

Research on the Impacts of Humble Leadership on R&D Team Innovation Performance based on the Social Information Processing Perspective

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Abstract. Based on the social information processing theory, the present takes paired data of 512 employees and their immediate supervisors in 139 R&D teams as a sample, which aims to examine the influence and mechanisms of humble leadership on the R&D team innovation performance. The results show as follows: humble leadership has a significant positive effect on team psychological safety; team psychological safety partial mediates the relationship between humble leadership and R&D team innovation performance; task interdependence moderates the positive effect of the humble leadership on R&D team innovation performance via team psychological safety. That is, when the task interdependence is high, the positive indirect effect was stronger than the condition when the task interdependence was low.

Keywords: Humble Leadership; R&D Team Innovation Performance; Team Psychological Safety; Team Task Interdependence.

1. Introduction

Faced with competitions and uncertainties in the context of globalization, the companies were in a tough situation. The team is the unit of innovation work [1], R&D personnel are the main force of team innovation, Team innovation performance is an important indicator of the R&D team success [2]. Therefore, this research explores the antecedents and boundary conditions that affect the R&D team innovation Performance.

First, according to social information processing theory (SIP), social cues in the environment affect individuals' perceptions and responses to the environment[3]. Team leadership is an organizational factor that related to employees closely, affecting members to obtain resources and information, member interaction, and task execution[4]. In addition, creative componential theory found that leaders' attention to one's contribution and leaders' feedback can influence the creativity of workers[5]. Research shows that shared, paternalistic leadership influences team innovation [4]. Humble leadership as a new type of supportive leadership style[6], there are few empirical studies on relationship between humble leadership and team innovation [6]. Therefore, this paper explores the impact of humble leadership on the R&D team innovation performance. Second, the team climate theory emphasized that participative safety affects team innovation [7]. Psychological safety reflects the participative safety, and the individual's psychological safety will "Bottom-up" through the communication between employees, and finally forms a team-shared atmosphere [8]. Therefore, this research explores the mediating role of team psychological safety between humble leadership and R&D team innovation performance. Finally, Contingency model emphasizes that task structure affects organizational performance [9]. Task interdependence is one of the characteristics of the task structure that influence organizational performance. Thus, we intend to investigate the moderating effect of task interdependence in the relationship between humble leadership and R&D team innovation performance.

2. Theory and Hypotheses

2.1 Social Information Processing Theory

Social information processing theory emphasized that social clues in the environment affect the individual information processing. As a source of information, leadership is related to R&D team

employees, shaping member's perception, attitudes and behavior [3]. At the same time, team members imitate leader's behavior and adjust their social interactions, which helps members to form team shared beliefs and improve innovation performance.

2.2 Leadership and Team Psychological Safety

Team psychological safety is the state in which individuals show themselves in the team without fearing of rejection and criticism [10]. According to SIP, leadership style affects the formation of employee team psychological safety. First, humble leaders affirm the strengths, contributions and abilities of others [11]. Humble leaders respect, care for subordinates and maintain harmonious interpersonal relationships with them. Second, humble leaders embrace new ideas [11], encouraging R&D personnel to access new information. Finally, for the uncertainty and mistakes in the innovation process, humble leaders understand and tolerate R&D personnel's trial [11], which are beneficial to improve the subordinates' psychological safety. Individual psychological safety has risen to the team psychological safety through team interaction, communication and cooperation [8], R&D personnel form a shared perception of team psychological safety. Thus, we propose:

H1: Humble leadership will positively be related to the R&D team psychological safety.

2.3 The Mediating Effects of Team Psychological Safety

The innovation process is accompanied by ambiguity and danger. R &D personnel with a sense of psychological safety dare to take risks, seek help, overcome difficulties and finally solve problems creatively. Xinghui Lei concludes that psychological safety can enhance innovation performance [6]. Therefore, combining the discussion of relationship between humble leadership and the R&D team psychological safety, we propose:

H2: Team psychological safety will mediate the relationship between humble leaders' hip and R&D team innovation performance.

2.4 The Moderating Effects of Team Task Interdependence

The contingency theory believes that the task structure affect team performance [9]. Task interdependence is one of the characteristics of the task structure, which refers to the extent to which individuals rely on the information, materials and support provided by team members to complete their work [12]. The R&D team stress the innovative integration of knowledge and information and cooperation.

