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Evaluating an Abbreviated Version of the Circumplex Team Scan Inventory of Within-Team Interpersonal Norms

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Abstract: The Circumplex Team Scan (CTS) assesses the degree to which a team's interaction/communication norms reflect each segment (16th) of the interpersonal circle/circumplex. We developed and evaluated an abbreviated 16-item CTS-16 that uses one CTS item to measure each segment. Undergraduates ($n = 446$) completing engineering course projects in 139 teams completed the CTS-16. CTS-16 items showed a good fit to confirmatory structural models (e.g., that expect greater positive covariation between items theoretically closer to the circumplex). Individuals' ratings sufficiently reflected team-level norms to justify averaging team members' ratings. However, individual items' marginal reliabilities suggest using the CTS-16 to assess general circumplex-wide patterns rather than specific segments. CTS-16 ratings correlated with respondents' and their teammates' ratings of team climate (inclusion, justice, psychological safety). Teams with more extraverted (introverted) members were perceived as having more confident/engaged (timid/hesitant) cultures. Members predisposed to social alienation perceived their team's culture as relatively disrespectful/unengaged, but their teammates did not corroborate those perceptions. The results overall support the validity and utility of the CTS-16 and of an interpersonal circumplex model of team culture more generally.

Keywords: interpersonal circumplex, teams, social norms, workplace culture, extraversion



A team is a bounded set of two or more individuals who interact with and depend on each other to accomplish shared goals. *Team culture* refers to shared norms governing interactions within a team. Team culture matters because it influences *consequential outcomes* including satisfaction and performance (Boyce et al., 2015) and *team climate*, which encompasses members' experiences of the general atmosphere (e.g., safety, inclusiveness) in the team.

The Circumplex Team Scan (CTS; Locke, 2019) is a measure of team interaction and communication norms (or culture) reflecting each segment of the interpersonal circumplex (see Figure 1). The circumplex is defined by a vertical *agentic* axis ranging from active, assertive stances (top) to passive, timid stances (bottom), and a horizontal *communal* axis ranging from warm, affiliative stances (right) to cool, hostile stances (left). Each segment progressively

reflects a different blend of agency and communion: adjacent segments are more similar than non-adjacent segments; opposite interpersonal stances occupy antipodal segments. The circumplex has been successfully used to assess, analyze, and juxtapose various constructs related to social interactions (Gurtman, 2016). However, whereas other circumplex inventories assess *individuals*, the CTS is unique in being the only inventory to apply the circumplex to the assessment of *teams*.

The current research has three aims. The first aim was to evaluate whether an abbreviated CTS would show adequate psychometric properties. A valid short CTS would be valuable, given that the full 64-item CTS is too lengthy for intensive longitudinal data collection and time-constrained surveys.

Second, we aimed to better comprehend the construct validity and situational generalizability of the CTS and the circumplex model of team culture on which it is based. Regarding generalizability, the CTS was intended to be applicable to any group of interdependent task-oriented individuals but heretofore has only been tested in workplace teams where members have preassigned roles and

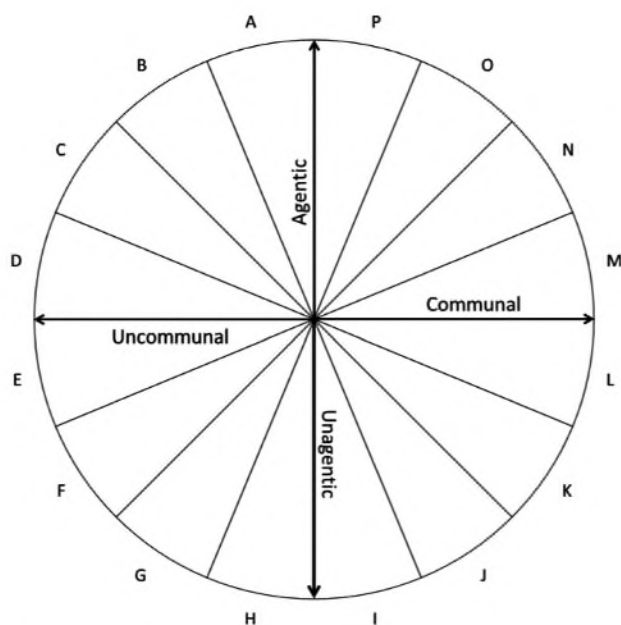


Figure 1. The Interpersonal Circumplex.

statuses. The current study tested the CTS in a new context: leaderless student teams. Regarding criterion validity, we predicted that agentic and communal norms assessed by the CTS would be positively associated with three aspects of team climate: justice, inclusion, and psychological safety (henceforth *safety*). *Justice* encompasses providing individuals respect and voice (reflecting agentic norms) and treating them fairly and equally (reflecting communal norms) (Colquitt & Rodell, 2015). *Inclusion* encompasses individuals experiencing opportunities to authentically express their unique selves (reflecting agentic norms) and experiencing themselves as embraced and cared about (reflecting communal norms) (Jansen et al., 2014). *Safety* encompasses individuals feeling both respected and unafraid (reflecting agentic norms) and trusting that they can depend on their teammates for support (reflecting communal norms) (Edmondson, 1999).

