

# Developing a scale to measure factors influencing skier's self-perceived group dynamics (FISSGD)

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# 1 Data Wrangling

For the interest of space, codes in this section will not be shown. Yet they are available in the .rmd file.

## 1.1 Read in the data

## 1.2 Combine 2022 and 2023 data

## 1.3 Reomove cases

### 1.3.1 Remove careless responses (according to attention trap)

Q10\_2 and Q10\_5, as well as Q19\_1 and Q19\_4 were same questions with different wordings. If the responses had conflictory results between them, they were regarded as careless responses.

### 1.3.2 Remove cases who did not consent

### 1.3.3 Remove cases with NA for if having a leader

## 1.4 Replace value of -99 with NA

## 1.5 Unify value labels

Values of some of the variables had been inconsistently labeled. They were unified here.

## 1.6 Relabel variables

Properly label the variables so that the interpretation can be better managed.

## 1.7 Replace “Don’t know” with NAs

## 1.8 Create data sets

Four data sets were created. They are a. 18 item with leader; b. 6 item with leader; c. 17 item without leader; d. 5 item without leader; 3. background. The case identifier is “index” variable across data sets.

### 1.8.1 Create with-leader and without-leader data-sets

### 1.8.2 Remove cases with 50% NAs across major questions for each data sets

### 1.8.3 Create data set: 17 item without leader

### 1.8.4 Create data set: 5 item without leader

### 1.8.5 Create data set: 20 item with leader

### 1.8.6 Create data set: 6 item with leader

# 2 Descriptive statistics

Table 1: Descriptive statistics for with-leader group (long)

	n	Question	n of NA	Central tendency		Dispersion tendency			
				Mean	Median	SD	Min	Max	Q1~Q3
i_leader1	100	The leader (formal or informal) was the best suited person in the group to make the decisions.	1	4.1	4.0	1.0	1.0	6.0	4.0 ~ 5.0
i_leader2	100	The leader (formal or informal) communicated openly and clearly	1	4.3	4.0	0.8	1.0	6.0	4.0 ~ 5.0
i_leader3	100	Everyone could voice their concerns to the leader (formal or informal)	1	4.6	5.0	0.7	1.0	6.0	4.0 ~ 5.0
i_skill1	101	The least knowledgeable group member could conduct satisfactory avalanche assessments for this trip	0	3.2	4.0	1.3	1.0	6.0	2.0 ~ 4.0
i_skill2	101	There was no large gap in avalanche assessment skills between the group members	0	2.5	2.0	1.3	1.0	6.0	1.0 ~ 4.0
i_skill3	101	There was no important difference in skiing skill level between group members, given the terrain	0	2.9	3.0	1.4	1.0	6.0	2.0 ~ 4.0
i_skill4	101	All group members were equipped with standard avalanche safety equipment (beacon, shovel, probe) and trained in the use of it	0	4.3	5.0	1.1	1.0	6.0	4.0 ~ 5.0
i_orga1	101	The group members knew each other well	0	3.8	4.0	1.2	1.0	5.0	3.0 ~ 5.0
i_orga2	100	The group size was appropriate for the trip (time, difficulty)	1	4.5	5.0	0.8	1.0	6.0	4.0 ~ 5.0
i_orga3	101	The roles of the group members were clearly defined	0	3.2	3.0	1.2	1.0	6.0	2.0 ~ 4.0
i_orga4	101	Some or all group members met each other for the first time on this trip	0	2.1	1.0	1.6	1.0	5.0	1.0 ~ 2.0
i_comm1	101	Decisions concerning avalanche hazard were well discussed in the group	0	4.1	4.0	0.9	2.0	6.0	4.0 ~ 5.0
i_comm2	101	Everyone in the group understood the decisions that were made	0	4.1	4.0	1.0	1.0	6.0	4.0 ~ 5.0
i_comm3	101	Everyone voiced their concerns whenever they felt necessary	0	4.0	4.0	1.1	1.0	6.0	3.0 ~ 5.0
i_iden1	101	There were clear expectations of each group member	0	3.4	3.0	1.0	1.0	6.0	3.0 ~ 4.0
i_iden2	101	Everyone was happy with the decisions that were made	0	4.3	4.0	1.0	2.0	6.0	4.0 ~ 5.0
i_anom1	100	The group decisions at the decision points were unanimous	1	4.0	4.0	1.1	1.0	6.0	4.0 ~ 5.0
i_anom2	101	Someone tried to impress others.	0	2.0	2.0	1.0	1.0	6.0	1.0 ~ 2.0
i_anom3	101	Love stories were going on in the group	0	2.3	1.0	1.6	1.0	6.0	1.0 ~ 4.0
i_anom4	101	The presence of other groups impacted my group's decision making	0	2.0	1.0	1.3	1.0	6.0	1.0 ~ 3.0

Table 2: Descriptive statistics for without-leader group (long)

	n	Question	n of NA	Central tendency		Dispersion tendency			
				Mean	Median	SD	Min	Max	Q1~Q3
i_skill1	116	The least knowledgeable group member could conduct satisfactory avalanche assessments for this trip	0	3.6	4.0	1.2	1.0	5.0	2.0 ~ 5.0
i_skill2	116	There was no large gap in avalanche assessment skills between the group members	0	3.2	3.0	1.3	1.0	5.0	2.0 ~ 4.0
i_skill3	116	There was no important difference in skiing skill level between group members, given the terrain	0	3.6	4.0	1.3	1.0	5.0	2.0 ~ 5.0
i_skill4	116	All group members were equipped with standard avalanche safety equipment (beacon, shovel, probe) and trained in the use of it	0	4.5	5.0	1.0	1.0	6.0	4.0 ~ 5.0
i_orga1	115	The group members knew each other well	1	4.2	5.0	1.1	1.0	5.0	4.0 ~ 5.0
i_orga2	115	The group size was appropriate for the trip (time, difficulty)	1	4.6	5.0	0.8	1.0	6.0	4.0 ~ 5.0
i_orga3	115	The roles of the group members were clearly defined	1	3.2	3.0	1.4	1.0	6.0	2.0 ~ 5.0
i_orga4	115	Some or all group members met each other for the first time on this trip	1	1.7	1.0	1.3	1.0	6.0	1.0 ~ 2.0
i_comm1	116	Decisions concerning avalanche hazard were well discussed in the group	0	4.0	4.0	1.0	1.0	5.0	4.0 ~ 5.0
i_comm2	116	Everyone in the group understood the decisions that were made	0	4.4	5.0	0.9	1.0	6.0	4.0 ~ 5.0
i_comm3	116	Everyone voiced their concerns whenever they felt necessary	0	4.3	4.0	1.0	1.0	6.0	4.0 ~ 5.0
i_iden1	116	There were clear expectations of each group member	0	3.6	4.0	1.0	1.0	5.0	3.0 ~ 4.0
i_iden2	116	Everyone was happy with the decisions that were made	0	4.4	5.0	0.8	1.0	6.0	4.0 ~ 5.0
i_anom1	116	The group decisions at the decision points were unanimous	0	4.2	4.0	1.1	2.0	6.0	4.0 ~ 5.0
i_anom2	116	Someone tried to impress others.	0	1.9	2.0	1.2	1.0	6.0	1.0 ~ 2.0
i_anom3	116	Love stories were going on in the group	0	1.8	1.0	1.3	1.0	6.0	1.0 ~ 2.0
i_anom4	116	The presence of other groups impacted my group's decision making	0	2.2	2.0	1.5	1.0	6.0	1.0 ~ 4.0

Table 3: Descriptive statistics for with-leader group (short)

	n	Question	n of NA	Central tendency		Dispersion tendency			
				Mean	Median	SD	Min	Max	Q1~Q3
i_leader0	100	The decisions were followed by all group members.	1	4.7	5.0	0.8	1.0	6.0	4.0 ~ 5.0
i_skill0	101	The level of avalanche assessment and rescue skills differed greatly across the group.	0	3.4	4.0	1.4	1.0	6.0	2.0 ~ 4.0
i_orga0	101	The group was well	0	3.9	4.0	0.9	1.0	5.0	3.0 ~ 4.0
i_comm0	101	The communication in the group was good	0	4.4	4.0	0.7	2.0	6.0	4.0 ~ 5.0
i_iden0	100	The group was cohesive and had a shared vision	1	4.2	4.0	0.8	2.0	6.0	4.0 ~ 5.0
i_anom0	101	Social interactions in the group negatively impacted decision	0	1.8	1.0	1.2	1.0	6.0	1.0 ~ 2.0

