyfree =~ BI_crueltyfree1         0.918 0.016 58.323  0.000
## 8   BI_crueltyfree =~ BI_crueltyfree2         0.896 0.017 51.532  0.000
## 9   BI_crueltyfree =~ BI_crueltyfree3         0.927 0.016 59.787  0.000
## 10     BI_organic1 ~~   BI_packaging1     c   0.269 0.059  4.560  0.000
## 11     BI_organic1 ~~ BI_crueltyfree1     c   0.336 0.071  4.756  0.000
## 12   BI_packaging1 ~~ BI_crueltyfree1     c   0.339 0.071  4.804  0.000
## 13     BI_organic2 ~~   BI_packaging2     d   0.506 0.059  8.556  0.000
## 14     BI_organic2 ~~ BI_crueltyfree2     d   0.541 0.061  8.852  0.000
## 15   BI_packaging2 ~~ BI_crueltyfree2     d   0.562 0.061  9.244  0.000
## 16     BI_organic3 ~~   BI_packaging3     e   0.204 0.058  3.507  0.000
## 17     BI_organic3 ~~ BI_crueltyfree3     e   0.309 0.082  3.771  0.000
## 18   BI_packaging3 ~~ BI_crueltyfree3     e   0.302 0.080  3.771  0.000
## 19      BI_organic ~~      BI_organic         0.530 0.068  7.784  0.000
## 20    BI_packaging ~~    BI_packaging         0.533 0.064  8.293  0.000
## 21  BI_crueltyfree ~~  BI_crueltyfree         0.481 0.060  7.978  0.000
## 22      BI_organic ~~    BI_packaging         0.852 0.044 19.159  0.000
## 23      BI_organic ~~  BI_crueltyfree         0.729 0.058 12.630  0.000
## 24    BI_packaging ~~  BI_crueltyfree         0.814 0.046 17.853  0.000
## 25       A_organic =~      A_organic1         0.835 0.034 24.572  0.000
## 26       A_organic =~      A_organic2         0.738 0.043 17.068  0.000
## 27       A_organic =~      A_organic3         0.700 0.048 14.582  0.000
```

```
## 28     A_packaging =~    A_packaging1         0.839 0.030 28.082  0.000
## 29     A_packaging =~    A_packaging2         0.797 0.034 23.312  0.000
## 30     A_packaging =~    A_packaging3         0.814 0.034 23.743  0.000
## 31   A_crueltyfree =~  A_crueltyfree1         0.887 0.023 38.896  0.000
## 32   A_crueltyfree =~  A_crueltyfree2         0.799 0.032 24.613  0.000
## 33   A_crueltyfree =~  A_crueltyfree3         0.882 0.025 35.590  0.000
## 34      A_organic1 ~~    A_packaging1     c   0.193 0.047  4.099  0.000
## 35      A_organic1 ~~  A_crueltyfree1     c   0.222 0.054  4.104  0.000
## 36    A_packaging1 ~~  A_crueltyfree1     c   0.229 0.055  4.140  0.000
## 37      A_organic2 ~~    A_packaging2     d   0.257 0.041  6.259  0.000
## 38      A_organic2 ~~  A_crueltyfree2     d   0.257 0.041  6.221  0.000
## 39    A_packaging2 ~~  A_crueltyfree2     d   0.289 0.046  6.327  0.000
## 40      A_organic3 ~~    A_packaging3         0.579 0.068  8.467  0.000
## 41      A_organic3 ~~  A_crueltyfree3         0.268 0.098  2.731  0.006
## 42    A_packaging3 ~~  A_crueltyfree3         0.123 0.111  1.114  0.265
## 43       A_organic ~~       A_organic         1.000 0.000     NA     NA
## 44     A_packaging ~~     A_packaging         1.000 0.000     NA     NA
## 45   A_crueltyfree ~~   A_crueltyfree         1.000 0.000     NA     NA
## 46       A_organic ~~     A_packaging         0.737 0.047 15.699  0.000
## 47       A_organic ~~   A_crueltyfree         0.634 0.058 10.834  0.000
## 48     A_packaging ~~   A_crueltyfree         0.709 0.049 14.571  0.000
## 49      BI_organic  ~       A_organic         0.686 0.050 13.803  0.000
## 50    BI_packaging  ~     A_packaging         0.683 0.047 14.538  0.000
## 51  BI_crueltyfree  ~   A_crueltyfree         0.721 0.042 17.230  0.000
## 52     BI_organic1 ~~     BI_organic1         0.231 0.040  5.782  0.000
## 53     BI_organic2 ~~     BI_organic2         0.225 0.037  6.059  0.000
## 54     BI_organic3 ~~     BI_organic3         0.293 0.046  6.339  0.000
## 55   BI_packaging1 ~~   BI_packaging1         0.231 0.039  5.937  0.000
## 56   BI_packaging2 ~~   BI_packaging2         0.216 0.035  6.081  0.000
## 57   BI_packaging3 ~~   BI_packaging3         0.301 0.046  6.523  0.000
## 58 BI_crueltyfree1 ~~ BI_crueltyfree1         0.157 0.029  5.444  0.000
## 59 BI_crueltyfree2 ~~ BI_crueltyfree2         0.198 0.031  6.353  0.000
## 60 BI_crueltyfree3 ~~ BI_crueltyfree3         0.141 0.029  4.915  0.000
## 61      A_organic1 ~~      A_organic1         0.302 0.057  5.320  0.000
## 62      A_organic2 ~~      A_organic2         0.455 0.064  7.136  0.000
## 63      A_organic3 ~~      A_organic3         0.510 0.067  7.580  0.000
## 64    A_packaging1 ~~    A_packaging1         0.295 0.050  5.889  0.000
## 65    A_packaging2 ~~    A_packaging2         0.365 0.054  6.700  0.000
## 66    A_packaging3 ~~    A_packaging3         0.338 0.056  6.056  0.000
## 67  A_crueltyfree1 ~~  A_crueltyfree1         0.214 0.040  5.293  0.000
## 68  A_crueltyfree2 ~~  A_crueltyfree2         0.361 0.052  6.955  0.000
## 69  A_crueltyfree3 ~~  A_crueltyfree3         0.222 0.044  5.073  0.000
```