Third, we wanted to explore whether team members' personality traits – specifically, extraversion and alienation – influence their team's interpersonal culture. The etiology of team interpersonal culture remains poorly understood. Clarifying how various personality traits do or do not influence team culture will help advance our understanding. Furthermore, in applied settings, knowledge about traits can also be used to inform team configuration. If, for instance, individuals prone to alienation tend to move team culture toward the dysfunctional (lower left) circumplex region, a leader might avoid placing many high-alienation individuals on the same team.

Extraverted individuals are gregarious and energetic rather than shy and withdrawn. At the individual level,

extraversion-introversion has been repeatedly shown to align with the circumplex axis running from the high-agency-and-communion region to the low-agency-and-communal region (Barford et al., 2015). Analogously at the group level, work settings described as characteristically extraverted were also described as having more agentic and communal norms (Locke, 2019). Teams with more extraverted members exhibit more cohesiveness and effectiveness (Barrick et al., 1998), normative cooperation (Gonzalez-Mulé et al., 2014), and prosociality (Pletzer et al., 2021). Thus, extraverted members may promote more agentic and communal interpersonal norms.

Individuals high in *alienation* – sometimes called *perceived victimization* (Jockin et al., 2001) – describe themselves as feeling betrayed, undermined, and exploited (Tellegen & Waller, 2008). Alienation predicts subsequent self-reported workplace conflict and aggressiveness (Jockin et al., 2001); however, we could find no studies of alienation in team contexts. Given the association between alienation and sensitivity to maltreatment, alienated individuals may view their team's norms more cynically and perhaps prod those norms towards being less engaged and more guarded.

Method

Participants and Procedure

We collected data from three samples of engineering undergraduates in the US. We excluded students who gave identical answers to every CTS item, completed < 50% of the assessment waves of the larger project that included this study, or were the only usable participant from their team. Sample 1 consisted of 135 students in 24 teams in a biomedical engineering course during the Fall 2020 semester. Sample 2 consisted of 92 students in 29 teams in the same course during Spring 2021. Sample 3 consisted of 219 students in 86 teams enrolled in a capstone course – mandatory for final-year engineering undergraduates – during Spring 2021. Sample sizes were determined by the class sizes rather than a priori. Exclusion criteria were established after data collection but prior to data analysis. In total, there were 446 participants ($M_{\text{age}} = 20.9$ years, $SD = 1.9$; 237 females, 194 males, 15 missing/other) working in 139 teams ($M_{\text{size}} = 3.21$ members, $SD = 1.43$, $Mdn = 3$, Range = 2–8). The racial/ethnic distribution was 41% Non-Hispanic White, 30% Asian or Asian-White biracial, 11% Hispanic, 8% Black, and 9% other or unknown.

Measures

Additional data were collected from each sample for course-related or research purposes, but the current

Table 1. CTS-16 scale names, items, and Intraclass Correlation (ICC) reliability indices

Scale	Item: Within my team, people tend to...	ICC(1)	F(138, 305)	p	ICC(2)
A – Pushy	strive to stand out	.09	1.30	.030	.23
B – Competitive	compete for status and prestige	.06	1.20	.096	.17
C – Combative	compete for dominance	.08	1.29	.034	.23
D – Rude	disrespect each other	.10	1.37	.012	.27
E – Guarded	ignore each other	.17	1.67	.000	.40
F – Evasive	lack confidence in themselves	.12	1.43	.006	.30
G – Hesitant	avoid speaking up	.22	1.91	.000	.48
H – Timid	prefer to be followers than leaders	.11	1.40	.009	.28
I – Cautious	avoid saying anything controversial	.08	1.28	.041	.22
J – Yielding	avoid conflict	.06	1.20	.098	.17
K – Modest	be careful not to annoy each other	.04	1.12	.216	.10
L – Respectful	make each other feel valued	.19	1.74	.000	.43
M – Open	have fun together	.31	2.44	.000	.59
N – Engaged	share their opinions clearly and confidently	.31	2.41	.000	.59
O – Confident	be bold and confident	.24	2.01	.000	.50
P – Courageous	be assertive	.14	1.51	.002	.34

Note. N = 446 members of 139 teams.

study only includes the measures completed by all three samples – namely, those detailed below.

Circumplex Team Scan-16 (CTS-16)

In the 64-item CTS (Locke, 2019), four items assess each 16th of the circumplex (see Figure 1). The CTS-16 was created by selecting one item from each segment as follows. First, we computed item-total correlations within each segment (i.e., between each item and the average rating across the four items) in two previously collected datasets. One set was individual-level data from the 1,413 individuals in Locke's (2019) Study 2. The other data set was team-level data from 67 teams from various Australian organizations (i.e., 38 teams from Locke's Study 3 and 29 teams assessed after that study was completed). We used these two different data sets to increase confidence that the selected items would be relevant to both individual-level and group-level assessments. Next, the item-total correlations were z-scored (separately within each segment in each sample) and averaged across the two samples. Finally, the item with the highest average item-total correlation within each segment was selected for the CTS-16. Table 1 shows the items. Our current participants rated how much members of their team tended to engage in each of these 16 behaviors on 1 (= *strongly disagree*) to 5 (= *strongly agree*) scales.