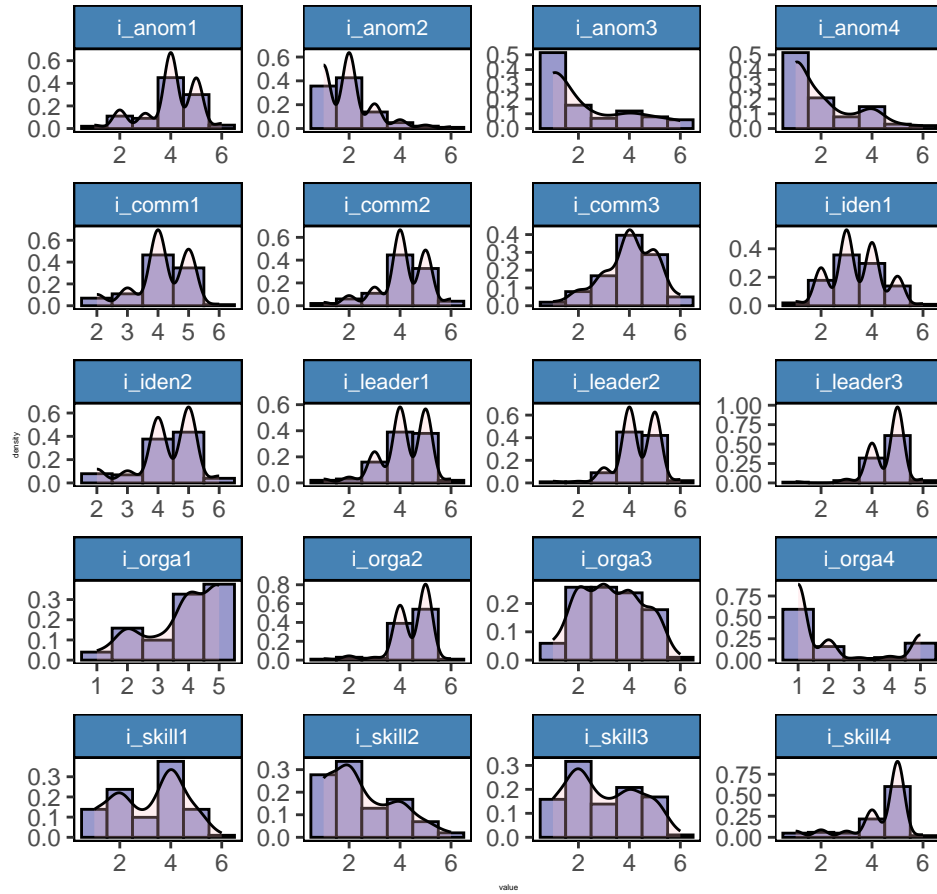
Table 4: Descriptive statistics for without-leader group (short)

	n	Question	n of NA	Central tendency		Dispersion tendency			
				Mean	Median	SD	Min	Max	Q1~Q3
i_skill0	116	The level of avalanche assessment and rescue skills differed greatly across the group.	0	2.7	2.0	1.4	1.0	6.0	2.0 ~ 4.0
i_orga0	116	The group was well	0	4.1	4.0	0.9	2.0	5.0	4.0 ~ 5.0
i_comm0	116	The communication in the group was good	0	4.3	5.0	0.9	1.0	5.0	4.0 ~ 5.0
i_iden0	116	The group was cohesive and had a shared vision	0	4.2	4.0	0.8	1.0	5.0	4.0 ~ 5.0
i_anom0	115	Social interactions in the group negatively impacted decision	1	1.9	2.0	1.1	1.0	6.0	1.0 ~ 2.0

