Psychometric Properties of the Norwegian Short Version of the Team Climate Inventory (TCI)

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Abstract

Objective: To examine the psychometric properties of the short version of the Team Climate Inventory (TCI) in a Norwegian sample. *Method:* A multi-level confirmatory factor analysis (MCFA) was conducted using Mplus. The sample (N = 1380) comprised employees working in the private- (n = 657) and in the public sector (n = 723) in Norway. A multi-group comparison was conducted to examine if the structure of the TCI fits across groups. *Results:* The fit indices with the original four-factor structure on the within- and between level revealed acceptable results for the total sample (TLI .91, CFI .93, and RMSEA .042). The multi-group analysis did result in significant change to model fit when the factor loadings and intercepts on the between level were fixed across groups, $\Delta\chi^2(25) = 182.58$. The individual- and group-level reliability estimates for the total scale of the TCI were satisfying, but not acceptable for two (Participative safety and Support for innovation) of the four scales. *Conclusion:* The results of the MCFA indicated that the short version of the TCI may be used for assessing team climate for organizations and for research purposes, but some caution should be taken when interpreting results from two sub-scales with marginal reliability.

Keywords: team climate inventory, multi-level confirmatory factor analysis, reliability, validity

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The Team Climate Inventory (TCI) was originally developed by Anderson and West (1994; 1998) to assess team climate for innovativeness. It is based on the four-factor model of climate for innovation as established by West in 1990. The four-factors, Vision, Participative safety, Task orientation, and Support for innovation, refer to aspects of the climate within a team that enhance team innovation or rather the capability of teams to develop and implement new and creative ideas (West, 2012). In order for teams to be innovative, the team's objectives need to be clearly defined, understood, accepted, and valued by the team members (Vision). In addition, the team members need to feel safe to propose ideas and to participate in decision-making (Participative safety). Innovativeness also requires that the team members are committed to achieve the highest possible outcomes (Task orientation), and that new ideas or innovative attempts are accepted and supported (Support for innovation) (Anderson & West, 1998).

The TCI has been widely used, translated, and validated in different countries such as Sweden (Agrell & Gustafson, 1994), Italy (Ragazzoni, Baiardi, Zotti, Anderson, & West, 2002), and Greece (Chatzi & Nikolaou, 2007). The psychometric properties of the Norwegian adaptation of the long version of the TCI (38 items) has been examined in two studies. The first study, conducted by Mathisen, Einarsen, Jørstad, and Brønnick (2004), used four different samples. The samples included different teams from the private and public sector (e.g., Norwegian postal organization and distribution teams, sea-food production and oil, and gas industry companies, banking, and school administrations). Chronbach's alphas ranged from .83 to .89 (Sample 1, $N = 1460$). Exploratory factor analysis indicated a fifth factor with four items from the Participative safety scale (item 5, 26, 20, and 3). The confirmatory factor analysis, using sample 2, yielded moderate and equal model fit for the four- and a five-factor model of the TCI, as indicated by the Tucker Lewis index (TLI; both .82), the comparative fit index (CFI; both .83), and by the root mean square error of approximation (RMSEA; both .11). Furthermore, the TCI scales were correlated with customer satisfaction scores (sample 3 and 4), and a positive relationship was found for three scales. The second study, which examined the psychometric properties of the Norwegian long version of the TCI (Mathisen, Torsheim, & Einarsen, 2006), is, to our knowledge, the only article which takes into account the hierarchical structure of the data frequently found in studies of teams by using a multilevel approach.

The short version of the TCI (14 items) was developed and tested by Kivimaki and Elovainio (1999) in two Finnish samples comprising social- ($N = 1494$) and health care professionals ($N = 771$). Item reduction was carried out using LISREL and in accordance with theory to maintain the original four-factor structure of the long version of the TCI. None of the items which were found to load on the extracted fifth factor found by Mathisen et al. (2004) in the long version, were included in the short version of the TCI. The correlation of the four shortened scales with the original scales were high (range between .85-.97), and internal consistency for the total score was excellent for both samples (.91), and good for the four scales (range from .79-.86).