```
##    ci.lower ci.upper
## 1     0.833    0.922
## 2     0.839    0.922
## 3     0.787    0.895
## 4     0.833    0.920
## 5     0.846    0.925
## 6     0.782    0.890
## 7     0.887    0.949
## 8     0.862    0.930
## 9     0.896    0.957
## 10    0.153    0.384
## 11    0.197    0.474
## 12    0.201    0.477
## 13    0.390    0.621
## 14    0.421    0.661
## 15    0.443    0.681
## 16    0.090    0.317
## 17    0.148    0.469
## 18    0.145    0.459
## 19    0.397    0.664
## 20    0.407    0.659
## 21    0.363    0.599
## 22    0.765    0.939
## 23    0.616    0.843
## 24    0.725    0.904
## 25    0.769    0.902
## 26    0.653    0.823
## 27    0.606    0.794
## 28    0.781    0.898
## 29    0.730    0.864
## 30    0.747    0.881
## 31    0.842    0.931
## 32    0.736    0.863
## 33    0.834    0.931
## 34    0.101    0.285
## 35    0.116    0.329
## 36    0.121    0.337
## 37    0.176    0.337
## 38    0.176    0.338
## 39    0.199    0.378
## 40    0.445    0.713
## 41    0.076    0.460
```

```
## 42   -0.094    0.340
## 43    1.000    1.000
## 44    1.000    1.000
## 45    1.000    1.000
## 46    0.645    0.829
## 47    0.519    0.748
## 48    0.613    0.804
## 49    0.588    0.783
## 50    0.591    0.776
## 51    0.639    0.803
## 52    0.152    0.309
## 53    0.153    0.298
## 54    0.202    0.383
## 55    0.155    0.307
## 56    0.146    0.285
## 57    0.210    0.391
## 58    0.101    0.214
## 59    0.137    0.259
## 60    0.085    0.198
## 61    0.191    0.413
## 62    0.330    0.580
## 63    0.378    0.642
## 64    0.197    0.394
## 65    0.258    0.472
## 66    0.228    0.447
## 67    0.135    0.293
## 68    0.259    0.463
## 69    0.136    0.308
```

The structural equation model shows that all correlations between latent variables are positive and highly significant.

- an increase of one unit in attitude_organic increases the behavior intention with 0.686.
- an increase of one unit in attitude_packaging increases the behavior intention with 0.683.
- an increase of one unit in attitude_crueltyfree increases the behavior intention with 0.721.

These population regression coefficients are quite similar so we next test a model that imposes that all three regression coefficients are the same.

1.3.1 The same population regression coefficient

```
## lavaan 0.6-12 ended normally after 60 iterations
##
##   Estimator                                         ML
```

```
##   Optimization method                           NLMINB
##   Number of model parameters                        63
##   Number of equality constraints                    14
##
##   Number of observations                           150
##
## Model Test User Model:
##
##   Test statistic                               146.205
##   Degrees of freedom                               122
##   P-value (Chi-square)                           0.067
##
## Parameter Estimates:
##
##   Standard errors                             Standard
##   Information                                 Expected
##   Information saturated (h1) model          Structured
##
## Latent Variables:
##                    Estimate  Std.Err  z-value  P(>|z|)
##   BI_organic =~
##     BI_organic1       1.000
##     BI_organic2       1.006    0.062   16.302    0.000
##     BI_organic3       0.943    0.066   14.391    0.000
##   BI_packaging =~
##     BI_packaging1     1.000
##     BI_packaging2     1.001    0.059   16.885    0.000
##     BI_packaging3     0.951    0.066   14.426    0.000
##   BI_crueltyfree =~
##     BI_crueltyfre1    1.000
##     BI_crueltyfre2    0.987    0.052   19.098    0.000
##     BI_crueltyfre3    1.014    0.051   20.042    0.000
##   A_organic =~
##     A_organic1        0.847    0.069   12.225    0.000
##     A_organic2        0.742    0.072   10.294    0.000
##     A_organic3        0.696    0.070    9.882    0.000
##   A_packaging =~
##     A_packaging1      0.839    0.066   12.723    0.000
##     A_packaging2      0.800    0.068   11.828    0.000
##     A_packaging3      0.827    0.067   12.406    0.000
##   A_crueltyfree =~
##     A_crueltyfree1    0.884    0.063   14.034    0.000
```

