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Fostering Innovation: The Mediating Role of Need Satisfaction between Managerial Need Support and Team Innovation Behavior

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Innovation is essential for organizational survival and development. Intrinsically motivated individuals are more likely to exhibit innovative behavior, and Self-Determination Theory (SDT) suggests that intrinsic motivation requires three basic psychological needs: Autonomy, Competence, and Relatedness. Thus, it was hypothesized that managerial support of employees' basic psychological needs would enhance need satisfaction and thereby promote team innovative behavior. It was further hypothesized that the autonomy relationships would be moderated by the restrictive work design of the sample. A pre-registered analysis was performed of 546 blue collar workers in four production companies in Sweden. Structural Equation Modeling (SEM) was used to test the mediation hypotheses, with multi-group analysis testing moderation. The results demonstrated that the relationship between managers' support of autonomy and team innovative behavior was fully mediated by autonomy need satisfaction. Competence and relatedness did not demonstrate mediation. Work design autonomy did not moderate the relationships between autonomy dimensions. A supplemental second-order factor (SOF) of need support was created due to potential discriminant validity problems. The SOF of managerial need support demonstrated a full mediation effect through need satisfaction onto innovative behavior. This study demonstrated that managers could improve the innovative behavior of their employees via supporting their psychological needs.

Organizations need to innovate in order to survive and thrive, with meta-analysis demonstrating robustly positive relationships between innovation and organizational performance (Katebi et al., 2024; Khosravi et al., 2019). In the classical hierarchical structure of organizations, innovation can be thought to occur through leaders who set goals and drive the direction of an organization by delegating work to subordinates (Diefenbach & Sillince, 2011). However, the past decades have acknowledged that employees also drive a large amount of innovative behavior in organizations, which ultimately helps them remain sustainable and competitive (AlEssa & Durugbo, 2021). The antecedents of innovative behavior have been a large interest of researchers for decades, and many theories of motivation have been investigated, including Self-Determination Theory (SDT). According to SDT, humans can be intrinsically motivated (that is, motivated beyond simply pleasure and pain) if they have three basic psychological needs satisfied, which are: autonomy, competence and relatedness (Deci & Ryan, 2000). The work environment presents an interesting dynamic for satisfaction with these basic needs. Supervisors/managers have responsibility over their subordinates' performance and behavior; and thus, they can have a large role in supplying these basic needs to their employees (otherwise known as Need Support) (Gagné & Deci, 2005). Many researchers have investigated mediation models of leadership towards various organizational outcomes, and basic need satisfaction was a mediator for many of these relationships. These outcomes include: work motivation (Ballart & Ripoll, 2024; Jensen & Bro, 2018), performance (Kovjanic et al., 2013), and job satisfaction (J. Hetland et al., 2015). This study employs a similar mediation model from a SDT perspective, with innovative behavior as the outcome. Therefore, this study investigates whether the relationship between managerial Need Support and innovative behavior is mediated by Need Satisfaction.

Innovative behavior: What is it? And what is necessary for innovative behavior?

According to the Oxford Bibliography in Management, innovative behavior refers to the "introduction and application of new ideas, products, processes, and procedures to a person's work role, work unit, or organization" (Yuan & Marquardt, 2015). The innovative climate is also frequently studied alongside innovative behavior (the innovative climate is the atmosphere of innovation that may be provided by an organization). A systematic review of 78 articles about innovation climate from 1994 to 2018 found many antecedents for an innovation climate at a team and organizational level. Workforce, workplace, team, and leader characteristics significantly influence innovative climates across multiple levels of an organization (Newman et al., 2020). In the Componential Model of Creativity (a popular psychological model examining the antecedents for innovative behavior), intrinsic motivation has been identified as a critically important requirement for improving creativity and innovation (Amabile, 1988, 1997; Amabile & Pratt, 2016). Furthermore, several studies and reviews have supported the positive relationship between intrinsic motivation and innovative behavior/creativity (Anderson et al., 2014; Auger & Woodman, 2016; Venketsamy & Lew, 2024).

Organizational leadership and fostering employee innovative behavior

If intrinsic motivation is fundamental for innovative behavior, then researchers and organizations would also want to know how intrinsic motivation could be applied and harnessed in organizations. Fortunately, leadership theories have identified many ways how leaders can foster intrinsic motivation in organizations. Multiple researchers have identified intrinsic motivation as a mediator between leadership and innovative behavior. Zafar et al. (2023), hypothesized that autonomous motivation (very similar concept to intrinsic motivation) would mediate the relationship between inclusive leadership (a component of Leader-Member Exchange Theory) and innovative behavior. Leader-Member Exchange Theory (LMX) is a leadership theory concentrated on the relationships that managers make with their subordinates, and inclusive leadership is a style of leadership that focuses on establishing good quality relationships with subordinates (Korkmaz et al., 2022). Their hypothesis was supported in mediation testing using SEM, thus demonstrating that the relationship between inclusive leadership and innovative behavior was mediated by autonomous motivation. Or in other words, leaders improved the autonomous motivation of their subordinates by maintaining positive relationships with them, and this led to more innovative behavior.

Similar results were also found by Xie et al. (2020). They hypothesized that managers who had strong relationships with their subordinates (another component of Leader-Member Exchange Theory) would see increased intrinsic motivation and more positive moods in their employees, and this would subsequently increase creative performance. They used Structural Equation Modeling (SEM) to demonstrate that intrinsic motivation was a mediator between positive leader-member exchange and creative performance.

This mediation model has also been demonstrated in the reverse, using abusive leadership styles to see a decrease in intrinsic motivation, which thereby reduced innovative behavior amongst IT workers (Ali et al., 2022). Thus, leadership within organizations can support innovative behavior by improving the intrinsic motivation of their employees. However, what behavioral features do these good leaders exhibit to improve their subordinate's intrinsic motivation? SDT proposes that the mechanism behind these changes in intrinsic motivation are from satisfaction of basic psychological needs.

What is Self-determination Theory (SDT)? What are the basic psychological needs?

SDT is a broad theory of motivation that suggests people are innately driven to learn, grow and succeed (Deci & Ryan, 2000). It initially began its development as a reaction to behaviorist metapsychology, which suggested that human motivation exists in order to return people to their physiological state of homeostasis (for example, people are motivated to work in order to obtain food and shelter, which therefore provides relief and reward) (Ryan & Deci, 2019). However, this view was challenged by Deci (1971), who found that students had less motivation to complete puzzles after they were provided with a reward (when compared to getting no reward). Furthermore, they found that motivation was higher when participants found personal reasons for completing the task, such as curiosity, pursuit of challenge, and learning. Thus, they found that people experienced intrinsic motivation when their motivations aren't tied to some kind of external reward. This area of research was avidly pursued for the next few decades. A subsequent meta-analysis of 128 studies further demonstrated this diminishing effect of external rewards on motivation, thereby supporting the theory of intrinsic motivation (Deci et al., 1999).

SDT has continued extensive development. Further research by Deci and Ryan explored the conditions of intrinsic motivation and found evidence that intrinsic motivation is increased when certain psychological needs are satisfied within individuals. This was known as the basic needs theory within SDT, and three basic needs were identified: Competency, Relatedness, and Autonomy (Deci & Ryan, 2000). In other words, satisfying these three needs is necessary for intrinsic motivation. Since inception of these basic needs, it was also theorized that it could be effectively applied to the workplace to enhance a variety of outcomes (Gagné & Deci, 2005).

Further decades explored many antecedents and outcomes of basic need satisfaction. A 2016 meta-analysis Van den Broeck et al.) reviewed 99 studies that examined the antecedents and consequences of need satisfaction in the workplace and found numerous significant relationships with various aspects of personality (such as Big 5 and self-esteem), organizational tenure and values. Additionally, more specific organizational attributes were linked to need satisfaction, such as cognitive and emotional demands, job insecurity, and role stressors/ambiguity. SDT eventually found prominence in the management and organizational psychology field, particularly in literature regarding innovative behavior. A recent systematic review by Corzo and Contreras-Pacheco (2024) looked at 49 articles retrieved between 2017 and 2021 and found three major individual areas of study within innovative behavior: individual personality traits, social sharing theory, and SDT.

Bringing everything together: Can leaders improve intrinsic motivation through satisfaction of basic needs, and will this lead to greater innovative behavior?

As established earlier, intrinsic motivation is an important requirement for creativity and innovative behavior. And SDT proposes that satisfaction of basic needs is necessary for intrinsic motivation to flourish. Therefore, it follows logically that satisfaction of basic needs will improve intrinsic motivation, thereby improving innovative behavior. This idea has been pursued in the research on innovative behavior, and researchers have also recognized the influence that leaders have on their employee's need satisfaction. Cross-sectional studies have recognized that positive leadership qualities are associated with greater need satisfaction of employees across all dimensions (Hetland et al., 2011). Another study examined leadership

need satisfaction and employee need satisfaction, and whether this relationship was mediated by leader-member exchange. They found a significant "trickle-down" effect of need satisfaction from leader to employee (mediated through leader-member exchange). However, the implementation of this idea has not been as successful as cross-sectional studies. One study provided leadership training, with an emphasis on training managers specifically on the three psychological need dimensions (Tafvelin et al., 2019). They found no significant differences between an intervention group and a control group, but this was also attributed to many contextual and methodological factors.