The short version of the TCI has been evaluated in a Canadian study. Loo and Loewen (2002) administered the TCI at two time points to a sample of 288 management undergraduate students who were equally distributed in 72 team research projects. They reported results for both the long and the short version of the TCI. Chronbach's alpha for the four scales of the long version ranged between .84 to .93, and between .70 to .82 for the short version. Chronbach's alpha for the total score of the short version of the TCI for both time points was .90 and .93, respectively. This study also showed good model fit for both the long and short versions of the TCI.

Strating and Nieboer (2009) tested the four-factor structure of the short version of the TCI at two time points in 125 healthcare quality improvement teams, including different professions such as nurses and social workers (baseline $N = 270$, follow-up $N = 139$). Chronbach's alpha ranged between .73 and .80 at baseline, and between .79 and .84 at follow-up for the four scales. The model fit indices provided by the confirmatory factor analyses supported the four-factor structure of the TCI for both time points. The scales of the TCI, especially Participatory safety, predicted perceived effectiveness as measured by the perceived effectiveness questionnaire (Strating & Nieboer, 2009).

Although the long version has been assessed in a Norwegian sample, to our knowledge, the psychometric properties of the short version of

the TCI have not been previously examined in a Norwegian context. In addition, none of the conducted validation studies of the short version of the TCI accounted for the hierarchical structure of the data that is, that the individuals or employees (within level) are usually nested in teams (between level). Ignoring clustering in confirmatory factor analysis increases model misfit, and inaccurate estimation of standardized parameters (when the intraclass correlation coefficient (ICC) is higher than .15) and standard errors (when the ICC is higher than .05) (Pornprasertmanit, Lee, & Preacher, 2014). The ICC is an estimate of the proportion of the variance in a variable that is explained by the between-group level or rather, in our case, the team level (Pornprasertmanit et al., 2014). According to the study from Mathisen et al. (2006), the ICC for the full version of the Norwegian TCI ranged between .30 to .39, indicating that the team level explained a none negligible proportion of the variance. At the same time Mathisen et al. (2006) underlines the importance of individual factors that play a role when it comes to teamwork. Therefore it may not be the best choice to ignore the individual level and analyze aggregated data where the individuals ratings are averaged to a group mean (Loo & Loewen, 2002; Mathisen et al., 2004) but to account for both the individual- and team variability. While single-level CFA uses the total variance-covariance matrix, multi-level confirmatory factor analysis (MCFA) estimates one covariance matrix for the within level and another one for the between level (Dedrick & Greenbaum, 2011). The deviation from each individual's score to the group mean contributes to the within-level variation and each group mean contributes to the between-level variation (Zyphur, Kaplan, & Christian, 2008). Therefore, MCFA provides the possibility to examine if the suggested factor structure is valid on both levels. Mathisen et al. (2006) concluded in their article, that the four-factor structure for the long version of the TCI provides the best fit on both levels. However, it has not been tested if this is also the case for the short version of the TCI.

The aim of the current study is therefore (1) to examine the internal consistency of the Norwegian short version of the TCI, (2) to test the factorial validity of the TCI short version by using multi-level confirmatory factor analyses techniques, and (3) to test if the structural components of the TCI short version are consistent for different response groups (i.e., public and private sector employees).

Method

Participants and Procedure

Human Factors AS is an international management consultant company with a focus on assessment of teams and individuals for feedback and development (www.human-factors.no). The company has used the TCI since 1995. Through consultancy, aggregated data was gathered and made accessible for research purposes. This sample has been selected from ordinary commercial assessments done by Human Factors AS or by other organizations supervised by Human Factors. The sample used in this analysis is the same sample used in Mathisen et al. (2006) and as sample 1 from Mathisen et al. (2004), except for a small sub-sample of student- or temporary teams which were excluded from the current analysis (n = 99). Hence, the total sample consisted of N = 1380 employees, of which n = 657 employees were from the private sector (e.g., school administration, administrative counties, highway authority), and n = 723 employees were from the public sector (e.g., hospitals, Norwegian Postal Services). Because the data were collected in the context of consultancy work and in order to keep the answers anonymous, the respondents did not report information about age or gender.