Inclusion, Psychological Safety, Justice

Participants rated how much their experiences in the team were characterized by inclusion, safety, and justice on either 1 (= *very inaccurate*) to 7 (= *very accurate*) scales in Samples 1 and 2 or 1 (= *strongly disagree*) to 5 (= *strongly agree*) scales in Sample 3.

Electronic Supplementary Material (ESM 1) Section 1 details the climate scales' items and climate/personality scales' reliabilities in each sample. Inclusion was assessed with items from Jansen et al.'s (2014) inclusion scale. Psychological safety was assessed with items from Edmondson's (1999) safety scale. Justice was assessed with both novel and published items (Colquitt & Rodell, 2015; Molina et al., 2016) reflecting distributive, informational, interactional, and procedural justice.

Extraversion

Samples 1 and 2 used the HEXACO-100 16-item Extraversion scale (Lee & Ashton, 2018). Sample 3 used 15 items from the Faceted Inventory of the Five-Factor Model Extraversion scale (FI-FFM; Watson et al., 2019). Participants responded on 1 (= *strongly disagree*) to 5 (= *strongly agree*) scales.

Alienation

Participants completed seven items from the Alienation subscale of the Multifaceted Personality Questionnaire (Tellegen & Waller, 2008). The University of Minnesota Press granted us permission to use – but not reproduce – these items. Participants rated each statement “with regard to your life overall” on 1 (= *not at all true*) to 5 (= *completely true*) scales.

Participants completed the Extraversion and Alienation scales before starting their team projects. Participants completed the CTS, Inclusion, Safety, and Justice near the project's midpoint (in Sample 1) or endpoint (in Samples 2 and 3). When completing the CTS, Inclusion, Safety, and Justice items, participants were asked to describe “your

project team over the past 7 days” (Samples 1 and 2) or “all of your experiences with your team” (Sample 3). Our data and analysis syntax are posted at <https://osf.io/4jsft>.

Results

For simplicity, the samples were combined in all analyses. However, course formats and procedures (and the climate and extraversion measures) differed between samples. Therefore, to remove semester effects we standardized CTS-16, safety, justice, extraversion, and alienation scores within samples prior to conducting the analyses. Three participants did not respond to one CTS-16 item; we replaced those three missing values with zero (the mean of the standardized distributions).

Reliability of CTS-16 as a Measure of Team Norms

To the degree CTS ratings reflect *team-level* interactional norms, ratings should be more consistent within than across teams. Accordingly, to assess the scales’ reliabilities as indicators of team norms, we used one-way random-effects ANOVAs with team membership as the between-participants variable to compute two types of intraclass correlations (ICCs; see Table 1). ICC(1)s (aka ICC(1, 1)s) – the proportion of variance in CTS ratings explained by team membership – estimate the reliability of a *single member’s* rating of a team’s norms. The ICC(1)s show that group membership explained at least a marginally significant proportion of the variance in individuals’ ratings on 15 of the 16 CTS scales, but reliabilities were clearly lower in the ABC and IJK regions than the DEFGH and LMNOP regions. ICC(2)s (aka ICC(1, *k*)s) estimate the reliability of a *team’s average* rating across its members; averaging members’ ratings naturally improved reliability, but with such small teams the reliabilities of the team means were still low. Overall, the results supported averaging the CTS scores across team members, but the marginal reliabilities of some items suggest caution when interpreting a team’s results for each CTS-16 item individually.

Nonetheless, the observed ICC(1) values are comparable to those typically observed for single-item indicators of group-level constructs (Bliese et al., 2019). Indeed, they are comparable to those often observed for multi-item scales; for example, a review of hundreds of ICC(1)s reported in the literature found that over half were between 0.10 and 0.30 (Woehr et al., 2015). Moreover, because CTS-16 items form a circumplex, a respondent’s CTS-16 responses can be summarized as overall communal and

agentic vector scores as follows: Communal = $\Sigma(S_i \times \cos\theta_i)/8$, Agentic = $\Sigma(S_i \times \sin\theta_i)/8$, where S_i is the respondent’s score on item i and θ_i is that item’s angular location on the circumplex (Gurtman & Pincus, 2003). In the current study, the ICC(1)s for the multi-item CTS-16 communion and agency scores were 0.28 and 0.26. By comparison, the ICC(1)s for the inclusion, safety, and justice scales were, respectively, 0.17, 0.17, and 0.32. (The ICC(1)s for alienation and extraversion were 0.00 and 0.01, indicating as expected that they were independent of team membership).

Moreover, when using ICC(1)s as an index of the effect of the group on ratings, LeBreton and Senter (2008, p. 838) “encourage researchers to adopt traditional conventions used when interpreting effect sizes (i.e., percentage of variance explained). Specifically, a value of .01 might be considered a “small” effect, a value of .10 might be considered a “medium” effect, and a value of .25 might be considered a “large” effect”. Using these heuristics, a team’s “true” score exerted at least a medium effect on most items. Finally, for ICC(2)s traditional heuristics for evaluating reliability are applicable, but ICC(2)s depends on the number of raters; thus, for example, for a 12-person team, the Spearman-Brown formula predicts that the ICC(2)s for six of the segments would exceed the traditional 0.70 criteria for acceptable reliability.