```
##     A_crueltyfree2     0.788    0.066   11.902    0.000
##     A_crueltyfree3     0.871    0.063   13.843    0.000
##
## Regressions:
##                   Estimate  Std.Err  z-value  P(>|z|)
##   BI_organic ~
##     A_organic  (p)    0.594    0.049   12.197    0.000
##   BI_packaging ~
##     A_packagng (p)    0.594    0.049   12.197    0.000
##   BI_crueltyfree ~
##     A_crultyfr (p)    0.594    0.049   12.197    0.000
##
## Covariances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##  .BI_organic1 ~~
##    .BI_pckgng1 (c)    0.057    0.015    3.770    0.000
##    .BI_crltyf1 (c)    0.057    0.015    3.770    0.000
##  .BI_packaging1 ~~
##    .BI_crltyf1 (c)    0.057    0.015    3.770    0.000
##  .BI_organic2 ~~
##    .BI_pckgng2 (d)    0.104    0.018    5.928    0.000
##    .BI_crltyf2 (d)    0.104    0.018    5.928    0.000
##  .BI_packaging2 ~~
##    .BI_crltyf2 (d)    0.104    0.018    5.928    0.000
##  .BI_organic3 ~~
##    .BI_pckgng3 (e)    0.056    0.018    3.008    0.003
##    .BI_crltyf3 (e)    0.056    0.018    3.008    0.003
##  .BI_packaging3 ~~
##    .BI_crltyf3 (e)    0.056    0.018    3.008    0.003
##  .BI_organic ~~
##    .BI_packgng        0.323    0.054    5.929    0.000
##    .BI_crltyfr        0.268    0.048    5.569    0.000
##  .BI_packaging ~~
##    .BI_crltyfr        0.297    0.049    6.053    0.000
##  .A_organic1 ~~
##    .A_packgng1 (c)    0.057    0.015    3.770    0.000
##    .A_crltyfr1 (c)    0.057    0.015    3.770    0.000
##  .A_packaging1 ~~
##    .A_crltyfr1 (c)    0.057    0.015    3.770    0.000
##  .A_organic2 ~~
##    .A_packgng2 (d)    0.104    0.018    5.928    0.000
##    .A_crltyfr2 (d)    0.104    0.018    5.928    0.000
```

```
##  .A_packaging2 ~~
##    .A_crltyfr2 (d)    0.104    0.018    5.928    0.000
##  .A_organic3 ~~
##    .A_packgng3        0.238    0.048    4.994    0.000
##    .A_crltyfr3        0.089    0.037    2.409    0.016
##  .A_packaging3 ~~
##    .A_crltyfr3        0.034    0.032    1.061    0.289
##   A_organic ~~
##     A_packagng        0.742    0.046   16.165    0.000
##     A_crultyfr        0.634    0.058   10.861    0.000
##   A_packaging ~~
##     A_crultyfr        0.708    0.049   14.592    0.000
##
## Variances:
##                   Estimate  Std.Err  z-value  P(>|z|)
##    .BI_organic        0.381    0.067    5.676    0.000
##    .BI_packaging      0.377    0.064    5.913    0.000
##    .BI_crueltyfree    0.351    0.055    6.442    0.000
##     A_organic         1.000
##     A_packaging       1.000
##     A_crueltyfree     1.000
##    .BI_organic1       0.216    0.033    6.570    0.000
##    .BI_organic2       0.214    0.030    7.019    0.000
##    .BI_organic3       0.267    0.038    7.045    0.000
##    .BI_packaging1     0.211    0.031    6.746    0.000
##    .BI_packaging2     0.199    0.028    7.042    0.000
##    .BI_packaging3     0.279    0.038    7.255    0.000
##    .BI_crueltyfre1    0.136    0.022    6.258    0.000
##    .BI_crueltyfre2    0.173    0.023    7.445    0.000
##    .BI_crueltyfre3    0.121    0.022    5.405    0.000
##    .A_organic1        0.308    0.052    5.909    0.000
##    .A_organic2        0.457    0.059    7.722    0.000
##    .A_organic3        0.497    0.068    7.262    0.000
##    .A_packaging1      0.291    0.043    6.701    0.000
##    .A_packaging2      0.361    0.047    7.622    0.000
##    .A_packaging3      0.340    0.053    6.418    0.000
##    .A_crueltyfree1    0.217    0.036    6.011    0.000
##    .A_crueltyfree2    0.360    0.045    7.954    0.000
##    .A_crueltyfree3    0.222    0.040    5.585    0.000