Measures

The full version of the TCI consists of 38 items distributed on four scales: Vision (11 items), Participative safety (12 items), Task orientation (7 items), and Support for innovation (8 items), in addition to six items measuring social desirability. Chronbach's alpha was examined in a sample of 155 managers from 27 different hospitals in England and found to be excellent for the four TCI scales (between .89 to .94) (Anderson & West, 1998).

In the present study, all participants completed the full version of the Norwegian TCI. For the data analysis, only the 14 items which comprise the short version of the TCI were used: 4 items from the Vision scale (e.g., How far are you in agreement with the teams objectives?), 4 items from the Participative safety scale (e.g., We have a "we are in it together" attitude.), 3 items from the Task orientation scale (e.g., Do members of the team build on each other's ideas in order to achieve the best possible outcome?), and 3 items from the Support for innovation scale (e.g., People in the team cooper-

ate in order to help develop and apply new ideas.). The items were rated on a five-point scale with different response categories (e.g., *strongly disagree* to *strongly agree* or *not at all* to *completely*).

Statistical Analysis

The statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS 22) and Mplus 7 (L. K. Muthén & Muthén, 1998-2012). The data screening included the analyses of missing values (Little's MCAR test), and of the distribution of the data. Skewness and kurtosis values are recommended to be below +1.5 and above -1.5 (Tabachnick & Fidell, 2013). The reliability of the four TCI scales was calculated by computing Chronbach's alpha (α). However, for data with a hierarchical structure Chronbach's alpha may not be the best choice since it does not account for the dependency of the data and, thus, provide inflated estimates. Therefore, we also calculated the individual- (α_i) and group-level (α_g) reliability by using the following formulas:

$$\alpha_i = \frac{\sigma^2_{individual}}{\sigma^2_{individual} + \frac{\sigma^2_{item}}{p}} \quad (1)$$

$$\alpha_g = \frac{\sigma^2_{group}}{\sigma^2_{group} + \frac{\sigma^2_{individual}}{n} + \frac{\sigma^2_{item}}{p*n}} \quad (2)$$

where σ^2 is the variance, p the number of items per scale, and n the group size (Bonito, Ruppel, & Keyton, 2012). The means and standard deviations of the 14 items and of the four scales as well as the inter-item correlations per scale were calculated.

To examine if MCFA was appropriate we investigated the within group variation as a portion of the total variance (ICC). Measurement invariance between the within- and between level was tested in accordance to the analyses Mathisen et al. (2004) conducted. In addition, we ran the analyses for the total sample and for the two groups of employees separately. In model 1 (M1: Configural model) all parameters were estimated freely to examine if the factor structure fits the sample. Model fit was evaluated using RMSEA, TLI, CFI, the Akaike information criterion (AIC), and the χ^2 statistic. We also considered the χ^2/degrees of freedom ratio (χ^2 / *df*), where values of as high as 5 indicate acceptable model fit (Hooper, Coughlan, & Mullen, 2008). Recommended cut-off values for RMSEA vary between < .06 and < .07 (Hooper et al., 2008; Steiger, 2007), and recommended cut-off values for the CFI and TLI vary between > .90 and around .95 (Hooper et al., 2008; Hu & Bentler, 1999). The AIC is used to compare different models. There are no guidelines regarding cut-off values, however, the model with the lowest AIC value is the most parsimonious which implies the best fit (Hooper et al., 2008).

In model 2 (M2: Equal factor loadings) the factor loadings were fixed across levels to examine if the factor loadings were the same for the within- and between level. The results of model 2 were compared to model 1. We imposed additional constrains in model 3 (M3: Equal factor covariances) and model 5 (M5: Equal factor variances) and compared the results to the previous model, respectively. The difference in χ^2 ($\Delta\chi^2$) and in CFI (ΔCFI) were considered to evaluate measurement equivalence. For the latter one, ΔCFI ≥ .01 indicates significant measurement invariance (Cheung & Rensvold, 2002).

After fitting the multi-level model, a multi-level, multiple group comparison between the employees in the public- and the private sector was conducted. In the first model (MG1: Configural model) the two groups of employees were analyzed together and all parameters were estimated freely. In the next model (MG2: Equal factor loadings + intercepts on between level), measurement invariance of the between factor loadings and intercepts was tested, allowing the within structure to vary across groups. This model was compared to the previous one. If model fit did not significantly worsen, the factor loadings in the within level would have been constrained across groups in the next step (B. O. Muthén, Khoo, & Gustafsson, 1997).