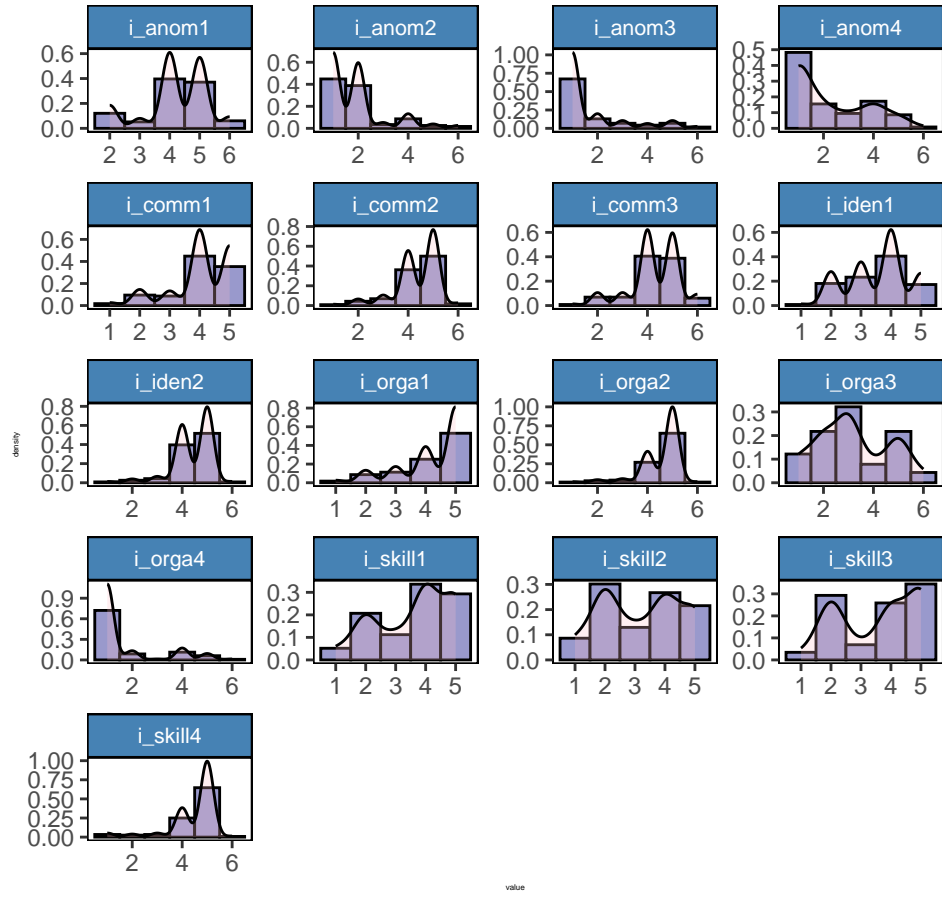
### 3 Visualization

#### 3.1 Distribution

**Figure 1** Distributions of the item for with-leader group (long

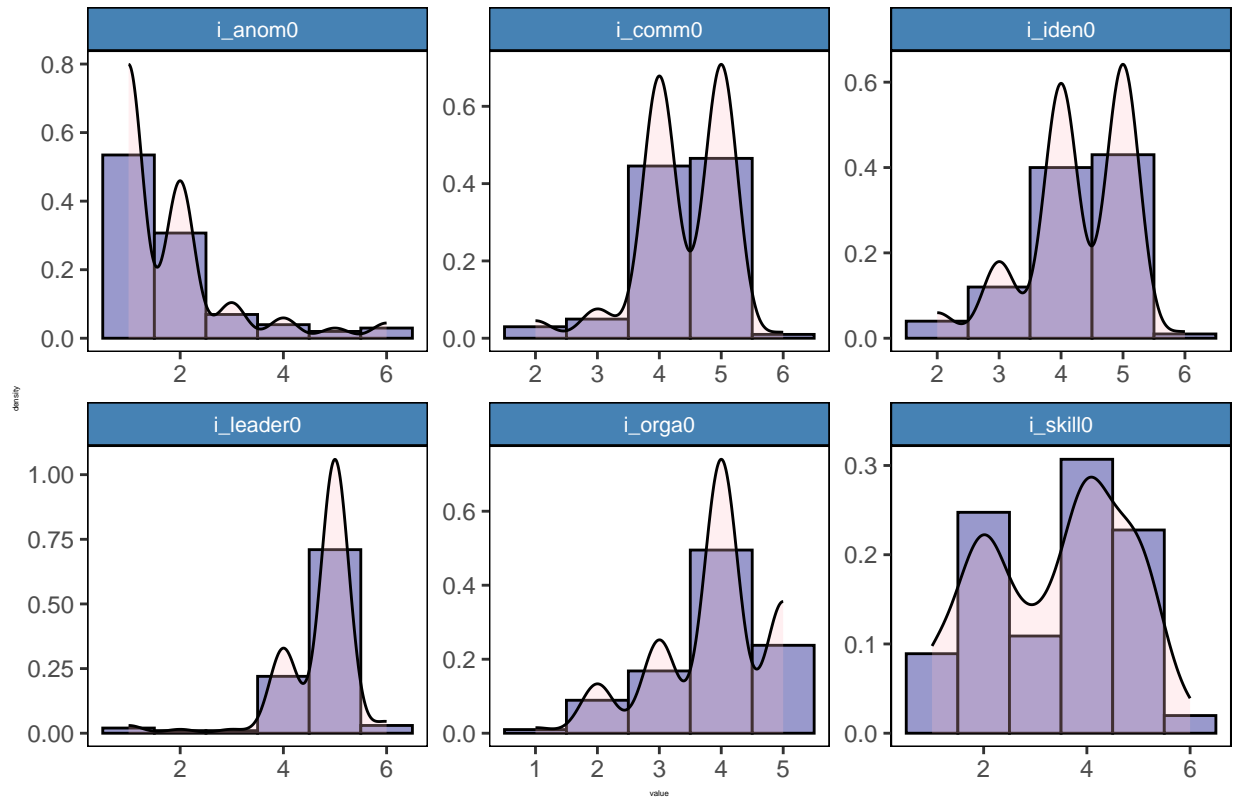


**Figure 2** Distribtuions of the item for without-leader group (lo

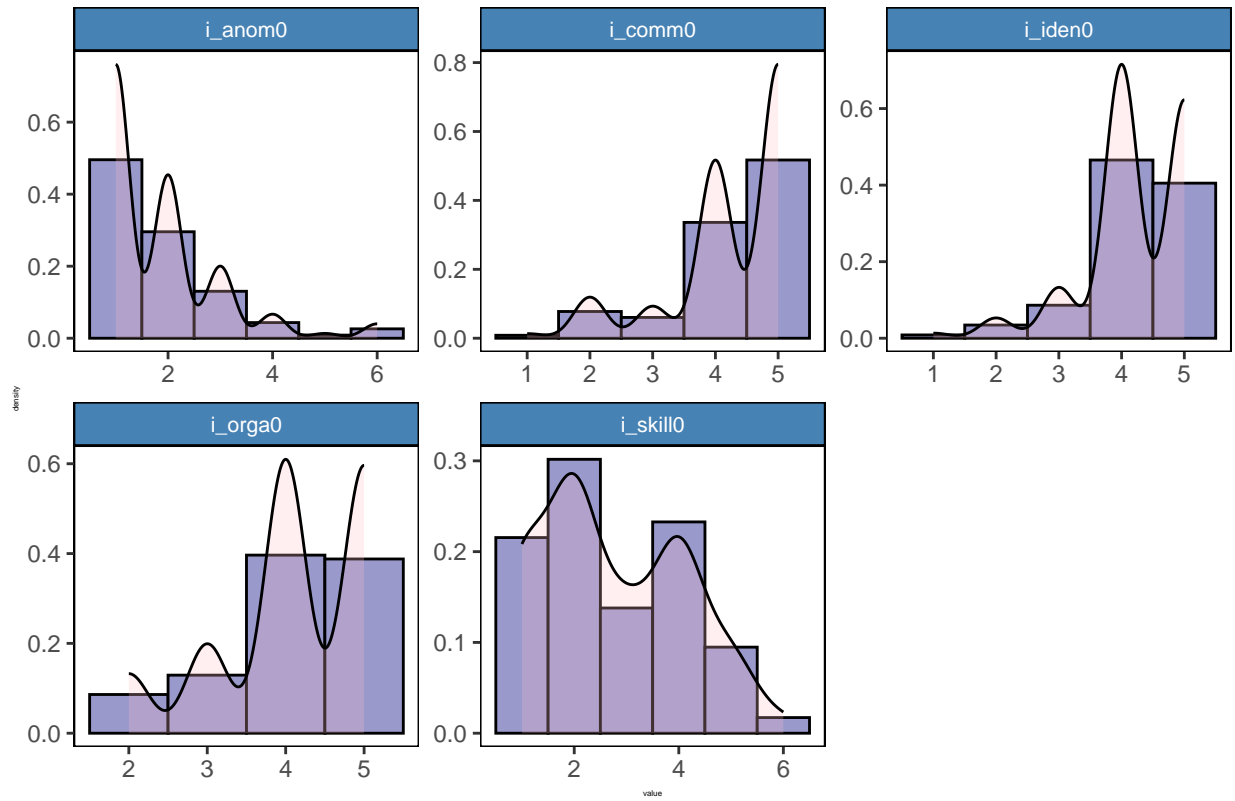




**Figure 3 Distributions of the item for with-leader group (short)**

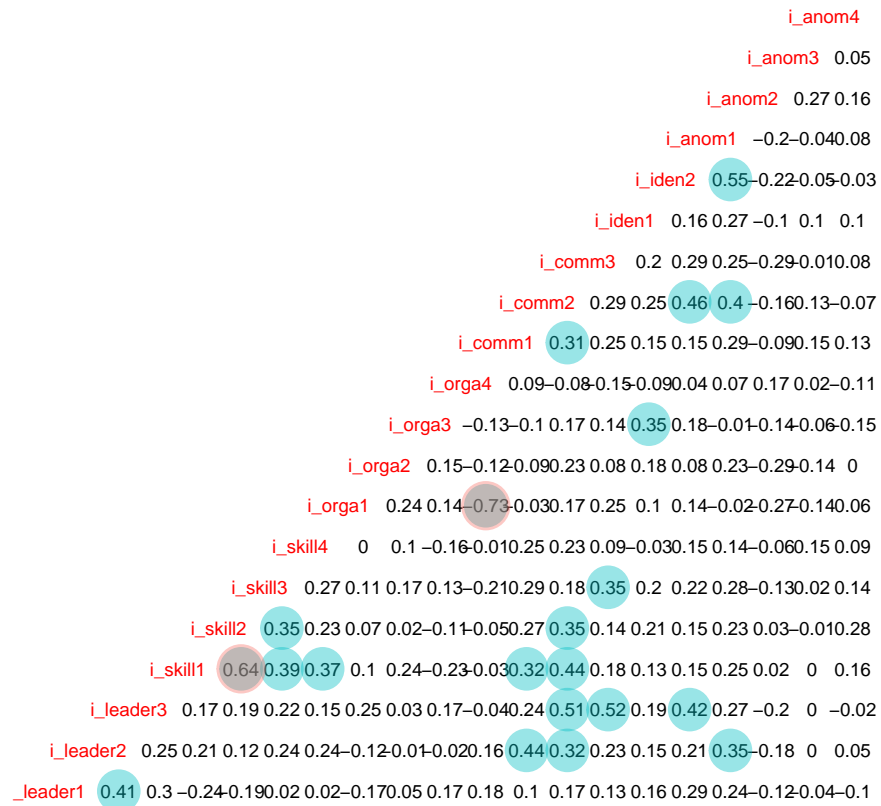


**Figure 4 Distributions of the item for without-leader group (short)**



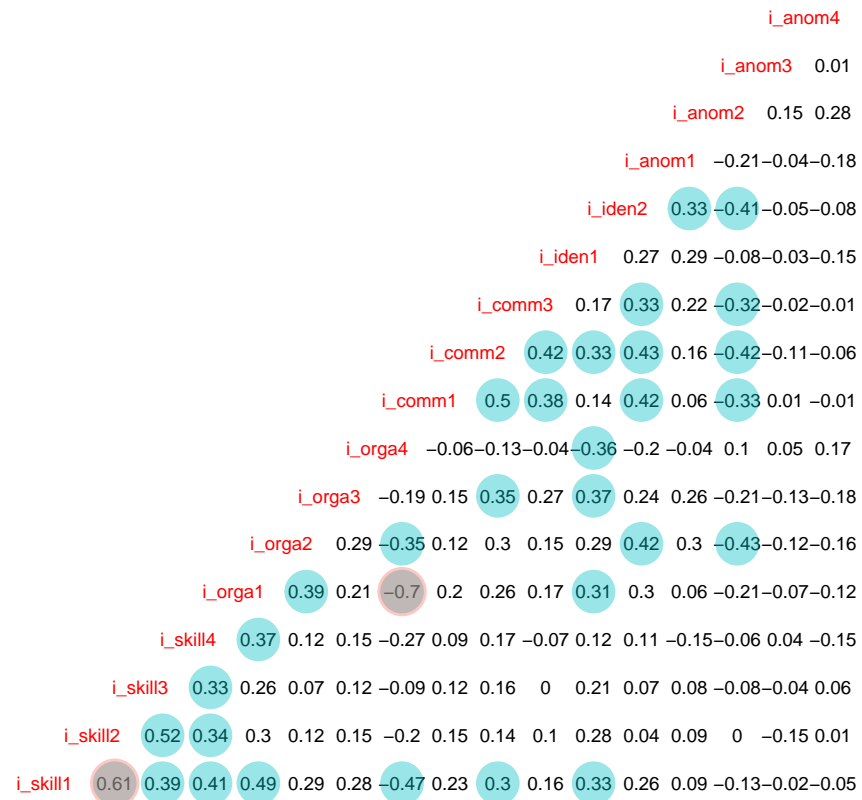
### 3.2 Correlation matrix

**Figure 51 Correlation matrix of the item for with-leader group (long)**



Red circles indicates the absolute of correlation coefficient  $\geq 0.6$   
green circle indicates  $\geq 0.3$

**Figure 6 Correlation matrix of the item for without-leader group (long)**



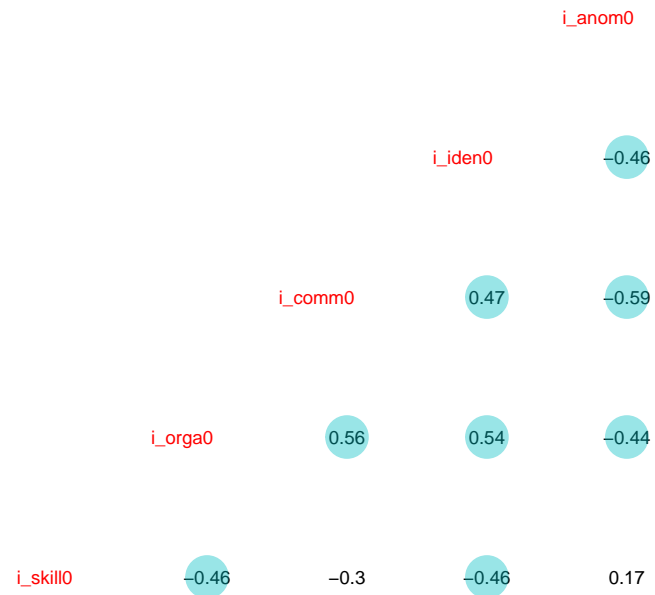
Red circles indicates the absolute of correlation coefficient  $\geq 0.6$   
green circle indicates  $\geq 0.3$

Figure 7 Correlation matrix of the item for with–leader group (short)



Red circles indicates the absolute of correlation coefficient >= 0.6  
green circle indicates >= 0.3

**Figure 8 Correlation matrix of the item for without-leader group (short)**



Red circles indicates the absolute of correlation coefficient  $\geq 0.6$   
green circle indicates  $\geq 0.3$

## 4 Impute NAs

Impute NAs with medians.

Table 5: Results of KMO test of sampling adequacy for with-leader group (long)

	KMO.ldr20
i_leader1	0.615
i_leader2	0.726
i_leader3	0.731
i_skill1	0.654
i_skill2	0.735
i_skill3	0.681
i_skill4	0.788
i_orga1	0.522
i_orga2	0.427
i_orga3	0.506
i_orga4	0.468
i_comm1	0.801
i_comm2	0.711
i_comm3	0.818
i_iden1	0.680
i_iden2	0.668
i_anom1	0.729
i_anom2	0.671
i_anom3	0.398
i_anom4	0.557
Overall	0.656

Table 6: Results of bartlett test for with-leader group (long)