##                lhs op             rhs label est.std    se      z pvalue
## 1       BI_organic =~     BI_organic1         0.879 0.021 42.166  0.000
```

```
## 2       BI_organic =~     BI_organic2         0.881 0.021 42.487  0.000
## 3       BI_organic =~     BI_organic3         0.842 0.027 31.306  0.000
## 4     BI_packaging =~   BI_packaging1         0.881 0.020 43.877  0.000
## 5     BI_packaging =~   BI_packaging2         0.887 0.020 45.204  0.000
## 6     BI_packaging =~   BI_packaging3         0.838 0.027 31.102  0.000
## 7   BI_crueltyfree =~ BI_crueltyfree1         0.915 0.015 59.215  0.000
## 8   BI_crueltyfree =~ BI_crueltyfree2         0.894 0.017 51.405  0.000
## 9   BI_crueltyfree =~ BI_crueltyfree3         0.926 0.016 59.066  0.000
## 10     BI_organic1 ~~   BI_packaging1     c   0.268 0.059  4.533  0.000
## 11     BI_organic1 ~~ BI_crueltyfree1     c   0.334 0.071  4.724  0.000
## 12   BI_packaging1 ~~ BI_crueltyfree1     c   0.337 0.071  4.769  0.000
## 13     BI_organic2 ~~   BI_packaging2     d   0.505 0.059  8.572  0.000
## 14     BI_organic2 ~~ BI_crueltyfree2     d   0.542 0.061  8.881  0.000
## 15   BI_packaging2 ~~ BI_crueltyfree2     d   0.563 0.061  9.273  0.000
## 16     BI_organic3 ~~   BI_packaging3     e   0.203 0.058  3.506  0.000
## 17     BI_organic3 ~~ BI_crueltyfree3     e   0.309 0.082  3.774  0.000
## 18   BI_packaging3 ~~ BI_crueltyfree3     e   0.302 0.080  3.773  0.000
## 19      BI_organic ~~      BI_organic         0.519 0.060  8.633  0.000
## 20    BI_packaging ~~    BI_packaging         0.517 0.058  8.872  0.000
## 21  BI_crueltyfree ~~  BI_crueltyfree         0.499 0.056  8.946  0.000
## 22      BI_organic ~~    BI_packaging         0.852 0.045 19.014  0.000
## 23      BI_organic ~~  BI_crueltyfree         0.732 0.057 12.750  0.000
## 24    BI_packaging ~~  BI_crueltyfree         0.816 0.045 17.938  0.000
## 25       A_organic =~      A_organic1         0.836 0.033 24.997  0.000
## 26       A_organic =~      A_organic2         0.739 0.043 17.374  0.000
## 27       A_organic =~      A_organic3         0.703 0.047 14.909  0.000
## 28     A_packaging =~    A_packaging1         0.841 0.029 28.903  0.000
## 29     A_packaging =~    A_packaging2         0.799 0.033 24.011  0.000
## 30     A_packaging =~    A_packaging3         0.817 0.033 24.514  0.000
## 31   A_crueltyfree =~  A_crueltyfree1         0.885 0.023 38.450  0.000
## 32   A_crueltyfree =~  A_crueltyfree2         0.796 0.033 24.460  0.000
## 33   A_crueltyfree =~  A_crueltyfree3         0.880 0.025 35.030  0.000
## 34      A_organic1 ~~    A_packaging1     c   0.191 0.047  4.074  0.000
## 35      A_organic1 ~~  A_crueltyfree1     c   0.221 0.054  4.081  0.000
## 36    A_packaging1 ~~  A_crueltyfree1     c   0.228 0.055  4.116  0.000
## 37      A_organic2 ~~    A_packaging2     d   0.256 0.041  6.268  0.000
## 38      A_organic2 ~~  A_crueltyfree2     d   0.257 0.041  6.231  0.000
## 39    A_packaging2 ~~  A_crueltyfree2     d   0.289 0.046  6.337  0.000
## 40      A_organic3 ~~    A_packaging3         0.578 0.068  8.445  0.000
## 41      A_organic3 ~~  A_crueltyfree3         0.268 0.098  2.729  0.006
## 42    A_packaging3 ~~  A_crueltyfree3         0.124 0.111  1.115  0.265
## 43       A_organic ~~       A_organic         1.000 0.000     NA     NA
```