When it comes to innovative behavior as the outcome, only a couple studies have explored the mediating relationship of need satisfaction between organizational leadership and innovative behavior. The first study by Messmann et al. (2022) used the theory of transformational leadership to investigate whether positive leadership traits could influence Need Satisfaction, which would then improve innovative behavior. Transformational leadership is a leadership theory that identifies multiple positive leadership qualities which are associated with inspiring their followers (Bass, 1995). Messman et al. used a longitudinal analysis on 130 teachers with three measurement points that were slightly over 1 year apart. They found that the relationship between innovative behavior and transformational leadership was significantly mediated by need satisfaction competence, but not relatedness and autonomy. Additionally, transformational leadership significantly influenced satisfaction autonomy, but autonomy did not affect innovative behavior. The second study by Evers et al. (2024) examines a similar demographic with similar research design, but used the theory of Leader-Member Exchange and Distributed Leadership (in which organizational leaders share decision-making and leadership responsibilities). They found that need satisfaction was a significant mediator between both leadership theories and innovative behavior at both time points.

Can organizational leadership provide specific support for each basic need, and will these influence innovative behavior?

All of the past research now converges to the research question. By returning to SDT, we can recall that there are three basic psychological needs that, if satisfied, will improve intrinsic motivation: the need for autonomy, the need for relatedness, and the need for competence. Previous research has found that effective leadership is associated with greater satisfaction of these basic needs. But from a SDT perspective, how did employees feel supported? It would be more insightful if leadership behaviors concentrated on providing these three needs could be measured and evaluated. Fortunately, this is possible due to a scale developed and adapted specifically for the organizational context (Tafvelin & Stenling, 2018). The Need Support scale measures the perceived support that a manager provides to the employees' basic psychological needs of competence, relatedness and autonomy. As a result, the scale allows for more accurate and specific conclusions to be drawn about a leader's influence on an employee's need satisfaction (and therefore intrinsic motivation). This also allows for more specific mediation hypotheses to be tested. For example, an employee may perceive that their manager supports their competence. In turn, this should hypothetically increase the employee's self-perceived competence, and this may improve their innovative behavior.

Hypotheses

As identified earlier, need satisfaction appears to mediate the relationship between leadership and innovative behavior. Thus, if using a need support perspective of leadership, it would be assumed that each dimension of need support will be responsible for influencing its respective dimension of need satisfaction. And thereafter, this will then influence innovative behavior. Therefore, the following hypotheses are listed:

H1a. It is hypothesized that the relationship between Autonomy need support (NSu-A) and Team Innovative Behavior (TIB) will be positively mediated through Autonomy need satisfaction Autonomy (NSa-A).

H1b. It is hypothesized that the relationship between Competence need support (NSu-C) and TIB will be positively mediated through Competence need satisfaction (NSa-C).

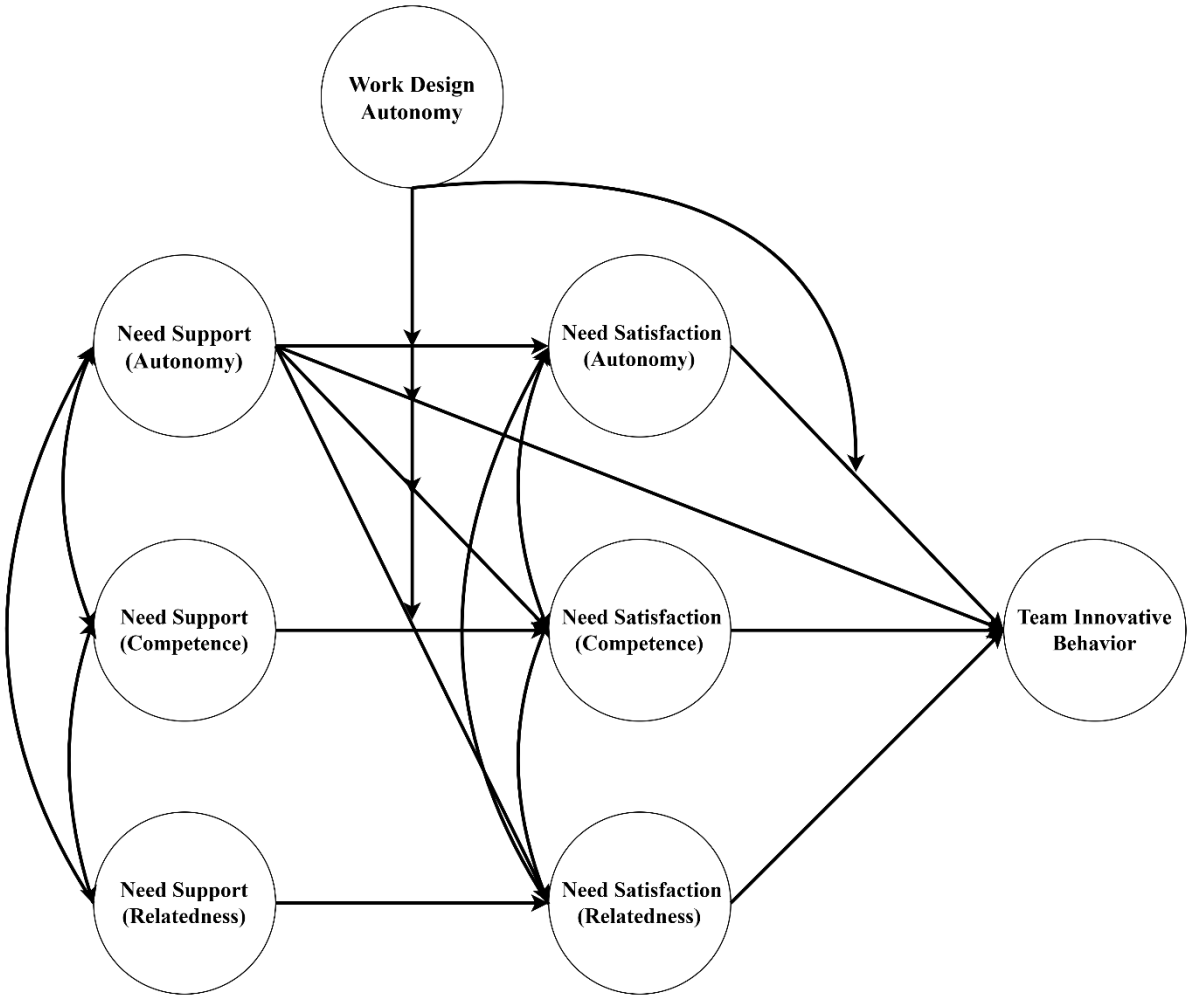
H1c. It is hypothesized that the relationship between Relatedness need support (NSu-R) and TIB will be positively mediated through Relatedness need satisfaction (NSa-R).

One more contextual consideration needs to be made about the autonomy dimension for this study. Previous qualitative studies of the participants in this project have identified that the job characteristics of the employees may offer little room for autonomy. As stated by Eden (2023, p 30-31) in her interviews with workers in these production teams, she noted that the workers "had very limited opportunities to shape and craft their jobs. Their imposed job design was generally very strict, having designated time sensitive tasks to perform throughout the workdays with little room for learning, development, or involvement in improvement work". Thus, there is a concern that the autonomy-related job characteristics may influence all relationships related to autonomy. This is particularly relevant for TIB, as models such as the Job Demands-Resources model (Bakker & Demerouti, 2007; Lesener et al., 2019) and Job Characteristics model (Pierce et al., 2009) have identified autonomy from a job's design as an important predictor on various outcomes including innovation. Further research has identified job autonomy (that is, the amount of autonomy provided by a job's characteristics) to positively influence innovative behavior (De Spiegelaere et al., 2016; Jong et al., 2015). If employees perceive that their role has limited autonomy, they may also perceive that their manager has limited capacity to affect their autonomy, thus masking the true influence of autonomy on TIB. Thus, in order to control these potential confounding effects, work design autonomy will be integrated into the mediation model.

H2. It is hypothesized that Work Design Autonomy will moderate the direct and indirect relationships between NSu-A, NSa-A, and TIB.

Figure 1.

Hypothesized paths within the model



Note: Each NSu dimension is modeled to load onto each NSa dimension, as well as have a direct loading onto TIB. To illustrate the hypotheses, only the mediation hypotheses and the moderation hypothesis of WDA were drawn.

Method

The study was approved by the Swedish Ethical Review Authority, Dnr 2021-02686. Participation was voluntary and could be withdrawn at any time. Signed informed consent was required for participation. Confidentiality was guaranteed to participants, and it was communicated that participation in this study would not result in any harm, risk, or negative consequences to them.