CTS Circumplex Structure

To the degree that a set of scales form a circumplex, the intercorrelations among its scales should meet certain criteria (Fabrigar et al., 1997). The ideal circumplex or “circulant” model requires the observed correlations to fit the sinusoidal pattern of correlations expected if all scales have equal communalities and equal spacing along the circumference (see Figure 1). There are two less restrictive “quasi-circumplex” models: (a) only the spacings (and not the communalities) are equal and (b) only the communalities (and not the spacings) are equal. Finally, the least restrictive “circular” model only expects the scales to show a circular ordering (without requiring equal spacing and communalities).

We tested how well our team-level (averaged across members of each group) CTS-16 data fit each model using confirmatory circumplex structural analyses implemented by the R package *CircE* (Grassi et al., 2010). Adequate fit to each model is typically defined as a Root Mean Square Error of Approximation (RMSEA) < 0.13, a Goodness-of-Fit Index (GFI) > 0.90, and/or an Adjusted Goodness-of-Fit Index (AGFI) > .85 (Gurtman & Pincus, 2003; Rogoza et al., 2021). As Table 2 shows, the “Equal Community” and “Circular” models had an excellent fit, while the

Table 2. Fit of teams' Circumplex Team Scan-16 scores to circular models

Model	χ^2	df	RMSEA	GFI	AGFI
1. Equal spacing and communality (Circulant)	253.4	116	.093	.847	.889
2. Equal spacing (Quasi-circumplex)	210.2	101	.089	.879	.909
3. Equal communality (Quasi-circumplex)	119.3	101	.036	.980	.984
4. Unconstrained circular ordering	89.9	86	.018	.996	.997

Note. $N = 139$ Teams. RMSEA = Root Mean Square Error of Approximation; GFI = Goodness-of-Fit Index; AGFI = Adjusted Goodness-of-Fit Index.

"Equal Spacing" and "Circulant" models had an adequate fit (meeting RMSEA and AGFI but not GFI criteria). Likewise, the χ^2 values indicated a much better fit for the "Equal Communality" model than the "Equal Spacing" model, further indicating that deviations from the ideal circulant model were mainly due to unequal spacing between scales.

Circumplex Structural Summary Analyses

A signature asset of circumplex inventories is that another variable's profile of correlations with each circumplex scale can be depicted by a smaller set of circumplex "summary parameters". For example, consider *justice*: To the degree, CTS scales (a) conform to a circumplex and (b) correlate with justice, justice's correlations with the CTS scales should conform to a sinusoidal wave functions which can be summarized via a few trigonometric parameters (Gurtman & Pincus, 2003; Zimmermann & Wright, 2017). Key parameters include a horizontal (X) vector averaging justice's correlations with the communal axis; a vertical (Y) vector summarizing justice's correlations with the agentic axis; and a summary vector (the vector sum of X and Y). The summary vector's *length* or *amplitude* indicates how distinctly justice correlates with relatively high scores (strong team norms) in one circumplex region and relatively low scores in the opposite region. The summary vector's *angle* indicates the circumplex region most associated with justice on average. However, justice's summary vector will be meaningful only to the degree that its profile of correlations mirrors a cosine curve. How well-observed correlations fit a perfect cosine wave is summarized in a goodness-of-fit index, R^2 . By convention (e.g., Richardson, Hart, & Kinrade, 2021), the minimal criteria for an interpretable circumplex profile with a clear "wave peak" in one segment and "wave trough" in the opposite segment is having an amplitude $> .1$ (and preferably $> .15$) and $R^2 > .7$ (and preferably $> .8$).

Do Teams' CTS-16 Ratings Correlate With Their Personality and Climate Ratings?

As Table 3 (upper section) shows, though climate variables (inclusion, safety, justice) had clearer circumplex profiles

than did personality variables (extraversion, alienation), all variables produced interpretable profiles with amplitudes $> .15$ and R^2 's $> .80$. Therefore, each variable's profile of correlations with the CTS-16 items (reported in ESM 1, Section 2) can be effectively summarized by its communal vector, agentic vector, and overall vector amplitude and angle (reported in Table 3, upper section). Importantly, even when measures of each circumplex segment have marginal reliabilities, the structural summary (weighted average of correlations across segments) can be highly reliable to the degree the correlations with those segments fit a circumplex profile.

All three climate scales showed positive correlations with both communal and agentic norms, thereby placing their summary vectors in the agentic-and-communal region of the circumplex. Specifically, because their correlations with communal norms exceeded their correlations with agentic norms, their summary vector angles ranged from 21° to 25° ("Open/Engaged" segments). A team's average extraversion also showed positive – but in this case similar – correlations with communal and agentic norms, placing extraversion's summary vector at 51° ("Confident" segment). Finally, a team's average alienation negatively correlated with communal norms, placing its summary vector at 196° ("Evasive" segment). Figure 2 plots the summary vectors' endpoints on the CTS circumplex. The figure highlights that the correlations with interpersonal norms were similar for the three climate scales and stronger than those for the personality scales.