```
## 44     A_packaging ~~     A_packaging         1.000 0.000     NA     NA
## 45   A_crueltyfree ~~   A_crueltyfree         1.000 0.000     NA     NA
## 46       A_organic ~~     A_packaging         0.742 0.046 16.165  0.000
## 47       A_organic ~~   A_crueltyfree         0.634 0.058 10.861  0.000
## 48     A_packaging ~~   A_crueltyfree         0.708 0.049 14.592  0.000
## 49      BI_organic  ~       A_organic     p   0.693 0.043 15.973  0.000
## 50    BI_packaging  ~     A_packaging     p   0.695 0.042 16.595  0.000
## 51  BI_crueltyfree  ~   A_crueltyfree     p   0.708 0.039 17.959  0.000
## 52     BI_organic1 ~~     BI_organic1         0.227 0.037  6.193  0.000
## 53     BI_organic2 ~~     BI_organic2         0.224 0.037  6.117  0.000
## 54     BI_organic3 ~~     BI_organic3         0.291 0.045  6.412  0.000
## 55   BI_packaging1 ~~   BI_packaging1         0.225 0.035  6.355  0.000
## 56   BI_packaging2 ~~   BI_packaging2         0.213 0.035  6.134  0.000
## 57   BI_packaging3 ~~   BI_packaging3         0.297 0.045  6.581  0.000
## 58 BI_crueltyfree1 ~~ BI_crueltyfree1         0.162 0.028  5.732  0.000
## 59 BI_crueltyfree2 ~~ BI_crueltyfree2         0.201 0.031  6.462  0.000
## 60 BI_crueltyfree3 ~~ BI_crueltyfree3         0.143 0.029  4.940  0.000
## 61      A_organic1 ~~      A_organic1         0.300 0.056  5.364  0.000
## 62      A_organic2 ~~      A_organic2         0.454 0.063  7.214  0.000
## 63      A_organic3 ~~      A_organic3         0.506 0.066  7.645  0.000
## 64    A_packaging1 ~~    A_packaging1         0.292 0.049  5.966  0.000
## 65    A_packaging2 ~~    A_packaging2         0.361 0.053  6.783  0.000
## 66    A_packaging3 ~~    A_packaging3         0.333 0.054  6.108  0.000
## 67  A_crueltyfree1 ~~  A_crueltyfree1         0.217 0.041  5.339  0.000
## 68  A_crueltyfree2 ~~  A_crueltyfree2         0.367 0.052  7.087  0.000
## 69  A_crueltyfree3 ~~  A_crueltyfree3         0.226 0.044  5.119  0.000
##    ci.lower ci.upper
## 1     0.838    0.920
## 2     0.841    0.922
## 3     0.790    0.895
## 4     0.841    0.920
## 5     0.848    0.925
## 6     0.785    0.891
## 7     0.885    0.946
## 8     0.860    0.928
## 9     0.895    0.956
## 10    0.152    0.384
## 11    0.195    0.472
## 12    0.198    0.475
## 13    0.390    0.621
## 14    0.422    0.662
## 15    0.444    0.682
```

```
## 16    0.090    0.317
## 17    0.149    0.469
## 18    0.145    0.459
## 19    0.402    0.637
## 20    0.403    0.631
## 21    0.390    0.608
## 22    0.764    0.940
## 23    0.619    0.844
## 24    0.726    0.905
## 25    0.771    0.902
## 26    0.656    0.823
## 27    0.610    0.795
## 28    0.784    0.898
## 29    0.734    0.865
## 30    0.752    0.882
## 31    0.840    0.930
## 32    0.732    0.859
## 33    0.830    0.929
## 34    0.099    0.283
## 35    0.115    0.327
## 36    0.119    0.336
## 37    0.176    0.336
## 38    0.176    0.338
## 39    0.199    0.378
## 40    0.444    0.712
## 41    0.075    0.460
## 42   -0.094    0.341
## 43    1.000    1.000
## 44    1.000    1.000
## 45    1.000    1.000
## 46    0.652    0.831
## 47    0.520    0.749
## 48    0.613    0.803
## 49    0.608    0.778
## 50    0.613    0.777
## 51    0.631    0.785
## 52    0.155    0.299
## 53    0.152    0.295
## 54    0.202    0.379
## 55    0.155    0.294
## 56    0.145    0.282
## 57    0.209    0.386
```

```
## 58    0.107    0.218
## 59    0.140    0.262
## 60    0.086    0.200
## 61    0.191    0.410
## 62    0.330    0.577
## 63    0.376    0.636
## 64    0.196    0.388
## 65    0.257    0.465
## 66    0.226    0.439
## 67    0.138    0.297
## 68    0.265    0.468
## 69    0.140    0.313
```

Since an anova test for the two sem models has a p-value of 0.794, we cannot reject the null hypothesis that the models are the same, meaning this new, simpler SEM fits as well as the more elaborate model.

- an increase of one unit in attitude_organic increases the behavior intention with 0.693.
- an increase of one unit in attitude_packaging increases the behavior intention with 0.695.
- an increase of one unit in attitude_crueltyfree increases the behavior intention with 0.708.

2 Task 2

2.1 Canonical correlation analysis

```
library(candisc)
zbenefits <- benefits
zbenefits[,2:14] <- scale(zbenefits[,2:14],scale=TRUE,center=TRUE)

cancor.out <- cancor(
  cbind(SL_pensioners, SL_unemployed, SL_old_gvntresp, SL_unemp_gvntresp)
~SB_strain_economy+SB_prevent_poverty+SB_equal_society+
SB_taxes_business+ SB_make_lazy+SB_caring_others+ unemployed_notmotivated+
SB_often_lessthanentitled+ SB_often_notentitled,
data=zbenefits)