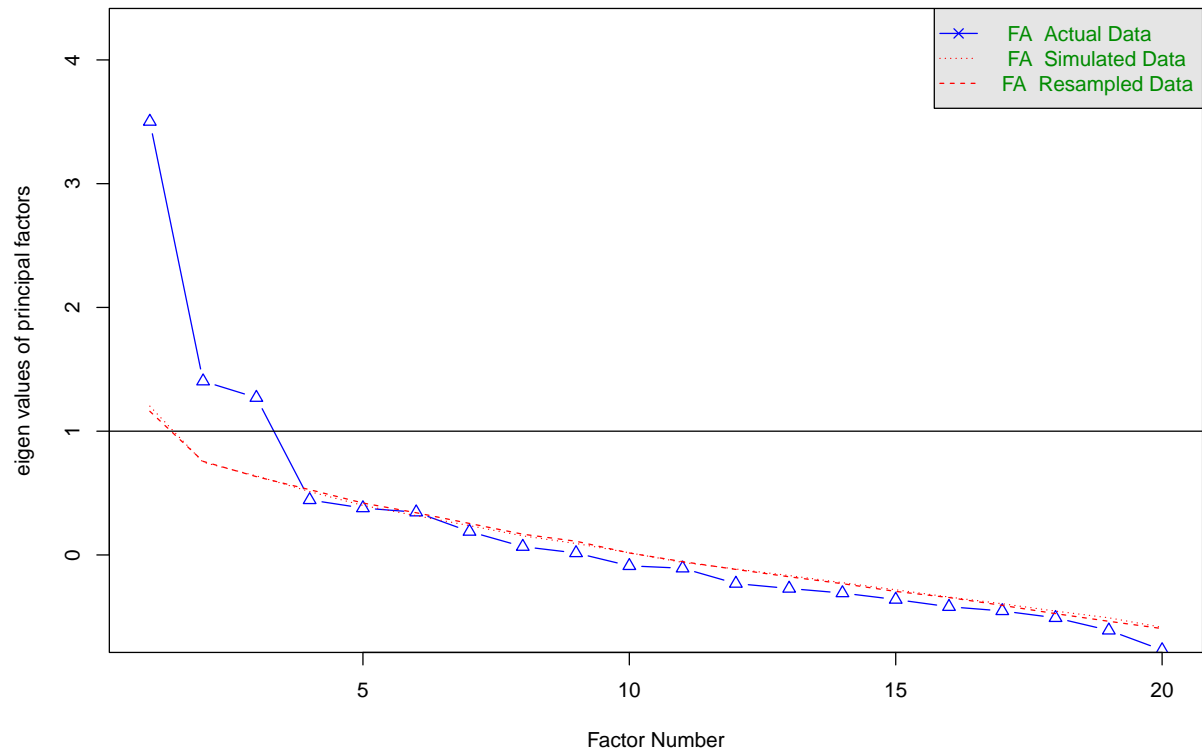
Chi-square	p-value	DF
611.49	<0.001	190

## 5 Factor analysis for with-leader group (long)

### 5.1 Check factorability

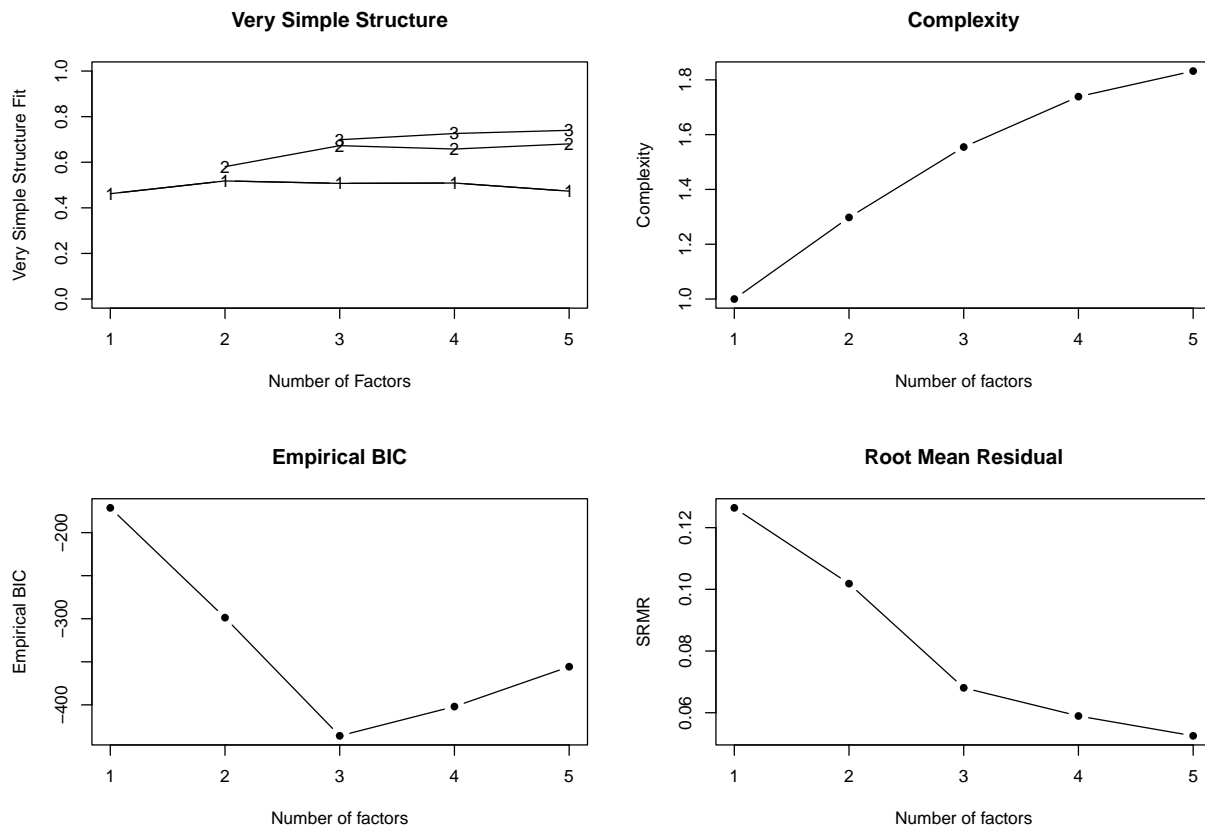
### 5.2 Explore number of factors

Figure 9. Scree plot for with-leader group (long)



## Parallel analysis suggests that the number of factors = 3 and the number of components = NA





```
##
## Number of factors
## Call: vss(x = x, n = n, rotate = rotate, diagonal = diagonal, fm = fm,
##       n.obs = n.obs, plot = FALSE, title = title, use = use, cor = cor)
## VSS complexity 1 achieves a maximum of 0.52 with 2 factors
## VSS complexity 2 achieves a maximum of 0.68 with 5 factors
## The Velicer MAP achieves a minimum of 0.02 with 3 factors
## Empirical BIC achieves a minimum of -435.96 with 3 factors
## Sample Size adjusted BIC achieves a minimum of -21.06 with 5 factors
##
## Statistics by number of factors
##   vss1 vss2  map dof chisq   prob sqresid  fit RMSEA  BIC SABIC complex
## 1  0.46 0.00 0.027 170   391 2.0e-19   20.1 0.46 0.113 -394   143    1.0
## 2  0.52 0.58 0.029 151   284 3.5e-10   15.7 0.58 0.093 -413    64    1.3
## 3  0.51 0.67 0.024 133   179 5.0e-03   11.2 0.70 0.058 -435   -15    1.6
## 4  0.51 0.66 0.029 116   151 1.6e-02    9.7 0.74 0.054 -385   -18    1.7
## 5  0.47 0.68 0.031 100   125 4.8e-02    8.6 0.77 0.048 -337   -21    1.8
##   eChisq SRMR eCRMS eBIC
## 1    613 0.126 0.134 -171
## 2    398 0.102 0.114 -299
## 3    178 0.068 0.081 -436
## 4    133 0.059 0.075 -402
## 5    106 0.053 0.072 -356
```

## 5.3 Explore factor solutions

### 5.3.1 Explore 5-factor solution

Figure 10. Five-factor solution, with-leader group (long)

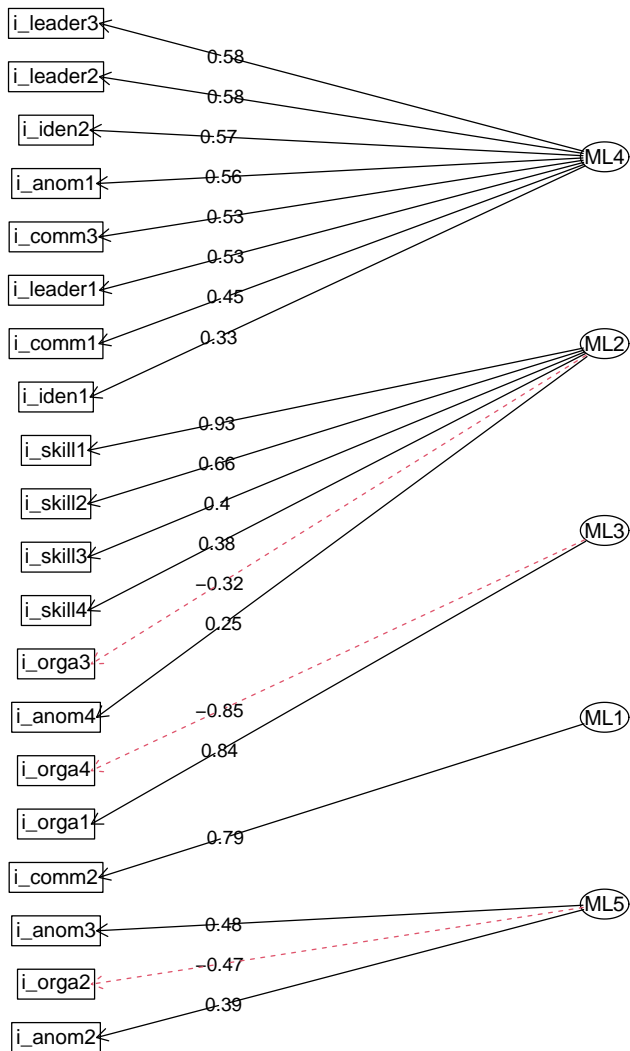


Table 7: Factor loadings of the 5-factor solution for with-leader group (long)

Item	ML4	ML2	ML3	ML1	ML5
i_leader1	0.526	-0.315			
i_leader2	0.576				
i_leader3	0.583				
i_skill1		0.93			
i_skill2		0.657			
i_skill3	0.392	0.4			
i_skill4		0.378			
i_orga1			0.843		
i_orga2					-0.471
i_orga3		-0.317			
i_orga4			-0.85		
i_comm1	0.455	0.354			
i_comm2	0.52			0.789	
i_comm3	0.527				
i_iden1	0.332				
i_iden2	0.565				
i_anom1	0.562				
i_anom2	-0.348				0.391
i_anom3					0.476
i_anom4					

### 5.3.2 Explore 4-factor solution

Figure 11. Four-factor solution, with-leader group (long)