For team with high task interdependence, members rely on the team and generate more communication and information sharing behaviors to finish the work efficiently [14]. R&D personnel's perception of humble leadership behavior depends on the level of task interdependence. As individual interactions and shared insights behaviors increasing, the influence of leadership style on individuals extends to the team level [8]. In this situation, leaders play the role of task assignment, at the same time, communication between leaders and subordinates also increase. These make it easier for employees to obtain supporting and guiding from leader [15], and it is easier to improve the psychology safety of R&D personnel. In the process of interaction with each other, members imitate leadership humility behavior, for example, respecting, caring for, accepting colleagues and tolerating colleagues' mistakes. These actions are beneficial to the establish the trust between R&D personnel. In the process of R&D personnel's sharing of emotions and of resources, psychological safety emerged from the individual level to the group level [8]. The relationship between humble leadership and team psychological safety is reinforced.

In contrast, for team with low task interdependence, team members tend to work independently and display their knowledge and skills to others, and the internal cooperation needs are reduced [13]. At the same time, due to the lack of interaction opportunities, the opportunities for R&D personnel to imitate humble behavior in team interaction are also decreased. The influence of humble leadership behavior is limited to the individual level [8]. It is not easy for R&D personnel to understand each other's' strengths and weaknesses, and it is difficult for them to accept team members' trial. R&D personnel therefore have to take on more interpersonal risks in the innovation process. It is hard to

form a team-shared atmosphere of psychological safety through a limited team interaction. Therefore, the relationship between humble leadership and team psychological safety is weakened.

H3: Team task interdependence will moderate the relationship between humble leadership and R&D team psychological safety; the relationship will be more strongly positive when team task interdependence is higher.

2.5 The Moderated Mediation Model

In this study, because we predict that the team task interdependence will moderate the previously hypothesized relationships, we also expect that it will conditionally influence the strength of the indirect effect between humble leadership and R&D team innovation performance. Consistent with our hypothesized model, we predict a moderated-mediation pattern whereby the indirect effect of humble leadership and R&D team innovation performance that occurs through psychological safety will depend on the moderator, team task interdependence. Thus, we propose:

H4: Team task interdependence will moderate the indirect effect of humble leadership and R&D team innovation performance (via psychological safety); the mediated relationship will be stronger when team task interdependence is high as opposed to low and will be weaker when team task interdependence is low as opposed to high. Thus, the theoretical model is shown in Figure 1.

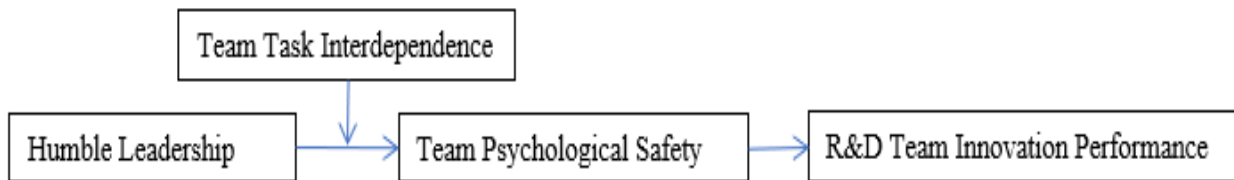


Figure 1. Theoretical Model

3. Method

3.1 Sample and Procedure

Our sample is from a R&D teams of pharmacy company in Shandong province. To reduce the impact of common method variance, both leaders and R&D personnel participated in the survey. Data were collected in the free day according to participants' schedule, and the questionnaires of the leaders and R&D personnel were matched. The humble leadership, team task interdependence, and team psychological safety questionnaires are finished by the R&D staff, and the leaders evaluate the team's innovation performance. After removing the invalid questionnaire, there are 139 leadership questionnaires (response rate=89.68%) and 512 researchers' questionnaires (response rate=93.09%).

The size of team is 3 to 5, and the average size is 3.68 (SD=0.4). Among the 512 team members, 60.4% were male, 39.9% had an undergraduate degree or higher, 73.12% has served for 0 to 5 years, 19.53% has served for 6 to 10 years and 10.35% has served for 10 years or more. Among the 139 team leaders, 88.5% were male, 21.58% had an undergraduate degree or higher 39.57% has served for 0 to 5 years, 50.36% has served for 6 to 10 years and 10.07% has served for 10 years or more.