This study was pre-registered after data collection but before data analysis. The initial theoretical background, hypotheses, variables used, analysis plan, inference criteria, and baseline model was documented at the following website: https://osf.io/tcswg

Participants

This study used pre-existing cross-sectional data from the first wave of the LOOP project (Wänström et al., 2023). The LOOP project was a longitudinal study of managers and front-line employees with a leadership training intervention (occurring after the first wave of data collection). This analysis used data from 546 front-line (or blue collar) employees from four production companies in Sweden. Two large companies were in the automotive industry, and two small/ medium enterprises were in the turning and milling industry. Each employee worked in a team with the same manager. The mean age of participants was 33 (*SD* = 11), with 13 age values missing and 2 removed due to being impossible values (2 & 8). Participant gender was: 145 women, 390 men, 2 other, and 9 missing. The response rate of participants at the first measurement time-point was 86%.

Procedure

Paper surveys were completed during working hours by the front-line workers. Participants were informed that it would take 15-20 minutes to complete the surveys, and the survey was completed during each company's working hours. Researchers were present to distribute/collect surveys and answer questions. Paper surveys were later digitized. The entire questionnaire had 121 questions from various scales; however, this analysis only used a portion of the questionnaire (totaling 40 questions and demographics).

Measured variables

Descriptive statistics and reliability estimates were obtained in SPSS 30 (IBM Corp, 2022) (see Appendix for questionnaires used, and mean (*SD*) for each question).

Need Satisfaction and Need Support

Need Satisfaction was measured via the Need Satisfaction at Work Scale (NSa-WS), and Need Support was measured via the Need Support at Work Scale (NSu-WS), which were both developed and validated by Tafvelin and Stenling (2018). Both these scales were developed for the workplace environment using expert panels for item development and validated in a diverse sample of workers in Sweden (*N* = 1,430). Both scales used a 5-point Likert scale, ranging across: "Never/hardly ever", "Seldom", "Sometimes", "Often, and "Always".

The NSa-WS uses 4 questions for the Competence dimension, 4 questions for the Autonomy dimension, and 5 questions for the Relatedness dimension, for a total of 13 questions. The NSa-WS questions asked the participant to rate how they perceive their work and workplace. Some example items include: "I have the possibility to influence my situation at work (NSa-A)", "I feel effective at my job (NSa-C)", and "I feel close to the people I work with (NSa-R)".

The NSu-WS uses 4 questions for each dimension, for a total of 12 questions. The NSu-WS questions asked the participant to rate their supervisor in a format of "My supervisor:". Some example items include: "Encourages me to take my own initiative at work (NSu-A)", "Clearly communicates the goals for my work (NSu-C)", and "Shows that he/she appreciates me as an individual (NSu-R)".

Team Innovative Behavior

Team Innovative Behavior (TIB) was measured via an adapted scale derived from Scott and Bruce's (1994) innovative behavior questionnaire. The original questionnaire was used by managers to rate their subordinate's innovative behavior. This measure was adapted to this study by asking the participant to rate the innovative behavior of their team. For example, instead of rating a subordinate's ability to "generate creative ideas", the questionnaire asks each participant to rate their team by stating "this team creates creative ideas". This scale used a 5-point Likert scale, ranging across: "Not at all", "To a very small extent", "To some extent", "To a large extent", and "To a very large extent". Some example questions include: "This team brings forward ideas and anchors them in others", and "This team develops appropriate plans and timetables for the implementation of new ideas".

Work Design Autonomy

The perceived autonomy provided by a job's design was measured using parts of the Work Design Questionnaire, which was developed and validated by Morgeson and Humphrey (2006). The full Work Design Questionnaire has 20 dimensions, but only three dimensions are directly related to the autonomy provided by a job's design, which are: work scheduling autonomy (WSA), decision-making autonomy (DMA), and work methods autonomy (WMA). Each dimension has three questions on a 5-point Likert scale, for a total of nine questions, ranging across: "Strongly disagree", "Disagree", "Neither agree nor disagree", "Agree", and "Strongly Agree". Some examples questions are: "The job allows me to make my own decisions about how to schedule my work (WSA), "The job gives me a chance to use my personal initiative or judgment in carrying out the work (DMA)", and "The job allows me to decide on my own how to go about doing my work (WMA)".

Table 1.

Reliability statistics for each scale

Scale	Cronbach's α	McDonalds ω
Need Satisfaction at Work Scale	0.884	0.886
NSa-Autonomy	0.821	0.825
NSa-Competence	0.784	0.786
NSa-Relatedness	0.900	0.903
Need Support at Work Scale	0.951	0.951
NSu-Autonomy	0.860	0.862
NSu-Competence	0.897	0.899
NSu-Relatedness	0.914	0.914

Scale	Cronbach's α	McDonalds ω
Work Design Questionnaire (Autonomy dimensions)	0.938	0.938
Work Methods Autonomy	0.855	0.585
Work Scheduling Autonomy	0.801	0.802
Decision Making Autonomy	0.873	0.874
Team Innovative Behavior	0.913	0.914

Note. No improvement in reliability occurred if an item was dropped from any scale

Missing data and outliers

Missing data testing, imputation, and Mahalanobis distances were calculated using SPSS 30 (IBM Corp, 2022). 1.7% (382 entries out of 21,840) of the data was missing prior to exclusion. Missing data for each question ranged from 0.9% to 4.4%. Little's Missing Completely at Random (MCAR) test of the raw data demonstrated a significant result ($\chi 2$ = 1557.59, *df* = 1412, *p*=.004), indicating data was not missing completely at random. Most of the missing data concentrated on 18 participants, who were then removed due to missing at least one scale in their responses (see Table 2). After the exclusion of these participants, 0.4% of data was missing (100 entries out of 21,120). MCAR testing indicated that this data was still significant (*p*= .006); however, further inspection of the missing data did not show any systemic pattern of missingness. Data imputation was then performed on each scale to resolve missing data issues. Data imputation was performed through SPSS using linear regression on each scale to predict the missing value.

The testing of multivariate outliers (Mahalanobis distance) indicated one possible outlier. This participant rated almost all questions (95%) with either 1 or 5, with 1 as the most common response (72.5%). However, this participant was not removed from further analysis, as their pattern may reflect their honest perceptions.

Table 2.

Participant removal based on each missing variable/s

Variable	>50% missing	Missing TIB + WDA	Missing TIB	Missing all NSu	Missing all NSa
Number of participants	3	4	8	1	2

Normality

Normality was calculated via SPSS 30 (IBM Corp, 2022). The acceptable thresholds for univariate normality were assessed according to Kline (2016), who suggested that skewness values less than -3 or greater than 3 indicate severe skewness, and kurtosis values less than -10 or greater than 10 indicate severe kurtosis. Univariate skewness and kurtosis were below 1 or above -1 for all items, except for NSa-C Q1 "I can handle the challenges I face in my job" (skewness = -1.27, kurtosis = 2.47). Nevertheless, this was deemed acceptable according to Kline (2016). Multivariate normality was severely violated, with Mardia's coefficients demonstrating significant skewness (χ^2 = 10510, *df* = 5456, $p < .001$) and kurtosis (z = 49.4, $p < .001$). Thus, standard errors and confidence intervals were bootstrapped (West et al., 1995).

Statistical analysis

CFA and SEM

The analysis uses the two-step approach to analysis, which validates latent constructs before estimating them in a path model (Anderson & Gerbing, 1988; Kline, 2016, pg. 338-339). Measurement validity of the observed indicators were assessed based on a review of best practice-recommendations, which desire a minimum standardized factor loading of 0.5 (and with 0.7 as good), and also ensuring that observed variables did not cross load onto multiple constructs (Cheung et al., 2023). Additionally, minimal residual correlations are desired across pairs of observed variables (<0.1). Discriminant validity was assessed by ensuring that each factor within each scale was not highly correlated. A review of best practices for assessing discriminant validity identified the inter-factor correlations of <0.8 as acceptable, >0.8 as problematic and >0.9 as severe (Rönkkö & Cho, 2022). Model fit indices for the CFA and SEM were evaluated based upon the recommendation of Kline (2016), Schermelleh-Engel et al. (2003) and Schreiber et al. (2006). They suggested evaluating four different model fit indices, with the following criteria for good model fit: Ratio of $\chi 2/df$ = <2 or 3, CFI = >0.95, SRMR = <0.08, and RMSEA = <0.06 to 0.08, with an upper confidence interval of <0.10.

CFAs was performed in Jamovi (The Jamovi project, 2024). The CFA for NSu-WS, NSa-WS, and WDQ were performed according to a 3-factor solution in order to confirm the internal structure of each scale. The CFA for TIB was performed using a 1-factor solution. The 3-factor solution of NSu and NSa corresponded with the three basic need dimensions of Autonomy, Competence, and Relatedness. The 3-factor solution for WDA corresponded with the three dimensions related to autonomy provided by the WDQ, which are: work methods autonomy (WMA), work scheduling autonomy (WSA), and decision-making autonomy (DMA). In order to perform moderation testing, all indicators for the WDQ were averaged and indexed into a single score; however, a 3-factor solution was performed to investigate the discriminant validity of the three factors and the measurement validity of the observed variables.