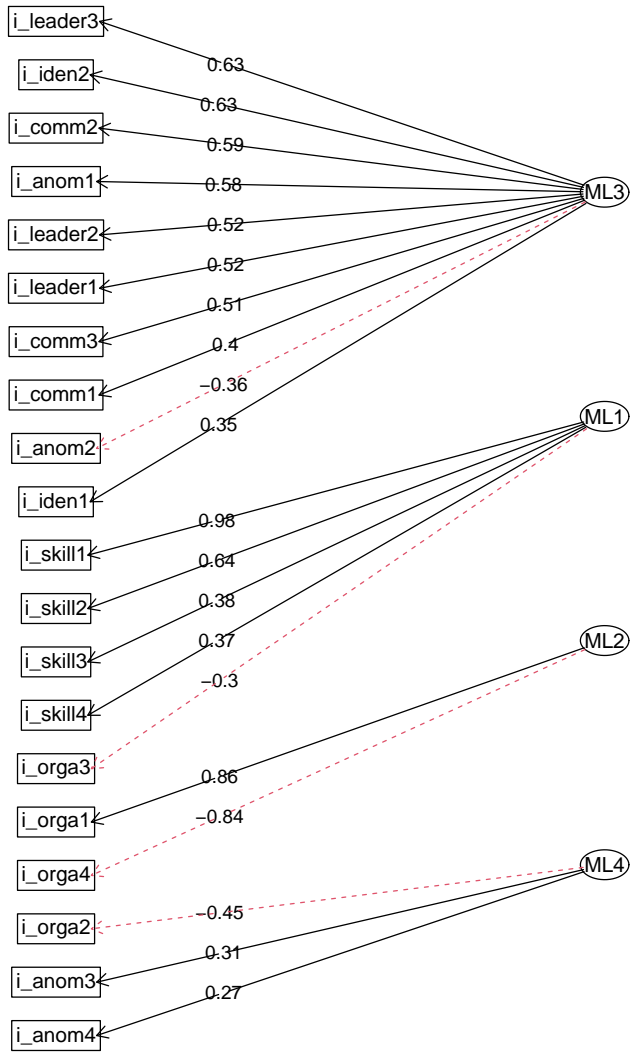


Table 8: Factor loadings of the 4-factor solution for with-leader group (long)

Item	ML3	ML1	ML2	ML4
i_leader1	0.521			
i_leader2	0.522			
i_leader3	0.632			
i_skill1		0.979		
i_skill2		0.643		
i_skill3	0.33	0.378		
i_skill4		0.372		
i_orga1			0.856	
i_orga2				-0.452
i_orga3				
i_orga4			-0.838	
i_comm1	0.401	0.347		0.374
i_comm2	0.594	0.357		
i_comm3	0.507			
i_iden1	0.347			
i_iden2	0.631			
i_anom1	0.577			
i_anom2	-0.362			
i_anom3				0.31
i_anom4				

### 5.3.3 Explore 3-factor solution

Figure 12. Three-factor solution, with-leader group (long)

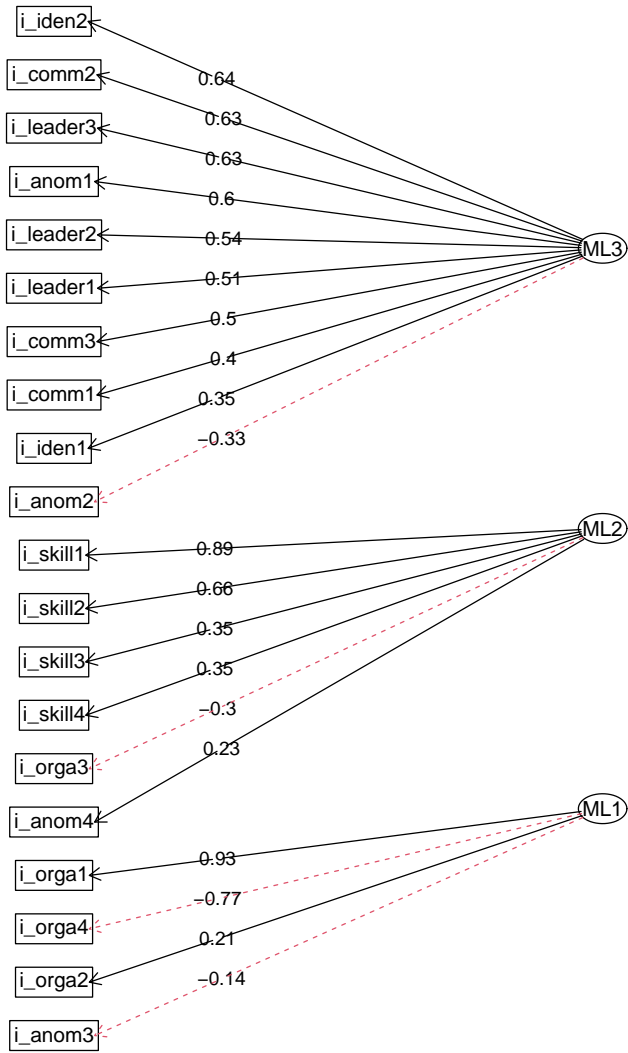


Table 9: Factor loadings of the 3-factor solution for with-leader group (long)

Item	ML3	ML2	ML1
i_leader1	0.513	-0.399	
i_leader2	0.537		
i_leader3	0.633		
i_skill1		0.895	
i_skill2		0.662	
i_skill3	0.351	0.351	
i_skill4		0.35	
i_orga1			0.933
i_orga2			
i_orga3		-0.301	
i_orga4			-0.771
i_comm1	0.401		
i_comm2	0.633	0.309	
i_comm3	0.496		
i_iden1	0.351		
i_iden2	0.637		
i_anom1	0.598		
i_anom2	-0.335		
i_anom3			
i_anom4			

### 5.3.4 Finetune 3-factor solution

Figure 13. Fine-tuned three-factor solution, with-leader group (long)

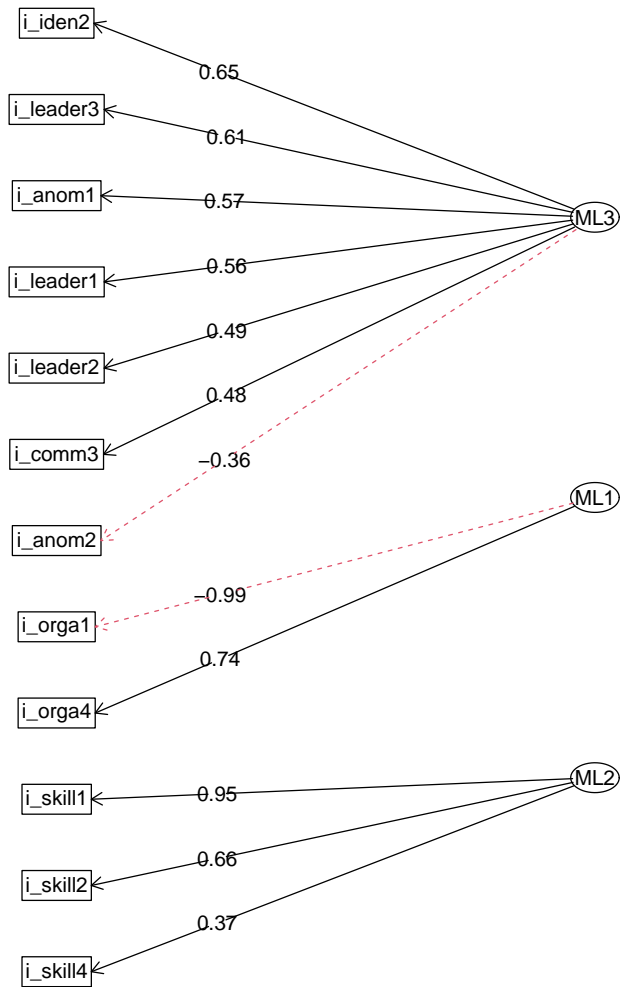




Table 10: Factor loadings of the 3-factor solution for with-leader group (long)

Item	ML3	ML1	ML2
i_leader1	0.561		
i_leader2	0.494		
i_leader3	0.606		
i_skill1			0.952
i_skill2			0.664
i_skill4			0.371
i_orga1		-0.986	
i_orga4		0.744	
i_comm3	0.484		
i_iden2	0.646		
i_anom1	0.571		
i_anom2	-0.364		

### 5.3.5 Explore 2-factor solution

Figure 14. Two-factor solution, with-leader group (long)