One caveat is that given the small team sizes, individual members can meaningfully affect team averages, possibly confounding these team-level associations with individual-level associations (between individuals' distinctive CTS and personality/climate ratings). We address this below by asking (a) do individuals' CTS ratings correlate with their personality and climate ratings *after* removing their team's averages from their ratings, and (b) do individuals' CTS ratings correlate with their team's average personality and climate ratings *after* removing their personality and climate ratings from their team's averages?

But before proceeding we should recall that some of the personality and climate measures in Samples 1 and 2 differed from those in Sample 3. The most noteworthy

Table 3. Summary parameters for relations between CTS-16 and personality or climate ratings

Measure	Communal vector [CI]	Agentic vector [CI]	Angle [CI]	Amplitude [CI]	R^2
Teams' average CTS ↔ teams' personality or climate ratings					
Inclusion	.62 [.52, .71]	.26 [.17, .34]	22.9 [15.0, 3.5]	.67 [.58, .76]	.94
Safety	.64 [.56, .71]	.24 [.14, .34]	21.0 [12.4, 28.5]	.68 [.60, .76]	.95
Justice	.69 [.62, .75]	.32 [.21, .41]	24.6 [16.3, 32.0]	.76 [.69, .82]	.96
Extraversion	.16 [.03, .29]	.20 [.09, .31]	51.3 [31.3, 78.3]	.26 [.12, .40]	.87
Alienation	-.19 [-.32, -.06]	-.06 [-.15, .05]	195.9 [153.9, 218.8]	.20 [.08, .34]	.83
Individuals' CTS ↔ individuals' personality or team climate ratings					
Inclusion	.25 [.17, .33]	.09 [.01, .16]	20.1 [3.3, 32.2]	.26 [.18, .35]	.93
Safety	.32 [.25, .39]	.08 [.02, .15]	14.6 [3.6, 23.9]	.33 [.25, .41]	.95
Justice	.34 [.28, .40]	.13 [.07, .19]	21.7 [12.8, 28.8]	.36 [.30, .43]	.96
Extraversion	.04 [-.03, .11]	.07 [.01, .13]	61.5 [27.2, 136.3]	.08 [.02, .16]	.78
Alienation	-.10 [-.18, -.02]	-.03 [-.08, .03]	193.7 [159.2, 220.2]	.11 [.03, .19]	.90
Individuals' CTS ↔ teammates' personality or climate ratings					
Inclusion	.25 [.19, .31]	.14 [.09, .19]	30.0 [20.2, 39.6]	.28 [.23, .35]	.93
Safety	.22 [.16, .29]	.14 [.08, .19]	31.9 [21.4, 43.4]	.26 [.19, .33]	.93
Justice	.29 [.23, .36]	.16 [.11, .21]	29.0 [20.1, 37.7]	.34 [.27, .40]	.95
Extraversion	.10 [.03, .16]	.08 [.02, .13]	38.3 [16.0, 64.8]	.12 [.06, .19]	.82
Alienation	-.03 [-.09, .04]	-.02 [-.07, .03]	213.4 [61.4, 1.3]	.03 [.01, .10]	.36

Note. N teams in upper section = 139. N respondents in middle and lower sections = 446 for Inclusion and Justice, 444 for Safety, and 441 for Extraversion and Alienation. Values in the first two (i.e., communal and agentic vector) columns can be interpreted as weighted average correlations. Confidence intervals (CIs) are computed using R *circumplex* package's resampling procedures (Girard et al., 2018).

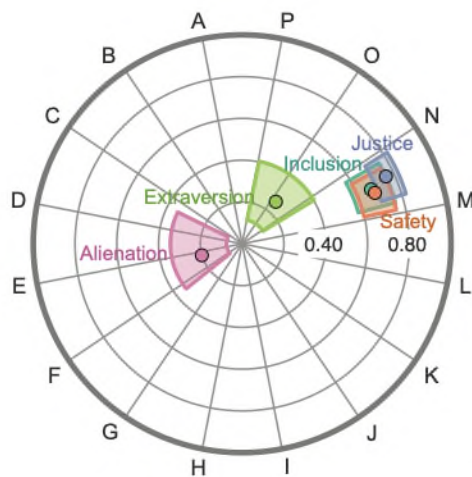


Figure 2. Association between a team's average CTS-16 ratings and a team's average climate and personality ratings. The scale ranges from $r = 0$ (at the center) to $r = 0.9$ (at the circumference). Dots represent correlations averaged across segments and tinted regions represent bootstrapped 95% confidence intervals (computed/plotted using *circumplex* package for R; Girard et al., 2018).

difference was extraversion being measured with the HEXACO scale in Samples 1 and 2 and the FI-FFM scale in Sample 3. Although correlations between FFM and HEXACO extraversion scales typically exceed .70, some researchers suggest FFM and HEXACO extraversion scales measure slightly different constructs (Watson & Clark, 2020; David Watson, personal communication, 09/2021).

Therefore, for each analysis reported in Table 3, we tested for differences between Sample 3 and Sample 1 and 2 results using bootstrapped 95% CIs calculated by the R *circumplex* package. As detailed in ESM 1, Section 5, there were no significant differences between samples.

Do Individuals' CTS-16 Ratings Correlate With Their Own Personality and Climate Ratings?