SEM was performed using AMOS version 30 (IBM Corp, 2023). Maximum Likelihood (ML) was used with 5000 bootstrapped samples due to severe violations of multivariate normality. Bias-corrected bootstrapped confidence intervals were used for significance testing. The decision to use ML instead of other robust estimators, such as least-squares based methods, was made based on previous reviews and simulation studies (Beauducel & Herzberg, 2006; Lei, 2007; Rhemtulla et al., 2012). These studies found that using ML with bootstrapped errors for data with at least 5 categories resulted in similar results when compared to other estimation

methods (such as Weighted Least Squares). Each NSu dimension was specified as an exogenous variable and correlated. Each NSu dimension had paths to each NSa dimension, as well as a direct path to TIB. Each dimension in NSa had a direct path to TIB, as well as correlations between each disturbance term.

Measurement invariance across WDA groups

In order to facilitate multi-group analysis, each observed indicator of WDA was indexed. The indexed WDA score had a range of 1-5, and the variance within WDA allowed for an effective multi-group analysis ($M = 2.48$, $SD = 0.95$, skewness = 0.226, kurtosis = -0.87). Multi-group analysis was then performed on the hypothesized model to test whether WDA had a significant effect on the autonomy paths. Participants were split according to the middle of the Likert scale (at 3). Participants scoring 1-2.99 were assigned to the low WDA group (N = 347), and participants scoring 3-5 were assigned to the high WDA group (N = 181). Splitting participants into three groups instead of two would result in the highest group only having 73 participants, which would not be sufficient for further analysis.

The low WDA group were 28.5% women, 71.5% men, with an average age of 33.16 ($SD = 11.36$). Age was significantly ($p < .001$) skewed and kurtose (skewness = 0.607, kurtosis = -0.724). The high WDA group were 25% women, 74% men (1% missing), with an average age of 33.00 ($SD = 11.30$). Age was significantly ($p < .001$) skewed and kurtose (skewness = 0.868, kurtosis = -0.174).

Measurement invariance was tested prior to constraining the autonomy paths (as defined in H2). Table 3 displays the results of various measurement constraints to the model across both WDA groups. Measurement invariance was tested and evaluated based on the recommendations of Kline (2016), Chen (2007), and Sass et al. (2014). Further recommendations regarding organizational psychology were also considered (Vandenberg & Lance, 2000). These recommendations vary based on the sample size, estimation method, type of data (for example, ordinal data), and configural model fit indices. Ultimately, this study used thresholds based on the sample size recommendations by Chen (2007), which also uses different thresholds of SRMR for weak (also known as metric) and strong (also known as scalar) invariance tests. Satisfying all these thresholds is not necessary to proceed but is desired. These thresholds are presented in Table 3.

Table 3

Acceptable, cautious, and unacceptable thresholds to model fit indices

	χ^2/df ratio	**Δ CFI**	**Δ SRMR**	**Δ RMSEA**
Measurement invariance accepted	< 2	<0.005	Weak: <0.025 Strong: <0.005	<0.010
Measurement invariance evaluated with caution or rejected	2 - 4	0.005-0.010	Weak: 0.025 - 0.030 Strong: 0.005 - 0.010	0.010 - 0.015

	χ^2/df ratio	Δ CFI	Δ SRMR	Δ RMSEA
Measurement invariance rejected	> 4	>0.010	Weak: > 0.030 Strong: > 0.010	> 0.015

Hypothesis 2 was then tested with the highest level of measurement variance that was achieved. A total of 5 structural weights were constrained, which includes NSu-A to each NSa dimension (3 total), NSu-A to TIB, and NSa-A to TIB. Moderation will be supported if a large change of model fit occurs according to the thresholds in Table 3.

Results

Confirmatory Factor Analysis

All observed variables had factor loadings above 0.5 (meaning that they shared more variance with their respective construct rather than error), with most factor loadings above 0.7. Residual correlations were adequate for all items in the NSu, NSa, and WDA scales. However, the NSa-A question "I can express who I am at my job" had a high observed residual correlation with each item of the NSa-R dimension (ranging from 0.120-0.164). Whilst this is an autonomy question, it is understandable that this question would also lead participants to consider their relationship to others (or their feelings of relatedness). Therefore, there was a consideration to cross-load this item onto NSa-R (in addition to NSa-A). However, this item loaded well onto its respective NSa dimension (0.645), and a cross-loading onto NSa-R would have been worse for both NSa-A (0.501) and NSa-R (0.260). Thus, this was unchanged.

As shown in Table 4, there was a major issue of discriminant validity reflected by the high correlations in the NSu-WS CFA. NSu-A and NSu-C demonstrated an extremely high correlation (> 0.90), and the remaining correlations with NSu-R were also very high (> 0.80). This was not an issue with the NSa scale. Whilst research in SDT highlights that these three dimensions should be separate and distinct, the very high correlation can also suggest that the three dimensions of NSu are measuring a single phenomenon instead of three. Thus, meaningful analysis and interpretation may be limited if this is not addressed. Thus, further analysis was performed using the hypothesized baseline model and a similar supplemental model with the second-order factor of NSu. The WDA scale also demonstrated extremely high correlations, suggesting that these factors are all measuring a single construct. However, this is expected and ideal, as this variable was indexed into a single score for multi-group analysis. The NSa-WS demonstrated acceptable correlations between factors, suggesting that each dimension represented a distinct construct.

Table 4.

Correlations for each dimension within the NSu-WS and NSa-WS

Scale	Estimate	Standard error	Unstandardized 95% CI	Correlation
Need Support				
NSu-A ↔ NSu-C	0.852	0.065	(0.545, 0.790)	0.938
NSu-A ↔ NSu-R	0.722	0.059	(0.607, 0.836)	0.876
NSu-C ↔ NSu-R	0.960	0.073	(0.817, 1.103)	0.855
Need Satisfaction				
NSa-A ↔ NSa-C	0.262	0.031	(0.201, 0.322)	0.617
NSa-A ↔ NSa-R	0.327	0.039	(0.250, 0.404)	0.498
NSa-C ↔ NSa-R	0.185	0.026	(0.133, 0.236)	0.446
Work Design Autonomy				
WMA ↔ WSA	0.748	0.064	(0.622, 0.873)	0.984
WMA ↔ DMA	0.849	0.069	(0.714, 0.983)	0.944
WSA ↔ DMA	0.804	0.066	(0.675, 0.933)	0.973

Note. All estimates were p <.001

Jamovi cannot obtain standardized CI, therefore the unstandardized CI was reported

As shown in Table 5, the TIB CFA initially demonstrated poor model fit indices. To improve model fit, two residual correlations were added between two pairs of items that exhibited high modification indices and for which theoretical justifications could be established. The first residual correlation was made between the questions “This team creates creative ideas” and “this team brings forward ideas and anchors them in others”. This residual covariance may also reflect idea generation, which is something not reflected in the TIB questionnaire (Doran & Ryan, 2017; Masianoga & Chakauya, 2023). The second residual correlations were made between the questions “this team is trying to get financing to be able to implement new ideas” and “this team develops appropriate plans and timetables for the implementation of new ideas” were also correlated. Both of these items may share variance due to reflecting “resource supply”, which was an antecedent of innovative behavior identified in Scott and Bruce's (1994) original path model. Thus, these correlations improve model fit by accounting for shared variance linked to theoretically plausible but unmeasured influences.

Whilst the RMSEA and χ^2 ratio for TIB was beyond acceptable thresholds, further analysis was continued due to the acceptable CFI and SRMR.

The final model fit indices for each CFA are summarized in Table 5. These model fit indices were acceptable for the NSu-WS, NSa-WS. Therefore, further SEM was performed to investigate the hypotheses.

Table 5.