Results

Missing Data

All of the 14 variables had at least one missing value (range between 0.1% – 1.3%). A total of 117 (0.61%) values were missing. Those 117 missing values were distributed on 53 cases (3.84%). The Little's MCAR test was significant, indicating that the data was not completely missing at random ($\chi^2(335) = 382.79$, $p = .037$). Examining the data showed that 11 people did not fill in any of the questions on the last page of the questionnaire, which suggests that those people may have simply forgotten to turn to the last page. After excluding these cases from the analysis, the Little's MCAR test was still significant ($\chi^2(308) = 350.57$, $p = .048$). However, less

than 5% missing data at random in a large data set will not cause major problems with the precision of estimates for missing values (Tabachnick & Fidell, 2007).

Descriptive Statistics

The means, standard deviations, skewness and kurtosis values, reliability, and the inter-item correlations for the four TCI scales are presented in Table 1. Descriptive statistics as well as the ICC for the 14 items are presented in Table 2. The data was approximately normally distributed with skewness and kurtosis values ranging from -.86 to .18 and -.53 to 1.00, respectively. Chronbach's alpha for the total score of the TCI was excellent ($\alpha = .86$), the reliability for the individual-level was good ($\alpha_i = .73$), and excellent for the group-level ($\alpha_g = 81$). The inter-item correlations were positive and significant ($p < .01$). The lowest correlation was found between item 31 and item 32 ($r = .31$) on the Vision scale.

Table 1. *Descriptive Statistics for the Four TCI Scales – Short Version*

Scale	*N*	*M* (*SD*)	Skew.	Kurtosis	α	α_i	α_g	Inter-item correlations
Vision (4 items)	1374	3.78 (0.63)	-.70	1.00	.76	.61	.75	.31-.52
Participative safety (4 items)	1380	3.53 (0.63)	-.33	.13	.73	.56	.81	.35-.51
Task orientation (3 items)	1369	3.18 (0.73)	-.17	.23	.72	.65	.66	.38-.56
Support for innovation (3 items)	1380	3.08 (0.67)	-.12	-.03	.66	.46	.75	.34-.43

Note. α = Chronbach`s alpha; α_i = individual-level reliability; α_g = group-level reliability.

Table 2. *Descriptive Statistics for the 14 Items of the TCI – Short Version*

Scale	Item number	*N*	*M* (*SD*)	Skewness	Kurtosis	Intraclass correlation
Vision						
	29	1369	3.77 (0.81)	-.48	.45	.20
	31	1371	3.61 (0.82)	-.29	-.04	.24
	32	1369	3.67 (0.80)	-.59	.80	.18
	34	1367	4.10 (0.84)	-.86	.84	.17
Participative safety						
	13	1378	3.22 (0.94)	-.12	-.53	.27
	16	1376	3.60 (0.82)	-.71	.39	.15
	7	1377	3.65 (0.82)	-.53	.02	.32
	23	1376	3.65 (0.77)	-.72	.64	.19
Task orientation						
	40	1362	3.20 (0.90)	-.11	.06	.10
	41	1362	3.05 (0.96)	-.16	-.30	.15
	42	1365	3.28 (0.88)	-.32	.09	.24
Support for innovation						
	21	1375	3.11 (0.84)	-.17	-.52	.13
	6	1379	2.73 (0.90)	.18	-.30	.18
	11	1377	3.39 (0.86)	-.40	-.15	.19

Note. Item numbers are based on the full version of the Norwegian TCI.

Estimation of Between Variation

To find out if MCFA is appropriate we inspected the ICC and the cluster size. The ICC ranged from 0.10 to 0.32 (Table 1). The 1380 employees were clustered within 177 teams, with a mean team size of 7.80. The ICC scores (range .10 to .32) suggest that multi-level analyses were necessary to account for the between-group variation. The number and size of the groups was large enough to do so (Dyer, 2005).