First, we team-mean centered each individual's score on each measure by subtracting the team's average from the member's raw score. Then, we correlated the individuals' centered CTS-16 ratings with their centered personality or climate ratings (see ESM 1, Section 3). As Table 3 (middle) shows, the climate measures produced readily interpretable circumplex profiles (with amplitudes $> .25$ and R^2 s $> .90$). The personality measures showed less pronounced circumplex profiles. Figure 3A plots the endpoints of the vectors summarizing each measure's correlations with CTS scales. Overall, these individual-level results mirror the results for team averages above but were weaker in magnitude because we removed covariation reflecting between-team covariation between measures.

Do Individuals' CTS-16 Ratings Correlate With Their Teammates' Personality or Climate Ratings?

To check whether team-level associations were attributable solely to the individual-level associations, we next tested whether an individual's CTS ratings correlated with ratings

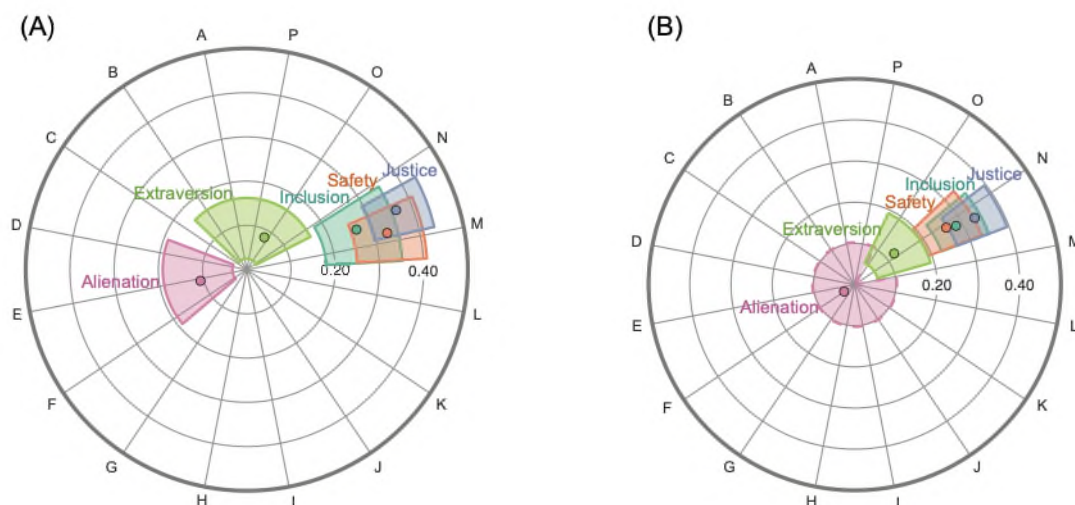


Figure 3. Radar charts show the association of an individual's CTS-16 ratings with the climate and personality ratings made by either that individual (A) or that individual's teammates (B). The scale ranges from $r = 0$ (at the center) to $r = 0.5$ (at the circumference).

their teammates made on the personality and climate scales (i.e., the team's average personality and climate ratings excluding that individual). ESM 1, Section 4 shows the results for each CTS segment. As Table 3 (bottom) shows, the climate measures produced readily interpretable circumplex profiles (with amplitudes $> .20$ and R^2 's $> .90$); thus, their summary vectors can effectively summarize their profiles of correlations. Extraversion yielded a less pronounced but still adequate circumplex profile. Alienation showed no clear pattern of correlations with the CTS scales.

Figure 3B plots the summary vectors' endpoints. The results generally mirror those reported above for teams but were weaker in magnitude because we removed covariation reflecting within-rater covariation between measures. These results indicate that members' impressions of team interpersonal norms partly reflect a consensually experienced team culture that is correlated with their teammates' impressions of team climate and shaped to some degree by their teammates' introverted-extraverted personalities. In contrast to extraversion, an individual's trait of alienation did not influence other individuals' impressions of the team's culture.

Multilevel Analyses of Team-Level and Individual-Level Associations

Because existing software for conducting tests on structural summary parameters cannot accommodate multilevel data, the preceding analyses did not account for the nested (individuals-within-teams) data structure. To address this limitation, we condensed each individual's profile of CTS-16 responses into two (i.e., agency and communion) vector scores. Next, we estimated multilevel models with the

agency or communion scores as outcome variables and individual- and team-level personality or climate scores as predictor variables (using MPlus 8.7 with the Bayes estimator). Intercepts and slopes were allowed to vary across teams. When analyzing climate variables (where the referent is the team) we estimated multilevel latent covariate models (Lüdtke et al., 2008) which treat within-team "individual-level" variation in the predictor as measurement error and correct for this unreliability by estimating the "team-level" predictor as a latent mean. When analyzing personality variables (where within-team variation partly reflects true personality differences rather than measurement error) we estimated conventional multilevel manifest covariate models (Lüdtke et al., 2008) and entered team averages as manifest team-level predictors.