Summary of CFA model fit statistics and factor loadings for each scale

Scale	χ^2 (*df*), *Ratio*	CFI	SRMR	RMSEA (90% CI)	Factor loadings: Standardized estimates range
Need Support (NSu)	217 (51), *4.25*	0.967	0.0275	0.0786 (0.0680, 0.0895)	
Need Support Autonomy (NSu-A)					0.760 - 0.793,
Need Support Competence (NSu-C)					0.737 - 0.904
Need Support Relatedness (NSu-R)					0.774 - 0.917
Need Satisfaction (NSa)	184 (62), *4.58*	0.963	0.0466	0.0612 (0.0511, 0.0714)	
Need Satisfaction Autonomy (NSa-A)					0.645 - 0.805
Need Satisfaction Competence (NSa-C)					0.589 - 0.780
Need Satisfaction Relatedness (NSa-R)					0.751 - 0.859
Work Design Autonomy (WDA)	130 (24), *5.42*	0.969	0.0247	0.0916 (0.0766, 0.107)	
Work Methods Autonomy (WMA)					0.768 – 0.876
Work Scheduling Autonomy (WSA)					0.718 – 0.809
Decision Making Autonomy (DMA)					0.765 – 0.893
Team Innovative Behavior (TIB)	132 (9), *14.67*	0.942	0.0417	0.161 (0.137, 0.186)	0.671 – 0.891
Improved model with correlated residuals	44 (7), *6.28*	0.982	0.0248	0.100 (0.0733, 0.130)	0.665 - 0.867

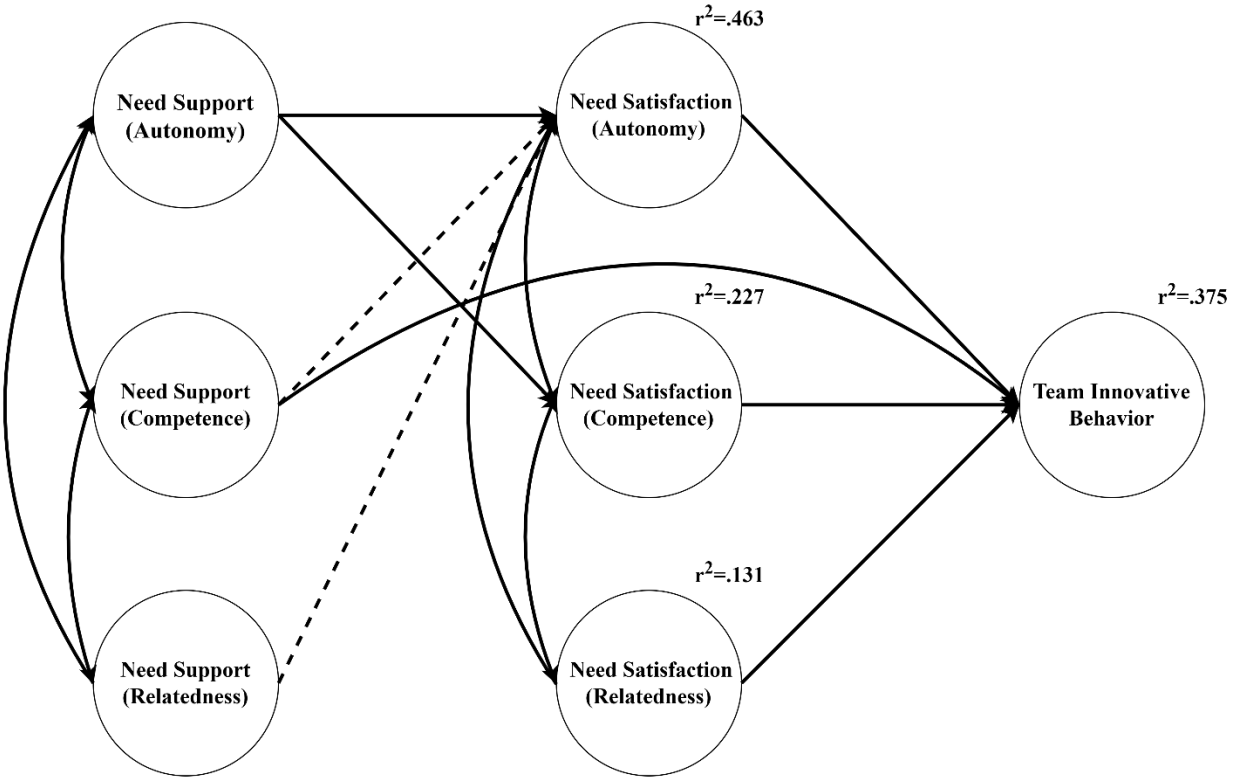
Structural Equation Model

Baseline SEM

Structural Equation Modeling was performed on the data in accordance with the hypothesized paths. The baseline model demonstrated good model fit indices, with good Chi square statistics (χ^2= 892, *df* = 411, *p* <.001, ratio χ^2/df = 2.17), good CFI (0.957), good SRMR (0.0413) and good RMSEA (0.047 (90% CI, 0.043, 0.051)). As seen in Figure 2 and Table 6, the only hypothesis confirmed by the baseline model was H1a, which suggested that NSa-A mediated the relationship between NSu-A and TIB. Additionally, each NSa dimension significantly influenced TIB, and NSu-C had a significant direct effect on TIB.

Figure 2.

Significant paths for baseline model



Note: Solid lines indicate *p* <.05 and broken lines indicate *p* < .1

Table 6.

Estimates of all paths in the hypothesized SEM

Predictor	Dependent	Estimate	Bootstrapped SE	Standardized Estimate	Standardized bootstrapped 95% CI	*p*
Need Support Autonomy	Need Satisfaction Autonomy	0.445	0.217	0.506	(0.044, 1.005)	.036
Need Support Autonomy	Need Satisfaction Competence	0.363	0.180	0.658	(0.101, 1.291)	.023
Need Support Autonomy	Need Satisfaction Relatedness	0.197	0.263	0.231	(-0.384, 0.838)	.421
Need Support Autonomy	Team Innovative Behavior	-0.260	0.257	-0.233	(-0.859, 0.228)	.294
Need Support Competence	Need Satisfaction Autonomy	0.309	0.186	0.373	(-0.067, 0.807)	.086
Need Support Competence	Need Satisfaction Competence	-0.094	0.137	-0.181	(-0.700, 0.320)	.476
Need Support Competence	Need Satisfaction Relatedness	0.049	0.199	0.062	(-0.420, 0.557)	.777
Need Support Competence	Team Innovative Behavior	0.538	0.199	0.625	(0.209 1.109)	.002
Need Support Relatedness	Need Satisfaction Autonomy	-0.179	0.102	-0.219	(-0.469, 0.016)	.069
Need Support Relatedness	Need Satisfaction Competence	-0.010	0.083	-0.019	(-0.366, 0.271)	.912
Need Support Relatedness	Need Satisfaction Relatedness	0.064	0.112	0.080	(-0.180, 0.379)	.545
Need Support Relatedness	Team Innovative Behavior	-0.198	0.119	-0.233	(-0.496, 0.055)	.104
Need Satisfaction Autonomy	Team Innovative Behavior	0.232	0.106	0.223	(0.026, 0.416)	.024
Need Satisfaction Competence	Team Innovative Behavior	0.272	0.128	0.164	(0.027, 0.316)	.016

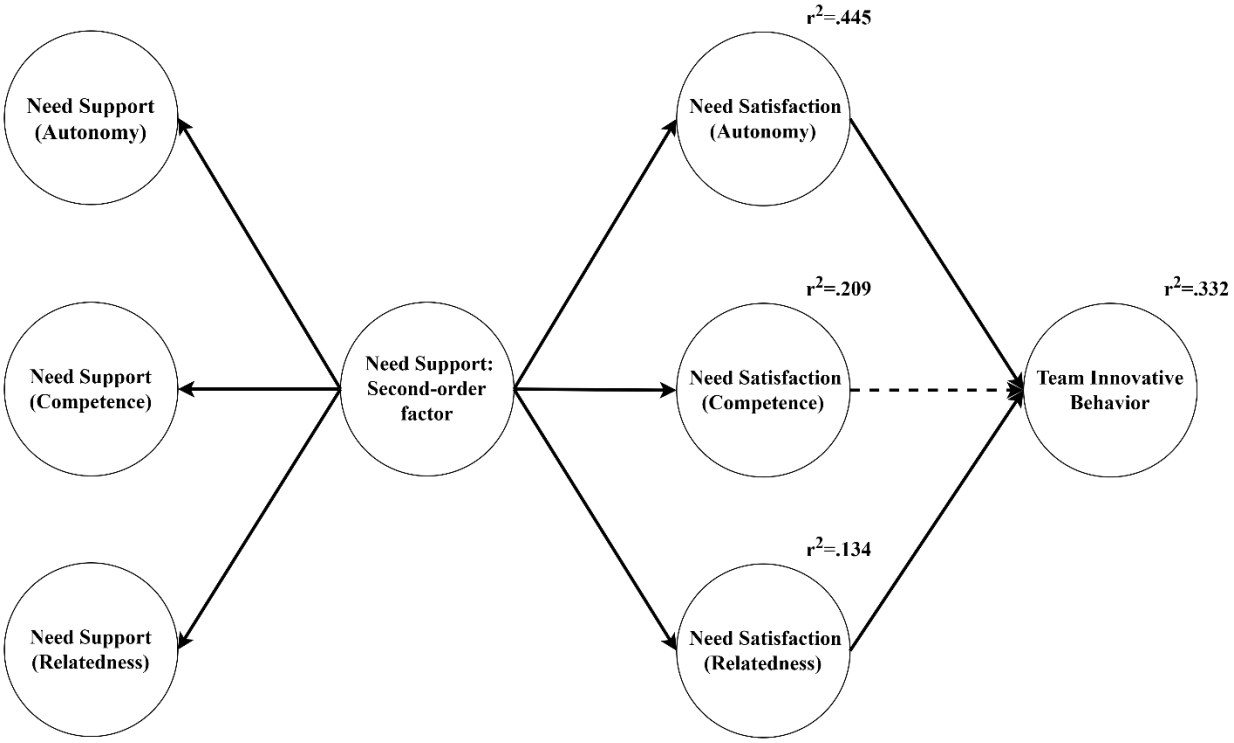
Need Satisfaction Relatedness	Team Innovative Behavior	0.229	0.065	0.213	(0.094, 0.330)	.001
Indirect effect: NSu-A → (NSa-A + NSa-C + NSa-R)	Team Innovative Behavior	0.247	0.139	0.151	(0.012, 0.587)	.041
Indirect effect: NSu-C → (NSa-A + NSa-C + NSa-R)	Team Innovative Behavior	0.058	0.104	0.121	(-0.172, 0.294)	.519
Indirect effect: NSuR → (NSa-A + NSa-C + NSa-R)	Team Innovative Behavior	-0.030	0.063	0.074	(-0.189, 0.103)	.602
Total effect: NSuA → NSu-A	Team Innovative Behavior	-0.014	0.247	-0.015	(-0.586, 0.484)	.961
Total effect: NSuC → NSu-C	Team Innovative Behavior	0.596	0.199	0.692	(0.267, 1.183)	.003
Total effect: NSuR → NSu-R	Team Innovative Behavior	-0.228	0.107	-0.268	(-0.504, -0.012)	.041
Correlations						
Need Support Autonomy	Need Support Competence	0.873	0.061	0.938	(0.910, 0.961)	.001
Need Support Autonomy	Need Support Relatedness	0.825	0.059	0.875	(0.831, 0.912)	.001
Need Support Competence	Need Support Relatedness	0.857	0.064	0.856	(0.816, 0.889)	< .001
Need Satisfaction Autonomy	Need Satisfaction Competence	0.130	0.026	0.475	(0.343, 0.595)	< .001
Need Satisfaction Autonomy	Need Satisfaction Relatedness	0.170	0.031	0.377	(0.260, 0.482)	< .001
Need Satisfaction Competence	Need Satisfaction Relatedness	0.115	0.028	0.341	(0.204, 0.469)	< .001