#print summary results
summary(cancor.out)
```

```
##
## Canonical correlation analysis of:
##   9   X  variables:  SB_strain_economy, SB_prevent_poverty, SB_equal_society, SB_t
##   with    4   Y  variables:  SL_pensioners, SL_unemployed, SL_old_gvntresp, SL_une
```

```
##
##      CanR   CanRSQ   Eigen percent    cum                              scree
## 1 0.48323 0.233515 0.30466 79.8465  79.85 ******************************
## 2 0.22817 0.052061 0.05492 14.3939  94.24 *****
## 3 0.13741 0.018883 0.01925  5.0442  99.28 **
## 4 0.05218 0.002723 0.00273  0.7155 100.00
##
## Test of H0: The canonical correlations in the
## current row and all that follow are zero
##
##      CanR LR test stat approx F numDF   denDF   Pr(> F)
## 1 0.48323      0.71092   32.719    36 12357.1 < 2.2e-16 ***
## 2 0.22817      0.92751   10.477    24  9565.8 < 2.2e-16 ***
## 3 0.13741      0.97845    5.163    14  6598.0 8.545e-10 ***
## 4 0.05218      0.99728    1.501     6  3300.0    0.1735
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Raw canonical coefficients
##
##    X  variables:
##                                 Xcan1      Xcan2     Xcan3     Xcan4
## SB_strain_economy         -0.0909717  0.4172121  0.564470 -0.059128
## SB_prevent_poverty         0.0779679 -0.0254661 -0.329579 -0.125299
## SB_equal_society           0.1279718  0.3828047 -0.585296 -0.097459
## SB_taxes_business         -0.0850983  0.0972611 -0.067364 -0.947887
## SB_make_lazy              -0.3819813  0.0411048 -0.206351  0.231770
## SB_caring_others           0.0069064  0.0060264  0.128499 -0.149934
## unemployed_notmotivated   -0.4933957 -0.1393655 -0.333507  0.134556
## SB_often_lessthanentitled  0.2525276 -0.6831611  0.127790 -0.360191
## SB_often_notentitled      -0.1393188 -0.4867982 -0.255268  0.146316
##
##    Y  variables:
##                        Ycan1     Ycan2    Ycan3    Ycan4
## SL_pensioners       0.220475  0.651836 -0.28265  0.78198
## SL_unemployed      -0.526682  0.156985 -0.64871 -0.63976
## SL_old_gvntresp    -0.098433 -0.599184 -0.55693  0.72377
## SL_unemp_gvntresp   0.764899  0.057483 -0.33698 -0.71784
```

```
#compute redundancies
R2tu<-cancor.out$cancor^2
R2tu<-cancor.out$cancor^2
```

```
VAFYbyt<-apply(cancor.out$structure$Y.yscores^2,2,sum)/3
redund<-R2tu*VAFYbyt
round(cbind(R2tu,VAFYbyt,redund,total=cumsum(redund)),4)
```

```
##         R2tu VAFYbyt redund  total
## Ycan1 0.2335  0.3799 0.0887 0.0887
## Ycan2 0.0521  0.4266 0.0222 0.1109
## Ycan3 0.0189  0.3635 0.0069 0.1178
## Ycan4 0.0027  0.1633 0.0004 0.1182
```

```
#print canonical loadings
round(cancor.out$structure$X.xscores,2)
```

```
##                            Xcan1 Xcan2 Xcan3 Xcan4
## SB_strain_economy          -0.54  0.27  0.44 -0.27
## SB_prevent_poverty          0.22  0.10 -0.53 -0.18
## SB_equal_society            0.33  0.33 -0.73 -0.15
## SB_taxes_business          -0.45  0.12  0.01 -0.85
## SB_make_lazy               -0.80 -0.02 -0.02 -0.05
## SB_caring_others           -0.56 -0.06  0.07 -0.21
## unemployed_notmotivated    -0.80 -0.19 -0.26 -0.02
## SB_often_lessthanentitled   0.30 -0.73  0.06 -0.36
## SB_often_notentitled       -0.56 -0.47 -0.19  0.00
```

```
round(cancor.out$structure$Y.yscores,2)
```

```
##                    Ycan1 Ycan2 Ycan3 Ycan4
## SL_pensioners       0.18  0.81 -0.36  0.42
## SL_unemployed      -0.61  0.31 -0.65 -0.32
## SL_old_gvntresp     0.11 -0.71 -0.60  0.34
## SL_unemp_gvntresp   0.85 -0.11 -0.42 -0.30
```

2.2 Split-half approach

```
train <- benefits[seq(2,3310,by=2),]
valid <- benefits[seq(1,3310,by=2),]
train[,2:14]<-scale(train[,2:14],center=TRUE,scale=TRUE)
valid[,2:14]<-scale(valid[,2:14],center=TRUE,scale=TRUE)