Multi-level Confirmatory Factor Analysis

To test if the structure and other parameters of the TCI are the same across levels, a series of analyses were conducted. In model 1 (M1: Configural model) all parameters were estimated freely. This analysis was conducted for the total sample (M1a: Configural model), for the employees in the private sector (M1b: Configural model), and for the employees in the public sector (M1c: Configural model). The fit indices for the different analyses are presented in Table 3. Table 4 presents the standardized factor loadings and standard errors and Table 5 the within- and between level inter-factor correlations for the total sample.

When the factor loadings were fixed across levels (M2: Equal factor loadings) the differences in χ^2 were not significant and the differences in CFI were smaller than .01, compared to the previous model, for the total sample and for the two groups of employees. When additional parameters were hold to be equal, model fit worsened. However, when the factor covariances were constrained, in addition to the factor loadings, only χ^2 was significant while the difference in CFI was lower than the recommended value. Only when the factor variances were fixed additionally, both indices indicated a significant worsening of the models, respectively. The same pattern of results was found in all three groups.

Table 3. *Results of the Multi-Level Structure Analysis*

	χ^2	df	RMSEA	TLI	CFI	AIC	Model comparison	
							Δdf	$\Delta\chi^2$
Total Sample (*N* = 1380; 177 teams)								
M1a: Configural model	459.95	136	.042	.91	.933	42385.21	-	-
M2a: Equal factor loadings	475.49	146	.040	.92	.932	42394.98	10	15.54
M3a: Equal factor covariances	490.01	152	.040	.92	.930	42399.53	6	14.52*
M4a: Equal factor variances	575.49	157	.044	.90	.914	42474.71	5	85.48**
Private Sector Employees (*n* = 657; 79 teams)								
M1b: Configural model	331.79	135	.047	.88	.911	20240.99	-	-
M2b: Equal factor loadings	340.42	146	.045	.89	.912	20265.12	11	8.63
M3b: Equal factor covariances	353.77	152	.045	.89	.909	20268.12	6	13.35*
M4b: Equal factor variances	400.58	157	.049	.87	.890	20300.90	5	46.81**
Public Sector Employees (*n*= 723; 98 teams)								
M1c: Configural model	387.19	137	.050	.90	.921	22144.72	-	-
M2c: Equal factor loadings	399.43	148	.048	.90	.920	22148.03	11	12.24
M3c: Equal factor covariances	414.59	154	.048	.90	.918	22152.12	6	15.16*
M4c: Equal factor variances	475.39	158	.053	.88	.900	22200.12	4	60.80**

Note. χ^2 = chi square; *df* = degrees of freedom; RMSEA = root mean square error of approximation; TLI = Tucker Lewis index; CFI = comparative fit index; AIC = Akaike information criterion; Δdf = difference in degrees of freedom; $\Delta\chi^2$ = difference in chi square.

*$p < .05$.

**$p < .001$.

Table 4. *Standardized Factor Loadings and Standard Errors for the Within- and Between Level (N = 1380; 177 teams)*

Item Number	Within Level		Between Level		Scale
	λ	SE	λ	SE	
29	0.66	0.04	0.97	0.05	Vision
31	0.57	0.04	0.79	0.10	Vision
32	0.52	0.04	0.85	0.09	Vision
34	0.62	0.05	0.94	0.07	Vision
13	0.61	0.03	0.97	0.03	Participative safety
16	0.60	0.04	0.87	0.05	Participative safety
7	0.48	0.03	0.87	0.04	Participative safety
23	0.57	0.03	0.92	0.04	Participative safety
40	0.45	0.04	0.77	0.09	Task orientation
41	0.61	0.03	0.88	0.04	Task orientation
42	0.79	0.03	0.99	0.02	Task orientation
21	0.53	0.03	0.89	0.05	Support for innovation
6	0.52	0.04	0.75	0.05	Support for innovation
11	0.67	0.02	1.00[1]	-	Support for innovation

Note. Item numbers are based on the full version of the Norwegian TCI. [1]The residual variance of item 11 was negative and therefore fixed to zero.

Table 5. *Within- and Between Level Inter-Factor Correlations (N = 1380; 177 teams)*

Scales	1.	2.	3.	4.
1. Vision	-	.73	.72	.63
2. Participative safety	.47	-	95.	.91
3. Task orientation	.41	.65	-	.93
4. Support for innovation	.46	.73	.75	-

Note. The within level inter-factor correlations are presented below the diagonal (*N* = 1380), and the between level factor correlations above the diagonal (*N* = 177 teams).