Second-order factor model of Need Support

Due to the extremely high correlations between the NSu dimensions (particularly between NSu-A and NSu-C), a second order factor model was also created to supplement this analysis. Researchers in the past have flagged discriminant validity problems above >0.8, with severe and obvious problems >0.9 (Rönkkö & Cho, 2022). Thus, both the pre-registered model and the second-order factor model (see Figure 3 and Table 7) were presented together to address the hypothesis and provide better interpretation.

Figure 3.

NSu second-order factor model of estimates



Note: Solid lines indicate p <.05 and broken lines indicate p < .1

Table 7.

Estimates for the NSu second-order factor (SOF) SEM model

Predictor	Dependent	Estimate	Bootstrapped SE	Standardized Estimate	Standardized bootstrapped 95% CI	*p*
Need Support (SOF)	Need Support Autonomy	1.000	0.00	0.980	(0.952, 1.003)	.001
Need Support (SOF)	Need Support Competence	1.200	0.065	0.962	(0.937, 0.984)	< .001
Need Support (SOF)	Need Support Relatedness	1.114	0.059	0.886	(0.851, 0.916)	.001
Need Support (SOF)	Need Satisfaction Autonomy	0.685	0.056	0.667	(0.590, 0.737)	< .001
Need Support (SOF)	Need Satisfaction Competence	0.292	0.045	0.457	(0.360, 0.551)	< .001
Need Support (SOF)	Need Satisfaction Relatedness	0.400	0.058	0.366	(0.272, 0.460)	< .001
Need Support (SOF)	Team Innovative Behavior	0.110	0.071	0.102	(-0.24, 0.229)	.108
Need Satisfaction Autonomy	Team Innovative Behavior	0.299	0.096	0.285	(0.104, 0.463)	.003
Need Satisfaction Competence	Team Innovative Behavior	0.201	0.123	0.119	(-0.012, 0.254)	.078
Need Satisfaction Relatedness	Team Innovative Behavior	0.199	0.055	0.202	(0.090, 0.311)	.000
Indirect effect: NSu → (NSa-A + NSa-C + NSa-R)	Team Innovative Behavior	0.343	0.055	0.318	(0.227, 0.417)	< .001
Total effect: NSu → (NSa-A + NSa-C + NSa-R)	Team Innovative Behavior	0.453	0.059	0.421	(0.331, 0.503)	< .001

Correlations		Covariance	Bootstrapped SE	Correlation	Correlation bootstrapped 95% CI	*p*
Need Support Autonomy	Need Support Competence	0.128	0.023	0.466	(0.338, 0.579)	< .001
Need Support Autonomy	Need Support Relatedness	0.178	0.033	0.362	(0.251, 0.467)	< .001
Need Support Competence	Need Support Relatedness	0.123	0.027	0.337	(0.215, 0.455)	< .001
Need Satisfaction Autonomy	Need Satisfaction Competence	0.475	0.064	0.466	(0.343, 0.595)	< .001
Need Satisfaction Autonomy	Need Satisfaction Relatedness	0.377	0.056	0.362	(0.260, 0.482)	< .001
Need Satisfaction Competence	Need Satisfaction Relatedness	0.341	0.066	0.337	(0.204, 0.469)	< .001

Multi-group testing

As shown in Table 8 and 9, weak invariance was achieved by constraining the factor loadings of all observed variables. There were only slight differences in the model fit indices for weak invariance when compared to the unconstrained/configural model. However, strong invariance was not achieved by constraining the factor intercepts of all observed variables. For the original hypothesized model, the strong invariance model demonstrated CFI and SRMR changes that were unacceptable according to the thresholds in Table 3. For the SOF model, only the CFI changed to an unacceptable level.

H2 was tested assuming weak invariance for the original model, and H2 was tested assuming both weak and strong invariance for the SOF model. In all cases, there were no significant shifts in model fit when the constraints for H2 were implemented. Therefore, H2 was not supported in any model.

Further exploration of the factor intercepts was performed to determine if the failure to achieve strong invariance was due to one scale, or all the scales in the model. First, weak constraints were placed on all scales (NSu, NSa, and TIB). Second, each scale had their factor intercepts individually constrained to be equal across both groups. As shown in Table 10, each scale demonstrated poor model fit after being constrained (relative to their degrees of freedom), meaning that the failure to obtain strong invariance was due to non-invariance across all the scales. TIB demonstrated cautious-poor invariance, and both NSu and NSa demonstrated unacceptable invariance.

Table 8.

Measurement invariance testing: Model comparisons with separate NSu dimensions

Model	χ^2 (*df*), ratio	*p*	CFI	SRMR	RMSEA (90% CI)
Baseline	892 (411), 2.17		0.957	0.0413	0.047 (0.043, 0.051)
Unconstrained/Configural	1409 (822), 1.71		0.942	0.0507	0.037 (0.034, 0.040)
Weak invariance	1444 (846), 1.71		0.941	0.0517	0.037 (0.033, 0.040)
(compared to unconstrained)	*35 (24), 1.46*	*.071*	*-0.001*	*0.0010*	*-0.00 (0.01, 0.00)*
Strong invariance	1670 (877), 1.90		0.922	0.1151	0.041 (0.038, 0.044)
(*compared to weak invariance)*	*226 (31), 7.29*	*<.001*	*-0.019*	*0.0634*	*0.005 (0.006, 0.005)*
Hypothesis 2: Weak + Autonomy paths constrained	1446 (851), 1.70		0.942	0.0518	0.036 (0.033, 0.040)
(compared to weak invariance)	*2 (5), 0.04*	*.835*	*0.000*	*0.0001*	*-0.01 (0.00, 0.00)*

Table 9.

Measurement invariance testing: Model comparisons with NSu as a second-order factor

Model	χ^2 (*df*), ratio	*p*	CFI	SRMR	RMSEA (90% CI)
Baseline	921 (419), 2.20		0.955	0.0413	0.048 (0.043, 0.052)
Unconstrained/Configural	1457 (838), 1.74		0.939	0.0513	0.037 (0.034, 0.041)
Weak invariance	1492 (862), 1.73		0.938	0.0531	0.037 (0.034, 0.040)
(compared to unconstrained)	*35 (24), 1.46*	*.057*	*-0.001*	*0.0018*	*-0.00 (0.00, 0.01)*
Strong invariance	1720 (893), 1.93		0.919	0.0572	0.042 (0.039, 0.045)
(*compared to weak invariance)*	*228 (31), 7.35*	*<.001*	*-0.019*	*0.0041*	*0.005 (0.005, 0.004)*
Hypothesis 2: Weak + Autonomy paths constrained	1493 (864), 1.73		0.938	0.0532	0.037 (0.034, 0.040)
(compared to weak invariance)	*1 (2), 0.50*	*.787*	*0.000*	*0.0001*	*-0.00 (0.00, 0.01)*
Hypothesis 2: Strong + Autonomy paths constrained	1724 (895), 1.93		0.919	0.0644	0.042 (0.039, 0.045)
(compared to strong invariance)	*4 (2), 2*	*.118*	*0.000*	0.0072	*0.000 (0.000, 0.000)*

Table 10.