#conduct CCA on training data

cancor.train<-cancor(cbind(SL_pensioners, SL_unemployed, SL_old_gvntresp, SL_unemp_gv
~SB_strain_economy+SB_prevent_poverty+SB_equal_society+
SB_taxes_business+ SB_make_lazy+SB_caring_others+ unemployed_notmotivated+
```

```
SB_often_lessthanentitled+ SB_often_notentitled , data=train)

#conduct CCA on validation data

cancor.valid<-cancor(cbind(SL_pensioners, SL_unemployed, SL_old_gvntresp, SL_unemp_gvt
~SB_strain_economy+SB_prevent_poverty+SB_equal_society+
SB_taxes_business+ SB_make_lazy+SB_caring_others+ unemployed_notmotivated+
SB_often_lessthanentitled+ SB_often_notentitled , data=valid)

# canonical variates calibration set
train.X1<-cancor.train$score$X
train.Y1<-cancor.train$score$Y

# compute canonical variates using data of calibration set and coefficients estimate
train.X2<-as.matrix(train[,6:14])%*%cancor.valid$coef$X
train.Y2<-as.matrix(train[,2:5])%*%cancor.valid$coef$Y

round(cor(train.Y1,train.Y2),3)
```

```
##         Ycan1  Ycan2  Ycan3  Ycan4
## Ycan1 -0.985  0.121 -0.148  0.044
## Ycan2 -0.057 -0.989 -0.116 -0.036
## Ycan3  0.146  0.083 -0.973 -0.145
## Ycan4  0.069  0.006 -0.130  0.988
```

```
round(cor(train.X1,train.X2),3)
```

```
##         Xcan1  Xcan2  Xcan3  Xcan4
## Xcan1 -0.985 -0.013 -0.058 -0.100
## Xcan2  0.040 -0.893 -0.219  0.283
## Xcan3  0.031  0.027 -0.557 -0.206
## Xcan4 -0.091  0.100  0.072  0.257
```

```
round(cor(train.X1,train.Y1),3)
```

```
##        Ycan1 Ycan2 Ycan3 Ycan4
## Xcan1 0.482 0.000 0.000 0.000
## Xcan2 0.000 0.244 0.000 0.000
## Xcan3 0.000 0.000 0.145 0.000
## Xcan4 0.000 0.000 0.000 0.046
```

```
round(cor(train.X2,train.Y2),3)
```

```
##        Ycan1  Ycan2 Ycan3  Ycan4
## Xcan1 0.468 -0.067 0.065 -0.026
```

```
## Xcan2 0.019  0.215 0.022  0.011
## Xcan3 0.019  0.043 0.089  0.016
## Xcan4 0.040 -0.076 0.027  0.011
```

```
round(cor(train.Y2,train.Y2),3)
```

```
##        Ycan1  Ycan2 Ycan3 Ycan4
## Ycan1  1.000 -0.050 0.001 0.006
## Ycan2 -0.050  1.000 0.014 0.034
## Ycan3  0.001  0.014 1.000 0.010
## Ycan4  0.006  0.034 0.010 1.000
```