Multi-group Comparison

To cross-validate the short version of the TCI using different sub-samples, we tested for measurement invariance using a multi-group comparison between the employees in the private sector and the employees in the public sector. The 657 employees in the private sector were clustered in 79 teams, with a mean team size of 8.32. The residual variance of three items (item 11, 23, and item 29) on the between level were negative and therefore fixed to zero. The 723 employees in the public sector were clustered in 98 teams, with a mean team size of 7.38. Also in this group three negative residual variances on the between level had to be fixed (item 11, 34, and item 42).

The model with no constrains (MG1: Configural model), where the factor structure was the same across groups and all parameters were freely estimated, revealed acceptable fit ($\chi^2(292) = 759.77$, $p < .001$, RMSEA = .048, TLI = .89, and CFI = .913; Table 6). Table 7 presents the standardized factor loadings for the employ-

ees of the private- and public sector. The comparison of the configural model with the first constrained model (MG2: Equal factor loadings + intercepts on between level) resulted in significant deterioration of model fit based on χ^2 ($\Delta\chi^2$ = 182.58, Δdf = 25, p < .001) and CFI (ΔCFI = .03; Table 6) and therefore we did not continue with further analysis.

Table 6. *Results of the Multigroup Comparison*

MCFA	χ^2	df	RMSEA	TLI	CFI	AIC	Model comparison	
							Δdf	$\Delta\chi^2$
MG1: Configural model	759.77	292	.048	.89	.913	42413.89	-	-
MG2: Equal factor loadings + intercepts on between level	942.35	317	.053	.87	.883	42552.01	25	182.58**

Note. χ^2 = chi square; *df* = degrees of freedom; RMSEA = root mean square error of approximation; TLI = Tucker Lewis index; CFI = comparative fit index; AIC = Akaike information criterion; Δdf = difference in degrees of freedom; $\Delta\chi^2$ = difference in chi square.
**p < .001.

Table 7. *Standardized Factor Loadings and Standard Errors for the Employees of the Private- and Public Sector*

Item no	Private Sector Employees				Public Sector Employees				Scale
	Within Level		Between Level		Within Level		Between Level		
	λ	SE	λ	SE	λ	SE	λ	SE	
29	0.65	0.05	[1]1.00	0.00	0.67	0.04	1.00	0.00	Vision
31	0.58	0.04	0.70	0.16	0.58	0.05	0.92	0.03	Vision
32	0.49	0.06	0.72	0.16	0.54	0.05	0.83	0.06	Vision
34	0.60	0.06	0.64	0.15	0.63	0.05	[1]1.00	0.00	Vision
13	0.61	0.04	0.92	0.08	0.57	0.04	0.97	0.03	Participative safety
16	0.54	0.06	0.87	0.07	0.58	0.06	0.91	0.06	Participative safety
7	0.49	0.04	0.94	0.05	0.47	0.04	0.85	0.05	Participative safety
23	0.57	0.05	[1]1.00	0.00	0.57	0.05	[1]1.00	0.00	Participative safety
40	0.56	0.05	0.69	0.16	0.52	0.05	0.83	0.12	Task orientation
41	0.63	0.05	0.83	0.08	0.71	0.03	0.90	0.05	Task orientation
42	0.71	0.03	0.97	0.04	0.76	0.03	[1]1.00	0.00	Task orientation
21	0.54	0.04	0.79	0.13	0.54	0.04	0.99	0.06	Support for innovation
6	0.52	0.05	0.66	0.09	0.53	0.05	0.83	0.07	Support for innovation
11	0.64	0.03	[1]1.00	0.00	0.68	0.03	[1]1.00	0.00	Support for innovation

Note. Item numbers are based on the full version of the Norwegian TCI. [1]The residual variance was negative and therefore fixed to zero.

Discussion

The aim of the current study was to examine the reliability and the factorial validity of the short version of the TCI in a Norwegian sample using multilevel confirmatory factor analysis (MCFA). An additional aim was to test for measurement equivalence across groups.