Strong invariance testing each scale

Original hypothesized model				
Constraint level	**χ^2 (*df*), ratio**	**CFI**	**SRMR**	**RMSEA**
Weak invariance	1444 (846), 1.71	0.941	0.0517	0.037 (0.033, 0.040)
Weak + NSu strong constraints	1531 (858), 1.78	0.934	0.0588	0.039 (0.035, 0.042)
(difference to weak)	*87 (12), 7.25*	*0.009*	*0.0083*	*0.002 (0.002, 0.002)*
Weak + NSa Strong constraints	1636 (859), 1.90	0.924	0.1040	0.041 (0.038, 0.045)
(difference to weak)	*192 (13), 14.77*	*0.017*	*0.0523*	*0.004 (0.005, 0.005)*
Weak + TIB strong constraints	1498 (852), 1.76	0.937	0.0531	0.038 (0.035, 0.041)
(difference to weak)	*54 (6), 9.00*	*0.006*	*0.0024*	*0.001 (0.002, 0.001)*
NSu second-order factor model				
Constraint level	**χ^2 (*df*), ratio**	**CFI**	**SRMR**	**RMSEA**
Weak invariance	1492 (862), 1.72	0.938	0.0531	0.037 (0.034, 0.040)
Weak + NSu strong constraints	1579 (874), 1.81	0.931	0.0537	0.039 (0.036, 0.042)
(difference to weak)	*87 (12), 7.25*	*0.007*	*0.0006*	*0.002 (0.002, 0.002)*
Weak + NSa Strong constraints	1684 (875), 1.93	0.921	0.0564	0.042 (0.039, 0.045)
(difference to weak)	*192 (13), 14.77*	*0.017*	*0.0066*	*0.005 (0.005, 0.005)*
Weak + TIB strong constraints	1564 (868), 1.78	0.934	0.0535	0.039 (0.035, 0.042)
(difference to weak)	*72 (6), 12.67*	*0.004*	*0.0004*	*0.002 (0.001, 0.002)*

Discussion

This study aimed to examine whether the effect of SDT-based leadership behaviors on a team's innovative behavior is mediated by employee need satisfaction. All dimensions of NSa significantly predicted TIB, which is concurrent with previous studies and reviews of this relationship (Corzo & Contreras-Pacheco, 2024; Messmann et al., 2022). Due to potential issues with discriminate validity between NSu dimensions, two models were created to provide better interpretation of the results. The original pre-registered and hypothesized model retained the distinctiveness of the NSu scale and thus allowed the specific hypotheses within H1 to be tested. However, the multicollinearity issues inflate standard errors and increase Type II error rates, making interpretation of specific paths more difficult (Grewal et al., 2004). However, the remaining unique variance, whilst low, may still reflect strong associations. Thus, when interpreted with caution, the results demonstrate that the significant relationship between NSu-A and TIB is fully mediated by NSa-A, which confirms H1a. This further suggests that when managers encourage initiative and explain the purpose of their assigned tasks to their employees, then their employees will feel more autonomous and thus rate their team as more innovative. This finding is somewhat concurrent with the finding of Evers et al. (2024), who found that distributed leadership (otherwise known as sharing leadership responsibilities, and thus lending autonomy to their subordinates) significantly improved innovative behavior via mediating through NSa.

Whilst the mediation hypothesis of competence was not supported, NSu-C demonstrated a significant direct effect on TIB. This suggests that employees are more likely to rate their team as innovative and creative if they felt their managers supported their professional development, provided useful feedback, and clearly communicated tasks. This significant direct effect may reflect previous studies using leader-member exchange theory, which posits that the relationship between boss and subordinate is itself responsible for shaping behavior in the workplace (and thus, positive behavior from management creates positive behavior from employees) (Xie et al., 2020). Past research has drawn a strong link between this leader-member exchange and innovative behavior (Lee, 2008; Schermuly et al., 2013).

If all three NSu dimensions were combined into a second-order factor, then the relationship between NSu and TIB was fully mediated via NSa. This suggests that employees will rate their team as more innovative if they perceive their manager as supporting their basic needs. This result is concurrent with past research using the same mediation mechanism, but using leadership theories such as transformational leadership (which also share a similar theoretical mechanism of improved intrinsic motivation) (Messmann et al., 2022). Thus, the results of these models suggest that intrinsic motivation is a key component to innovative behavior (or even ratings of innovative behaviors), which is concurrent with behavioral models of innovation (Amabile & Pratt, 2016).

Hypothesis 2 was not supported, meaning that the autonomy permitted by the job did not influence the autonomy-related relationships between manager and employee. Whilst the previous research indicated that the participants worked in fairly non-autonomous roles (Eden, 2023), this did not appear to affect their ratings of their managers autonomy support or its relationship to TIB. This doesn't exactly contrast previous research, as their investigations of WDA look at the direct effect of WDA on need satisfaction (De Cooman et al., 2013) and innovative work behavior (De Spiegelaere et al., 2012). Nevertheless, the original aim of H2 was accomplished by controlling its

potential confounding influence by implementing it into the mediation model. Additionally, whilst the moderation hypothesis was not supported, it would be premature to assume that WDA has no influence on TIB. As previously specified, WDA could have a direct influence on innovative behavior. Future research with this sample or other samples can investigate this notion.

Need Support: Multi-dimensional or not?

It was hypothesized that managers would uniquely support each NSa dimension, and this could result in an increase in the innovative behavior of their team. However, when employees were rating the extent that their manager supported their basic needs, their ratings across each dimension were very similar. It was not unexpected to see high correlations between these constructs, but a correlation of 0.8-1 suggests that further interpretation of these constructs must be done cautiously (Rönkkö & Cho, 2022). Whilst the initial development of the NSu-WS gave supporting evidence for a three-factor solution for NSu (Tafvelin & Stenling, 2018), other studies have merged all three dimensions of this scale in some way. Kaabomeir et al. (2020) used NSu as a second-order factor to predict work motivation and engagement, and the same authors who developed the NSu scale also found high correlations between each dimension, necessitating a one-factor model for NSu (Stenling et al., 2024). In these studies, NSu was used as the predictor variable for a variety of outcomes. However, when other studies used NSu as an outcome, they were able to keep the NSu dimensions separated in their models (Tafvelin et al., 2019, 2023; Tafvelin & Stenling, 2021).

It remains unclear whether NSu is better represented by three factors or a single factor. This problem of distinctive dimensions in leadership theories is not a novel issue. In their summary of several meta-analyses and reviews, Bormann and Rowold (2018) acknowledge many discriminate validity problems in leadership research. Furthermore, they suggested that many leadership theories could be better served by integrating dimensions that exhibit very high shared variance. This same logic could be applied to the NSu scale, thus making a more parsimonious construct by using a second-order factor. However, researchers in SDT have stressed the distinctiveness of each NSa dimension (Deci & Ryan, 2000; McAnally & Hagger, 2024). If NSa can demonstrate distinct dimensions of autonomy, competence, and relatedness (particularly in this study), why can't NSu also have this distinctiveness in its dimensions?

There is a possibility that the collinearity of the NSu dimensions are due to various measurement problems, particularly through common method bias. Podsakoff et al. (2024) review and summarize many sources of potential bias that can inflate or deflate ratings. In particular, statistical biases such as the halo effect (where a positive impression in one domain influences perceptions in others) may have contributed to the high correlations observed among the NSu dimensions (Lefkowitz, 2000). For example, participants may have a globally positive or negative evaluation of their manager. This may lead them to rate their manager consistently across all dimensions, so that their ratings accurately reflect this "good manager". As a result, this doesn't provide nuance to the specific dimensions of NSu and thus does not demonstrate discriminate validity. Future studies could slightly alter the questions or obtain different types of data to converge on a more honest reflection of these NSu dimensions.

Limitations

The moderating effect of the WDA variable was investigated via a multi-group comparison, which creates theoretical problems in the analysis. By splitting the participants into two groups, it is assumed that a participant scoring a 1 for WDA is theoretically identical to someone scoring a 2.9. However, a person scoring a 2.9 is theoretically different to someone scoring a 3.1 on WDA. It is obvious that this is theoretically problematic; however, multi-group analysis must split the participants at some point, and it was decided that the most reasonable split would occur in the middle of the Likert scale. This limitation was driven by the limitations of the statistical software used, which does not allow for testing moderation of a continuous latent variable within a SEM.

Several limitations in obtaining important statistics were due to the limitations of AMOS. Data imputation was used instead of Full Information Maximum Likelihood (FIML) due to the limitations of AMOS. However, data imputation was justified due to the extremely low proportion of missing data after exclusion (0.4%), which is below the 5% threshold that may cause concern (Kline, 2016, p 82-83). Some tests were desired but unavailable. Heterotrait-Monotrait Ratio of Correlations (HTMT), and Average Variance Extracted (AVE) were not able to be collected in AMOS. Future research should consider using statistical programs that allow for a greater range of testing.