3.2 Measures

A 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree) was used to measure all main variables in our study. We asked them to translate all original English measures into Chinese using the translation and back-translation procedure.

Humble leadership: We measured humble leadership using scale proposed by Owens et al [11], which include 9 items. A sample item is "Even if feedback is critical, leaders also actively seek feedback". Cronbach's α for this scale was .96.

Team task interdependence: We measured team task interdependence using 3 items from Campion et al [14]. A sample item is "If I don't have the information and materials provided by other members of the team, I can't complete my task". Cronbach's α for this scale was .89.

R&D team innovation performance: We measured R&D team innovation performance using 4 items from De Dreu [15]. A sample item is “team members always put new ideas into practice to improve the quality of products and services”. Cronbach’s α for this scale was .95.

Psychological safety: We measured psychological safety using 5 items from Liang et al [10]. A sample item is “In my team, I can express the real feelings related to work.” Cronbach’s α for this scale was .95.

3.3 Control Variables

We collected participants’ demographic information (gender, degree, term, size) in the survey.

3.4 Results

3.4.1 Harman's Single-Factor Test

In order to control the common method variance, we use the Harman's Single-Factor Test. Through the unrotated principal component analysis of all the items in the study, it is found that the first principal component in the exploratory factor analysis only explains 37.1% variance, which is lower than 50%[16], indicating that most of the variation cannot be explained by a single factor, and the common method variance has limited impact in this study.

3.4.2 Construct Validity Evidence

We conducted a series of confirmatory factor analyses (CFAs) in Amos to examine the construct validity of our variables at the individual level. As shown in Table 1, we can see Model 1 shows the well fit indices ($\chi^2=618.216$, $df=183$, $\chi^2/df=3.378$, $GFI=0.902$, $TLI=0.934$, $CFI=0.948$, $RMSEA=0.068$). And, the other models show worse fit than model 1. These results supported the discriminant validity of our variables.

Table 1. Comparison of Measurement Models

Model	Factors	χ^2	df	χ^2/df	GFI	TLI	CFI	RMSEA
Model1	Three factors: HL+TPS+TI	472.76	116	4.08	.91	.95	.95	.07
Model2	Two factors: HL+TPS, TI	1740.25	118	14.75	.66	.75	.78	.16
Model3	Two factors: TPS+TI, HL	1376.72	118	11.67	.78	.80	.83	.14
Model4	One factor: HL+TPS+TI	2643.82	119	22.22	.59	.61	.66	.20

Note: HL (Humble leadership), TPS (Team Psychological Safety), TI (Team Task Interdependence).

3.4.3 Aggregation Analysis

Because humble leadership, team psychological safety, team task interdependence are team-level constructs, we aggregated members’ responses to team-level variables. To justify aggregation, this research conducted one-way ANOVA based on team membership for these three variables. The results showed that all individual variables had significantly sufficient variance across teams to justify aggregation. Then, this study checked within group inter rater agreement (Rwg) for the individual level variables. To justify aggregation, this study further calculated intraclass correlation coefficients (ICC (1) and ICC (2)) for each variable. The aggregation indicators are as follows: humble leadership (ICC(1)=0.68; ICC(2)=0.89, Rwg=0.94); team psychological safety (ICC(1)=0.65; ICC(2)=0.88, Rwg=0.92); team task interdependence (ICC(1)=0.68; ICC(2)=0.9, Rwg=0.9). All of these values surpassed a cut-off of ICC(1) for 0.12, ICC (2) for 0.6 and Rwg for 0.7 respectively [17]. Therefore, this research aggregates these individual perceptions to the team-level variables.

3.4.4 Descriptive Statistics

Table 2 reports descriptive statistics and the correlations among all the study variables. We can see that humble leadership is positively related to team psychological safety ($\beta=0.29$, $p<0.01$), and

R&D team Innovation performance ($\beta=0.40$, $p<0.01$). The mediator, team psychological safety, was also positively related to R&D team Innovation performance ($\beta=0.5$, $p<0.01$).