The models output three effects: between, within, and contextual. *Between* effects indicate the overall team-level associations – for example, between teams' average extraversion and communal norms. *Within* effects indicate within-team associations between members' CTS ratings and their (group-mean-centered) climate or personality ratings – for example, within teams, between members' distinctive self-ratings of extraversion and perceptions of communal norms. Within effects tell us how individual differences contribute to team members reporting different experiences. *Contextual* effects indicate team-level associations absent any confounding individual-level associations – for example, between teams' average extraversion and communal norms while controlling for unique effects of individual members. Contextual effects "tells how characteristics or actions of other individuals in the same context affect individual-level outcomes or, alternatively, how characteristics or actions of an individual affect the outcomes of

Table 4. Multilevel models predicting CTS-16 agentic and communal norms from individual and team personality and climate

Predictor	Effect	Communal vector		Agentic vector	
		<i>B</i>	95% CI	<i>B</i>	95% CI
Inclusion	Between	.86	[.56, 1.38]	1.18	[.88, 1.52]
	Within	.33	[.16, .51]	.52	[.40, .66]
	Contextual	.55	[.16, 1.06]	.66	[.33, 1.01]
Safety	Between	1.11	[.82, 1.36]	.82	[.49, 1.17]
	Within	.58	[.47, .69]	.22	[.09, .38]
	Contextual	.52	[.23, .78]	.60	[.22, .97]
Justice	Between	.86	[.72, .99]	.64	[.41, .84]
	Within	.69	[.58, .82]	.38	[.24, .54]
	Contextual	.17	[−.03, .36]	.25	[−.04, .52]
Extraversion	Between	.27	[.08, .48]	.45	[.23, .63]
	Within	.06	[−.05, .17]	.12	[.03, .27]
	Contextual	.22	[−.01, .45]	.32	[.04, .48]
Alienation	Between	−.29	[−.51, −.09]	−.15	[−.34, .05]
	Within	−.19	[−.31, −.08]	−.06	[−.15, .04]
	Contextual	−.11	[−.34, .11]	−.09	[−.32, .09]

Note. Coefficients are unstandardized. CI = credibility interval computed using MPlus default Bayes estimation.

others in the same context, or how the mean of the characteristic in the context affects individual-level outcomes” (Antonakis et al., 2021, p. 452). Computationally, the between effect is the sum of the within effect and the contextual effect.

Table 4 shows the results. The results can be compared with those in Table 3 (communal and agentic vector columns). The absolute values are not comparable across tables because the values in Table 3 reflect weighted averages of correlations across CTS-16 segments whereas the values in Table 4 values are unstandardized coefficients (unstandardized because computing contextual effects preclude re-standardizing team-level predictors). Nonetheless, we can check whether the corresponding coefficients differ from zero in both tables.

Comparing the overall between-team results (Table 4’s *between* effects with Table 3’s top section) revealed no differences: All the associations significant in Table 3 were also significant in Table 4. Comparing the individual-level results (Table 4’s *within* effects with Table 3’s middle section) also revealed no differences. Comparing the contextual results (Table 4’s *contextual* effects with Table 3’s lower section) revealed three differences: Using multilevel modeling, the between-team associations between justice and agentic norms, justice, and communal norms, and extraversion and communal norms were no longer significant. However, even in these three cases the contextual effects estimated via multilevel models remained “marginally significant” ($ps \leq .1$) and thus the differences between the results were minor. In sum, the multilevel analyses and structural summary analyses yielded similar findings.

Discussion

CTS-16 Psychometric and Circumplex Properties

Our first two aims involved evaluating the psychometric/circumplex properties of the CTS-16, an abbreviated 16-item inventory of team interpersonal norms. Group membership explained a significant proportion of the variance in members’ ratings of almost all items; thus, CTS-16 ratings reflected team-level norms (and not simply idiosyncratic impressions or random error). However, the low interrater reliabilities for most items argue against interpreting the results for individual items (i.e., 16th of the circumplex), especially in smaller teams. Instead, the CTS-16 can be most confidently used to assess overall patterns averaging across the entire circumplex.

Regarding circumplexity, the CTS-16 showed excellent fit to models requiring items to conform to a two-dimensional circular structure with equal communalities, and – by most but not all criteria – adequate fit to the most stringent model requiring items to also to show equidistant spacing along the circle’s circumference. Thus, the CTS-16 scales can be combined into agentic and communal dimension scores. The weaker fit to models requiring equal spacing may be partly attributable to using unreliable single-item measures of each segment. Yet, the original 64-item CTS also showed unequal spacing between segments when administered to specific teams in organizational settings where members knew others would see their group’s results, despite showing equal spacing when online respondents anonymously

rated their workplaces which they knew could not be identified (Locke, 2019).

Therefore, another possible explanation is that the CTS scales conform to a circumplex when a team's norms are dispassionately evaluated in low-stakes settings (e.g., the team being described cannot be identified), but not when other members plus outside evaluators (such as instructors, consultants, or supervisors) will see the results. Those higher-stakes situations may motivate teams with contented members to portray their team as blessed with desirable (LMN) norms and teams with discontented members to portray their team as cursed with undesirable (EFGH) norms. Indeed, visually examining CTS-16 item intercorrelations suggests that their unequal spacing around the circumplex was partly due to desirable norms being tightly intercorrelated and undesirable norms also being tightly intercorrelated. The common influence of desirability/undesirability may also help explain why members showed greater consensus about their team having clearly socially undesirable (EFG) or clearly socially desirable (LMN) norms than about their team having norms whose desirability is more equivocal (i.e., ABC and IJK norms).