Another major limitation was the movement across levels of an organization by the variable TIB. All variables in this analysis were self-perceived behavioral/cognitive ratings from the participant. However, TIB was measured by rating the behavior of the team. Therefore, the level of analysis shifts from an individual basis to a team basis. This limitation can potentially cause wrong conclusions. It cannot be perfectly assumed that team innovation reflects personal innovative behavior. For example, one member of a team may not be innovative; but they may be part of a very innovative team, which results in their innovative behavior being rated as “high”. Thus, this person could inflate or deflate relationships with TIB.

However, self-ratings of innovative behavior also have the risk inaccurate measurement due to common method variance (variance is due to the measurement method instead of the constructs). A meta-analysis of self-ratings versus non-self-ratings of creativity demonstrated inflated observed correlations (or larger effect sizes) when creativity and its correlates are all self-rating measurements (Ng & Feldman, 2012). This effect was also present in an earlier meta-analysis of innovation at work (Hülsheger et al., 2009). It was further recommended in a state-of-the-science summary to move away from self-reports of innovation and creativity, due to the reasons listed before (Anderson et al., 2014). And lastly, in a study of self-ratings (including boss, peers, and other observers) of innovation, there were significant differences with self-ratings versus other raters, with self-ratings of innovative behavior being under-rated. Furthermore, the ratings of observers were correlated with each other, but self-report ratings were only correlated with ratings by peers, suggesting that there is greater consistency when ratings are not self-reports (Potočnik & Anderson, 2012). Therefore, there are advantages to the approach towards ratings teams rather than staying consistent with self-reports. Ultimately, the interpretation simply needs to be cognizant of the weaknesses and strengths of moving across levels in ratings.

Future directions

Future studies may also examine the longitudinal effects of NSu, NSa and TIB. A systematic review of 21 diary studies by Coxen et al. (2021) recognized that NSa can fluctuate on a daily and weekly basis. Future research can investigate whether the influence of leadership fluctuates, and whether perceptions of innovative behavior also change across time.

Additionally, further statistical analysis of this dataset could reveal interesting information from this sample. The data came from the LOOP project, which was a longitudinal study with a leadership training intervention. In addition, the survey used in this project examined several variables, such as job satisfaction, work motivation, and team effectiveness. It would be interesting to examine the influence of these variables on NSa and TIB. It would also be interesting to incorporate the effect of leadership training into a similar longitudinal model and determine whether leadership training further improved NSa and TIB after the intervention. Previous research has investigated a similar research question in a mixed-methods design, but no significant changes across time were found (Tafvelin & Stenling, 2021). However, the researchers identified several limitations in post-intervention interviews, such as the training lacked integration from the goals of the organizations, and uncharacteristically high workload during the intervention.

Finally, the TIB scale may benefit from more psychometric investigation, as the scale used in this study did not exhibit ideal model fit indices despite correlating residuals. Multiple scales measuring innovation have been developed that could be effectively used (Lukes & Stephan, 2017), and future studies should consider using various methods that converge to paint an accurate picture of innovation in the workplace

Conclusion

This analysis explored the influence of Need Support and Need Satisfaction on innovative behavior of front-line employees in the production context. Concurrent with previous research, these results emphasize the importance of leaders supporting the basic needs of their employees if they want to see innovative behavior in the workplace. Future research should be cautious about relying on traditional quantitative methods to examine leadership dimensions. It is recommended that future studies consider various methods to converge on and better capture the distinctiveness of Need Support dimensions.

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Appendix

Table 1.

Need Support at Work Scale (NSu-WS)

The following statements concern how you perceive your supervisor. For each statement mark the response that best represents your experiences. My supervisor:	Never/Hardly ever	Seldom	Sometimes	Often	Always	Mean (SD)
Need Support – Autonomy						
13. Tries to understand my perspective before stating his/her opinion.	1	2	3	4	5	3.48 (1.03)
14. Always explains the purpose of the tasks he/she asks me to do.	1	2	3	4	5	3.56 (1.05)
15. Encourages me to take my own initiative at work.	1	2	3	4	5	3.42 (1.16)
16. Allows me to choose the way I see best to perform my tasks at work.	1	2	3	4	5	3.23 (1.20)
Need Support – Competence						
17. Provides me with the support I need to develop at work.	1	2	3	4	5	3.24 (1.23)
18. Clearly communicates the goals for my work.	1	2	3	4	5	3.43 (1.14)
19. Provides me with opportunities to further develop my competencies.	1	2	3	4	5	3.08 (1.28)

The following statements concern how you perceive your supervisor. For each statement mark the response that best represents your experiences. My supervisor:	Never/Hardly ever	Seldom	Sometimes	Often	Always	Mean (SD)
20. Provides me with feedback that is useful in my work.	1	2	3	4	5	3.11 (1.19
Need Support – Relatedness						
21. Shows that he/she really listens to what I have to say.	1	2	3	4	5	3.59 (1.16)
22. Shows that he/she cares about me.	1	2	3	4	5	3.54 (1.24)
23. Always takes time to talk to me.	1	2	3	4	5	3.72 (1.13)
24. Shows that he/she appreciates me as an individual.	1	2	3	4	5	3.63 (1.18)

Table 2.

Need Satisfaction at Work Scale (NSu-WS)

The following statements concerns how you perceive your work and your work place. Please indicate in which degree you agree with these statements:	Totally disagree	Disagree	Somewhat disagree, somewhat agree	Agree	Totally agree	Mean (SD)
Need Satisfaction – Autonomy						
33. I can handle the challenges I face in my job	1	2	3	4	5	2.97 (1.05)
34. I can express who I am at my job.	1	2	3	4	5	3.66 (1.03)
35. I have the possibility to influence my situation at work.	1	2	3	4	5	2.94 (1.14)
36. What I do at my job is in line with who I am.	1	2	3	4	5	3.00 (1.20)
Need Satisfaction – Competence						
37. I can handle the challenges I face in my job.	1	2	3	4	5	4.17 (0.84)
38. I constantly improve at dealing with my job tasks.	1	2	3	4	5	4.01 (0.94)
39. I feel effective at my job.	1	2	3	4	5	3.93 (0.98)
40. I really feel skilled at my job.	1	2	3	4	5	3.98 (0.87)
Need Satisfaction – Relatedness						
41. I feel that I can trust the people I work with.	1	2	3	4	5	3.64 (1.07)

The following statements concerns how you perceive your work and your work place. Please indicate in which degree you agree with these statements:	Totally disagree	Disagree	Somewhat disagree, somewhat agree	Agree	Totally agree	Mean (SD)
42. I feel close to the people I work with.	1	2	3	4	5	3.54 (0.97)
43. I enjoy being with the people I work with.	1	2	3	4	5	3.95 (0.89)
44. I experience that the people I work with really care about me.	1	2	3	4	5	3.55 (1.01)
45. I feel safe with the people I work with.	1	2	3	4	5	3.89 (0.94)

Table 3.

Team Innovative Behavior scale

This section is about the creativity of the work team. By creativity we mean that creates new ideas and results that may be useful.	Not at all	To a small extent	Partially	To a large extent	To a great extent	Mean (SD)
Team Innovative Behavior						
110. This team is looking for new technology and new processes, techniques and/or product ideas.	1	2	3	4	5	2.81 (1.09)
111. This team creates creative ideas.	1	2	3	4	5	3.07 (1.06)
112. This team brings forward ideas and anchors them in others.	1	2	3	4	5	3.11 (1.00)
113. This team is trying to get financing to be able to implement new ideas.	1	2	3	4	5	2.50 (1.07)
114. This team develops appropriate plans and timetables for the implementation of new ideas	1	2	3	4	5	2.82 (1.04)
115. This work team is inventive.	1	2	3	4	5	3.19 (1.02)

Table 4.

Work Design Questionnaire – Work Design Autonomy dimensions

The questions in this section are about the characteristics of the job itself. Using the scale below, indicate the extent to which you agree with each statement. Remember to think only about the work itself, rather than how you react to the work	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Mean (SD)
Work scheduling autonomy						
78. The job allows me to make my own decisions about how to schedule my work	1	2	3	4	5	2.01 (1.17)
90. The job allows me to decide on the order in which things are done on the job	1	2	3	4	5	2.58 (1.19)
98. The job allows me to plan how I do my work.	1	2	3	4	5	2.49 (1.18)
Decision making autonomy						
81. The job gives me a chance to use my personal initiative or judgment in carrying out the work.	1	2	3	4	5	2.50 (1.18)
91. The job allows me to make a lot of decisions on my own.	1	2	3	4	5	2.48 (1.16)
93. The job provides me with significant autonomy in making decisions.	1	2	3	4	5	2.93 (1.11)
Work Methods Autonomy						

The questions in this section are about the characteristics of the job itself. Using the scale below, indicate the extent to which you agree with each statement. Remember to think only about the work itself, rather than how you react to the work	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Mean (SD)
71. The job allows me to make decisions about what methods I use to complete my work.	1	2	3	4	5	2.65 (1.18)
80. The job gives me considerable opportunity for independence and freedom in how I do the work.	1	2	3	4	5	2.24 (1.10)
82. The job allows me to decide on my own how to go about doing my work.	1	2	3	4	5	2.38 (1.19)