```
round(cor(train.X2,train.X2),3)
```

```
##        Xcan1  Xcan2  Xcan3 Xcan4
## Xcan1  1.000 -0.037 -0.047 0.020
## Xcan2 -0.037  1.000  0.024 0.017
## Xcan3 -0.047  0.024  1.000 0.035
## Xcan4  0.020  0.017  0.035 1.000
```

3 Appendix

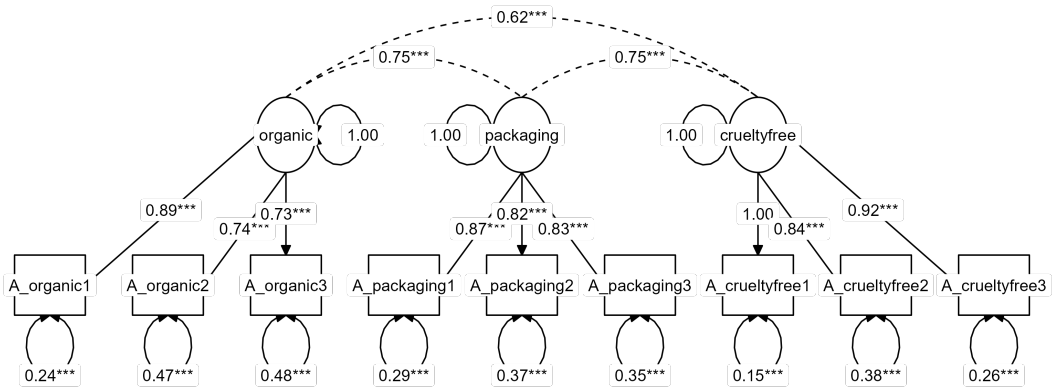

Figure 1: A graphical representation of the simple model for the attitudes.

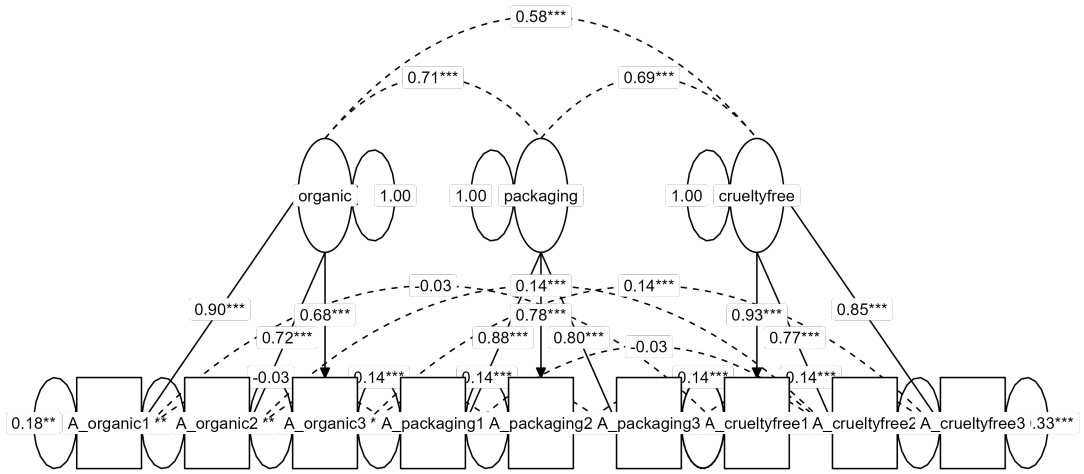

Figure 2: A graphical representation of the model for the attitudeswith correlated error terms for all pairs of items that focus on the same aspect.

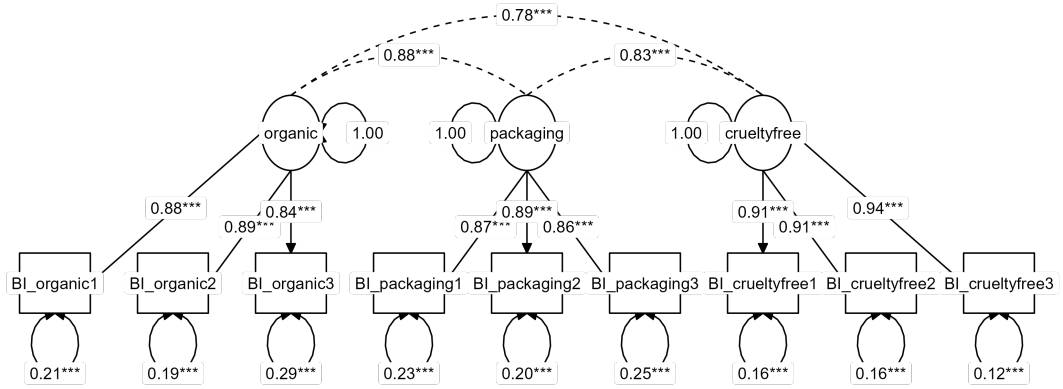

Figure 3: A graphical representation of the simple model for the behavior-intent items.

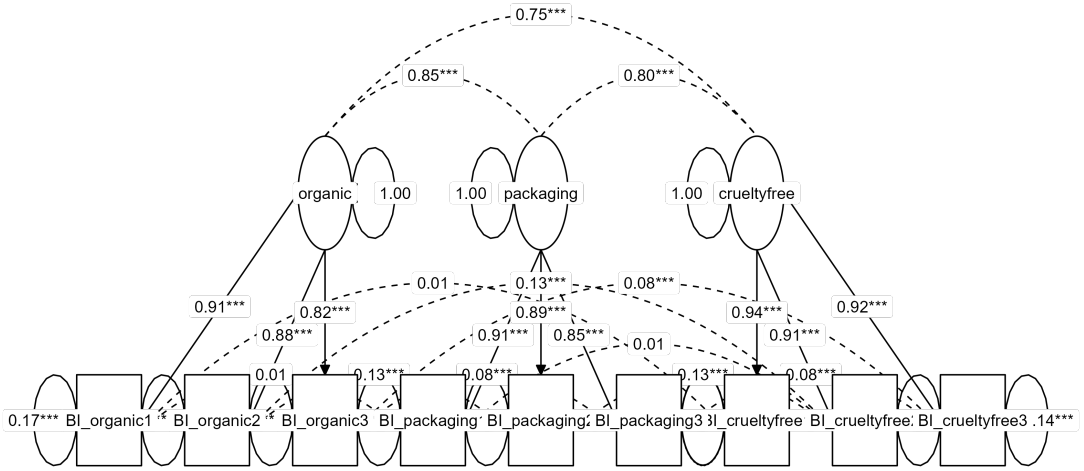

Figure 4: A graphical representation of the model with correlated error terms for the behavior-intent items that focus on the same aspect.