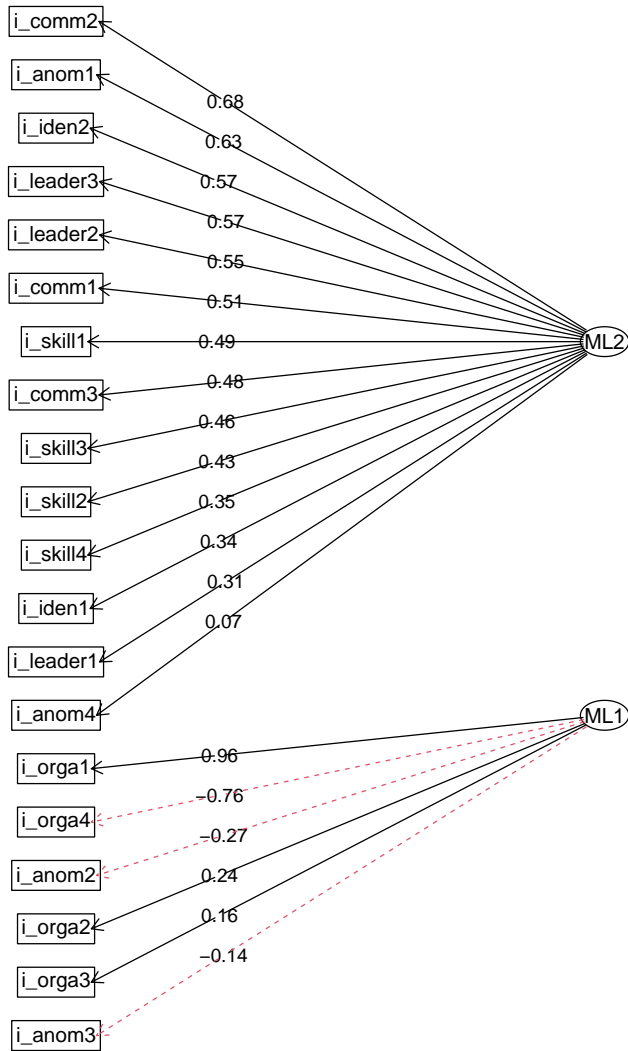


Table 11: Factor loadings of the 2-factor solution for with-leader group (long)

Item	ML2	ML1
i_leader1	0.31	
i_leader2	0.546	
i_leader3	0.568	
i_skill1	0.489	
i_skill2	0.43	
i_skill3	0.456	
i_skill4	0.349	
i_orga1		0.961
i_orga2		
i_orga3		
i_orga4		-0.757
i_comm1	0.51	
i_comm2	0.68	
i_comm3	0.475	
i_iden1	0.339	
i_iden2	0.573	
i_anom1	0.626	
i_anom2		
i_anom3		
i_anom4		

### 5.3.6 Finetune 2-factor solution

Figure 15. Fine-tuned two-factor solution, with-leader group (long)

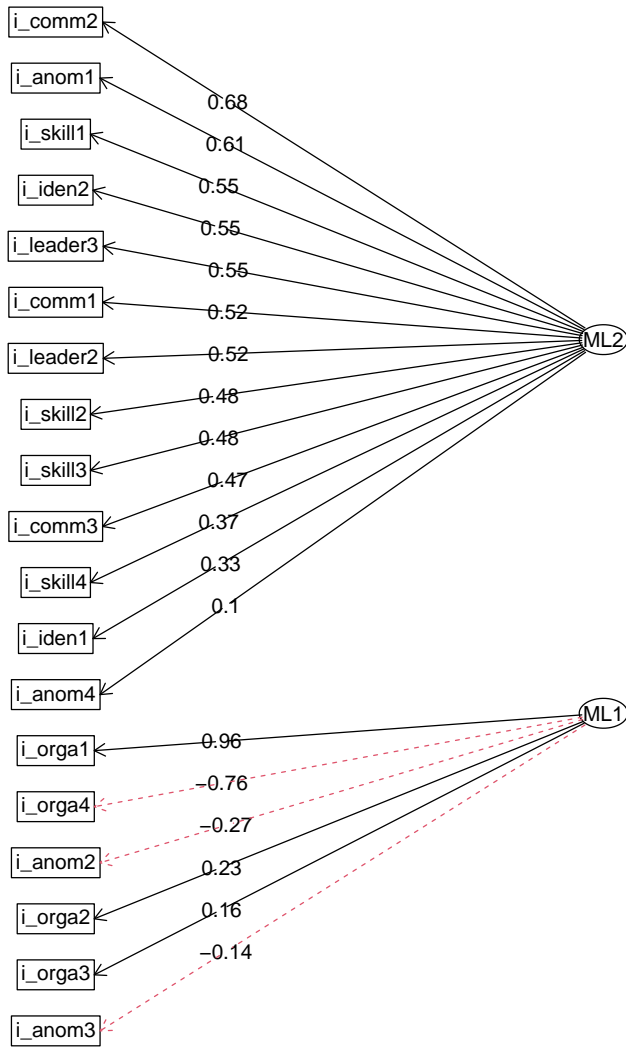


Table 12: Factor loadings of the 3-factor solution for with-leader group (long)

Item	ML2	ML1
i_leader2	0.519	
i_leader3	0.548	
i_skill1	0.548	
i_skill2	0.482	
i_skill3	0.478	
i_skill4	0.369	
i_orga1		0.962
i_orga2		
i_orga3		
i_orga4		-0.756
i_comm1	0.521	
i_comm2	0.682	

Table 13: Comparison between factor solutions, with-leader (long)

	CumulativeVariance
3-factor(tuned)	0.463
3-factor	0.352
4-factor	0.391
5-factor	0.432

Table 14: Final items for 3 factor solution, with-leader group (long)

Item	
<b>ML2: Leadership Quality</b>	
i_iden2	Everyone was happy with the decisions that were made
i_anom1	The group decisions at the decision points were unanimous
i_leader3	Everyone could voice their concerns to the leader (formal or informal)
i_comm3	Everyone voiced their concerns whenever they felt necessary
i_leader1	The leader (formal or informal) was the best suited person in the group to make the decisions.
i_leader2	The leader (formal or informal) communicated openly and clearly
i_comm2	Everyone in the group understood the decisions that were made
i_orga3	The roles of the group members were clearly defined
<b>ML3: Skill</b>	
i_skill1	The least knowledgeable group member could conduct satisfactory avalanche assessments for this trip
i_skill2	There was no large gap in avalanche assessment skills between the group members
i_skill4	All group members were equipped with standard avalanche safety equipment (beacon, shovel, probe) and trained in the use of it
i_skill3	There was no important difference in skiing skill level between group members, given the terrain
<b>ML1: Individual contribution</b>	
i_comm1	Decisions concerning avalanche hazard were well discussed in the group
i_iden1	There were clear expectations of each group member

Table 15: Results of KMO test of sampling adequacy for with-leader group (short)

	KMO
i_leader0	0.715
i_skill0	0.594
i_orga0	0.645
i_comm0	0.713
i_iden0	0.656
i_anom0	0.756
Overall	0.674

Table 16: Results of bartlett test for with-leader group (short)

Chi-square	p-value	DF
90.374	<0.001	15

## 5.4 Comparison between factor solutions, with-leader (long)

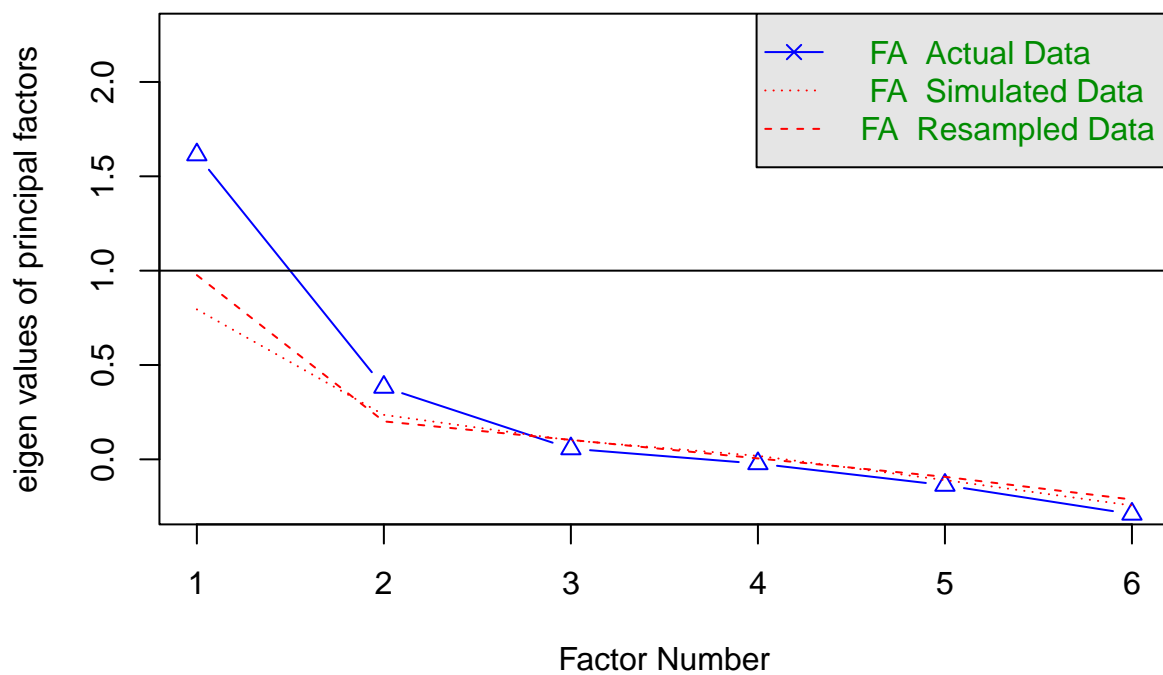
### 5.4.1 Check the factor connotation for 3-factor solution (fine-tuned)