The CTS-16 showed consistent, robust associations with measures of team climate. Specifically, both within and between teams, inclusion, and psychological safety were most positively correlated with the Open-Engaged (MN) region and most negatively correlated with the Rude-Guarded (DE) region of the circumplex. Perceptions of justice showed similar associations, but multilevel models suggested that these associations largely reflected members' unique (rather than shared) perceptions of team climate and culture. Collectively, these results add evidence for the construct validity of the CTS and expand the nomological network of constructs that can be usefully organized within an interpersonal circumplex model of team culture. The results also demonstrate that the CTS (which heretofore has only been administered in organizational contexts) can be successfully applied to teams outside workplace settings – in this case, peer teams without preassigned leaders or roles.

Individual Personality and Team Culture

Individuals more prone to experience alienation were more apt to describe their team's culture as disengaged, guarded, and rude. This may just reflect their generally cynical perspective (Tellegen & Waller, 2008) because their *teammates* did not share their negative impressions of the team's culture. But alienated individuals may also genuinely experience more rejection from teammates, perhaps because they are more apt to be targets of social prejudice or exclusion or are more forthright in complaining about problematic interactions.

The evidence for personality influencing team cultures was stronger for extraversion. Within teams, the more extraverted individuals tended to describe their team as having more agentic norms. But more importantly, at the between-team level (independent of the rater's level of extraversion) teams with more extraverted members were described as having more agentic and (to a lesser degree) communal norms. In other words, teams with higher average initial extraversion levels generally reported more engaged and open and less timid and hesitant cultures. Perhaps the behavior of relatively extraverted or introverted members shifts team norms towards more openness/expressiveness or towards more timidity/hesitancy. Or perhaps in small teams, the behavior of one extraverted or introverted member influences everyone's impressions of team norms without actually changing others' behavior. Future research could test these hypotheses.

Limitations and Future Directions

Three limitations and future directions merit highlighting. First, our results are based on teams at one engineering institution. On one hand, because the CTS was developed and validated in workplace contexts, it is reasonable to expect the CTS-16 to function as well in workplace contexts as in student teams. On the other hand, confidently establishing generalizability will require continuing to evaluate the CTS-16 in teams differing in, for example, their goals, sizes, and settings. Second, as with any subjective measure, response styles and personality styles (such as negativity and alienation) are potential sources of error; however, because these sources of error will typically vary unsystematically across raters, the impact of these sources should decrease as the number of individuals rating each team increases. Third, "halo/horns" effects (that could be shared across team members) may have partly shaped members' ratings of specific aspects of culture and climate; accordingly, studies employing less subjective indicators of team performance (e.g., objective metrics or uninvolved observers) would be informative.

Conclusions

The CTS assesses team interaction and communication norms reflecting all segments of the interpersonal circumplex. The abbreviated CTS-16 version uses just one item to measure each 16th of that space. The CTS-16 items may not prove sufficiently reliable to measure specific segments, especially in smaller teams; however, they did show sufficiently robust circumplex fit and between-group differentiation to validate them as a measure of a team's average inclinations across segments, which is useful for measuring change and comparing teams to each other.

Indeed, contemporary studies using interpersonal circumplex inventories typically emphasize the aggregated “structural summary” findings and often do not bother reporting findings for individual segments (e.g., Du et al., 2020; Kehl et al., 2021; Mongrain & Shoikhetbrod, 2021). Individuals’ personality dispositions and feelings about their team may bias their CTS-16 responses (with more alienated or dissatisfied members tending to portray their team’s norms as less supportive/empowering); nonetheless, individuals’ responses showed sensible associations with their teammates’ average impressions of team climate and average extraversion levels. Thus, overall, the results align with prior evidence suggesting the interpersonal circumplex can offer a useful framework for assessing and understanding groups’ interpersonal norms. Being relatively quick to administer, CTS-16 may provide an effective tool for comparing teams and for assessing change due to interventions, leadership change, maturation, and other factors.

Electronic Supplementary Materials

The electronic supplementary material is available with the online version of the article at <https://doi.org/10.1027/1015-5759/a000752>

ESM 1. Section 1 – Climate Scale Items and Climate/Personality Scale Reliabilities; Section 2 – Correlations between Teams’ Average CTS and Climate/Personality Ratings; Section 3 – Correlations between Individuals’ CTS and Climate/Personality Ratings; Section 4 – Correlations between Individuals’ CTS Ratings and their Teammates’ Climate/Personality Ratings; Section 5 – Comparing results for FFM versus HEXACO Extraversion Scales.

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Open Science

We report how we determined our sample size, all data exclusions (if any), all data inclusion/exclusion criteria, whether inclusion/exclusion criteria were established prior to data analysis, all measures in the study, and all analyses including all tested models. If we use inferential tests, we report exact *p* values, effect sizes, and 95% confidence or credible intervals.

Open Data: We confirm that there is sufficient information for an independent researcher to reproduce all reported results using the data and analysis code posted at <https://osf.io/4jsft> (Locke & Martin, 2022).

Open Materials: We confirm that there is sufficient information for an independent researcher to reproduce all the reported methodology with the exception that copyright restrictions prevented our posting items from the HEXACO-100 and MPQ inventories. For permission to use the CTS, please contact the first author.

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