Chronbach`s alpha was excellent for the total TCI score (α = .86), good for three of the scales (above .70), and acceptable for Support for innovation (α = .66). These values are slightly lower than those reported in previous studies, which used the short version of the TCI (Kivimaki & Elovainio, 1999; Loo & Loewen, 2002; Strating & Nieboer, 2009). However, these estimates do not take into account the multi-level structure of the data and may therefore provide imprecise and inflated estimates. While the individual- and group-level reliability estimates for the total scale of the TCI were satisfactory, the estimates for the four scales were low overall, especially on the individual-level (range .46-.65) where two scales (Participative safety and Support for innovation) did not reveal acceptable estimates. On the other hand, the estimates on the group-level displayed adequate to good internal consistency (range .66-.81). However, as Bonito et al. (2012) stated, the conceptual implications of such findings are not clear, other than that unreliable tests increase the standard error and may lead to more inaccurate estimates. The reliability estimates by Mathisen et al. (2006) for the four scales of the Norwegian full version of the TCI were generally higher than those reported here and, furthermore, slightly higher on the individual level (range .91-.94) compared to the between level (range .83-.89). The intra-class correlation (ICC) for the short version of the TCI were lower (range .10 to .32) than reported by Mathisen et al. (2006) for the full version, but indicated a need to account for the team-level variance by using a multilevel approach. This is in accordance with theory, since the TCI requires the team members to rate the teams' climate for innovativeness. Thus, a considerable part of the variability should be accounted for at the team level. One can assume that members of one team will evaluate the team's climate more similarly than members of other teams.

Overall, the results of the MCFA for the unrestricted model revealed good model fit for the original four-factor model of the TCI short version for the total sample (N = 1380). The CFI (.93) and the TLI (.91) were above the recommended criterion of .90, the RMSEA (.043), was under the two recommended cutoff values of .06 or .07 (Hooper et al., 2008; Steiger, 2007). The χ^2 statistics was significant, indicating a poor fit of the hypothesized model. However, the χ^2 statistics is sensitive to sample size and may lead to the rejection of models where large samples are used (Hooper et al., 2008). Therefore, the χ^2 degrees of freedom ratio should be used, which was also acceptable (χ^2/df = 3.38). Thus, the results indicate that the factor structure and item pattern are the same across the within- and between level. Furthermore, model fit did not significantly change when fixing the factor loadings, indicating that the loadings are also the same across levels for the short version of the TCI. There were contradictory results when the factor covariances were fixed. The χ^2 statistics changed significantly, however, the CFI did not. When the factor variances were fixed in addition to the covariances, both indices indicated a significant change in model fit.

Mathisen et al. (2006) conducted the same analyses for the full version of the TCI. Model fit for the baseline model was acceptable, however, it worsened significantly when the factor loadings and other constrains were imposed. Therefore, they also analyzed the covariance matrix for the within- and between-level separately. They tested different models, with different factor structure, and concluded that the original four-factor structure provided the best fit on both levels.

When testing for measurement invariance between the employees in the private- and public sector, the configural model revealed acceptable results, indicating that the factorial structure (e.g., number of factors and item pattern) of the TCI-short version fits the data for both groups (Byrne, 2009). However, there were significant differences between the configural model and the model with the fixed factor loadings and intercepts on the between level. It seems that the factor loadings for the public sector employees are somewhat higher than for the private sector employees. Interpretation of results when comparing public- and private-sector employees may require a level of caution due to the inconsistent factor structure between those groups.

Limitations

One strong point of this study is that we did not recruit students but that we used a large sample

with employees working in real teams. A limitation might be that the full version of the TCI was administered to the participants rather than the 14-item short version. It is difficult to say how that may have affected the results.

Conclusion

The results of the multilevel confirmatory factor analysis and the test for measurement invariance across levels indicated that the short version of the TCI reveals acceptable fit in a Norwegian sample. The reduction of questions with good scientific empirical grounding is a good alternative when there are limits to how many questions that can be integrated in an employee assessment. For research purposes, the short version will make it easier to assess climate of innovation in studies where also other scales are needed. The short version of the TCI might therefore be a useful instrument to measure team climate for organizations and in research.

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