## 6 Factor analysis for with-leader group (short)

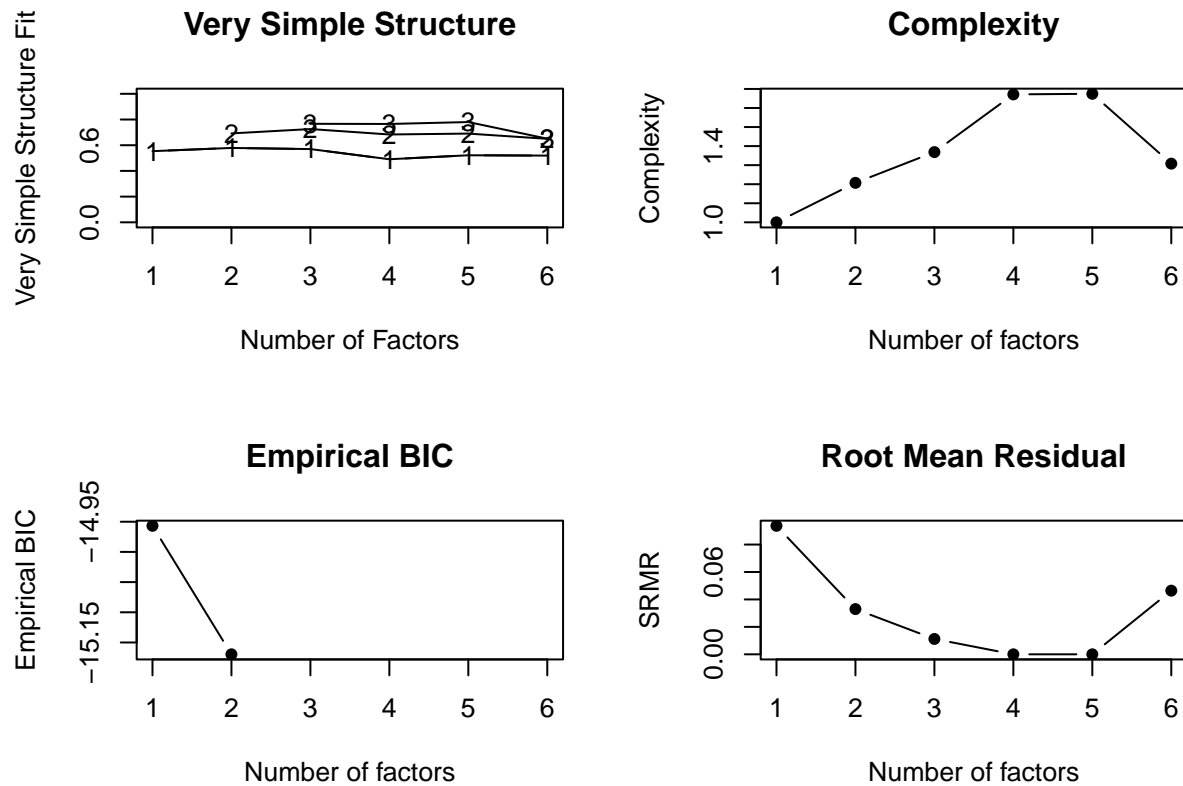
### 6.1 Check factorability

### 6.2 Explore number of factors

**figure 14. Scree plot, wiht–leader group (short)**



## Parallel analysis suggests that the number of factors = 2 and the number of components = NA



```
##
## Number of factors
## Call: vss(x = x, n = n, rotate = rotate, diagonal = diagonal, fm = fm,
##       n.obs = n.obs, plot = FALSE, title = title, use = use, cor = cor)
## VSS complexity 1 achieves a maximum of 0.58 with 2 factors
## VSS complexity 2 achieves a maximum of 0.73 with 3 factors
## The Velicer MAP achieves a minimum of 0.06 with 1 factors
## Empirical BIC achieves a minimum of -15.17 with 2 factors
## Sample Size adjusted BIC achieves a minimum of -2.46 with 2 factors
##
## Statistics by number of factors
##   vss1 vss2  map dof   chisq prob sqresid  fit RMSEA BIC  SABIC complex
## 1 0.55 0.00 0.063   9 2.0e+01 0.021    3.7 0.55  0.11 -22   6.5    1.0
## 2 0.58 0.69 0.109   4 3.4e+00 0.499    2.5 0.69  0.00 -15  -2.5    1.2
## 3 0.57 0.73 0.214   0 3.9e-01   NA    1.9 0.77   NA   NA   NA    1.4
## 4 0.49 0.68 0.432  -3 8.4e-14   NA    1.8 0.78   NA   NA   NA    1.7
## 5 0.52 0.69 1.000  -5 0.0e+00   NA    1.4 0.83   NA   NA   NA    1.7
## 6 0.52 0.65   NA  -6 6.7e+00   NA    2.9 0.65   NA   NA   NA    1.3
##   eChisq  SRMR eCRMS eBIC
## 1 2.7e+01 9.4e-02 0.121 -15
## 2 3.3e+00 3.3e-02 0.064 -15
## 3 3.8e-01 1.1e-02   NA  NA
## 4 8.5e-14 5.3e-09   NA  NA
## 5 1.6e-20 2.3e-12   NA  NA
## 6 6.5e+00 4.6e-02   NA  NA
```



Table 17: Factor loadings of the 5-factor solution for with-leader group (long)

Item	ML1	ML2
i_leader0	0.521	
i_skill0		
i_orga0		0.74
i_comm0	0.576	
i_iden0	0.765	
i_anom0		

### 6.2.1 Explore 2-factor solution

#### Factor Analysis, Varimax rotation

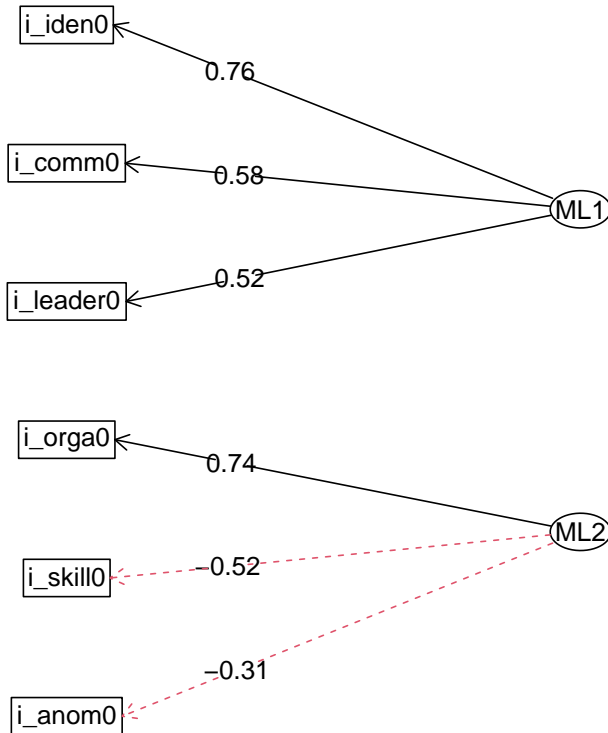


Table 18: Factor loadings of the 5-factor solution for with-leader group (long)

Item	ML2	ML3	ML1
i_leader0			0.948
i_skill0			
i_orga0	0.811		
i_comm0		0.664	
i_iden0		0.63	
i_anom0			

### 6.2.2 Explore 3-factor solution

#### Factor Analysis, Varimax rotation