Table 2. The Descriptions and Correlations of Main Variables.

Variables	Mean	SD	1	2	3	4	5	6	7	8
1.Degree	2.06	0.26	1.00							
2.Size	3.20	0.40	.10	1.00						
3.Term	6.10	6.59	-.03	.11	1.00					
4.Gender	.88	.32	-.01	.18*	.07	1.00				
5.HL	3.69	.82	.02	.41**	.12	.27**	1.00			
6.TI	3.76	.85	.01	.22**	.13	.188*	.35**	1.00		
7.TPS	2.71	.70	.08	.28**	-.07	.04	.29**	.08	1.00	
8TIP	2.52	1.24	.02	.35**	-.04	.06	.40**	.21*	.50**	1.00

Note: HL (Humble leadership), TPS (Team Psychological Safety), TI (Team Task Interdependence); TIP (R&D Team Innovation Performance), *** $p<.001$, ** $p<.01$, * $p<.05$.

3.4.5 Hypotheses Testing

The results from our tests of H1, H2 are reported in Table 3. We examined H1 in Model 2; we can see that humble leadership was positively related to team psychological safety ($\beta =0.27$, $p <.01$). Thus, H1 was supported. In addition, we examined H2 in Model 8, we can see team psychological safety was positively related to R&D team innovation performance ($\beta =0.07$, $p <.001$). Thus, H2 got preliminary supported.

Note: HL (Humble leadership), TPS (Team Psychological Safety), TI (Team Task Interdependence); TIP (R&D Team Innovation Performance)

*** $p<.001$, ** $p<.01$, * $p<.05$

To test H2, we conducted a bootstrapping-based mediation test using the PROCESS macro [19]. As shown in Table 4, Results revealed that humble leadership was associated with R&D team innovation performance, mediated by team psychological safety (indirect effect =.13, 95% CI = .03 to .28). Because the direct effect of humble leadership on the R&D team innovation performance is significant (direct effect = .36, 95% CI = .14 to .57). Thus, team psychological safety partially mediated the relationship between humble leadership and R&D team innovation performance, H2 was supported.

Table 3. Results of Regression Analyses.

	TPS				TIP			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Controls								
Degree	.03	.024	.023	-.039	.005	-.002	.001	.006
Term	-.003	.03	.039	.097	-.208	-.168	-.186	-.198
Size	.32***	.23*	.238*	.18*	.33***	.23**	.22*	.092
gender	-.004	-.057	-.053	-.016	-.001	-.063	-.071	-.047
Independent variable								
HL		.27**	.281**	.39***		.319***	.29**	.146*
Mediator								
TPS								.07***
Moderator								
TI			-.043	.016*			.088	.241
Interaction								
HL×TI				.35***				
R2	.10	.16	.16	.25	.15	.23	.23	.41
ΔR2	.10	.05	.002	.01	.15	.08	.01	.18
F	3.01*	4.05**	3.48**	5.47***	4.62***	6.36***	5.61***	9.89***

Table 4. Mediation test for team psychological safety

	Effect	BootSE	95%CI
Direct effect (HL→TIP)	.36	.11	[.14,.57]
HL→TPS→TIP	.13	.63	[.03,.28]

Note: HL (Humble leadership), TPS (Team Psychological Safety), TIP (R&D Team Innovation Performance).

We tested H3 by examining the interactive effect of humble leadership and team task interdependence on R&D team innovation performance. In Step 1, as shown in Table 3, we can see both humble leadership ($\beta = .27, p < .01$) (Model 2) and team task interdependence ($\beta = .016, p < .05$) (Model 4) were positively related to team psychological safety. In Step 2, results suggested that after the inclusion of the interaction term, the model explained significantly more variance (adjusted $R^2 = .25$; $\Delta R^2 = .10, p < .001$) and that the interaction term was significant ($\beta = .35, p < .001$). To aid interpretation, we finished the simple slope test according to the procedure recommended by Aiken and West [18]. We plotted the interaction effect in Figure 2 and it was in the expected direction. Thus, H3a was supported.

Table 5. Simple Slope Test

Team task interdependence	Team psychological safety	
	B	t
High	.43	5.56***
Low	.11	1.76

*** $p < .001$, ** $p < .01$, * $p < .05$

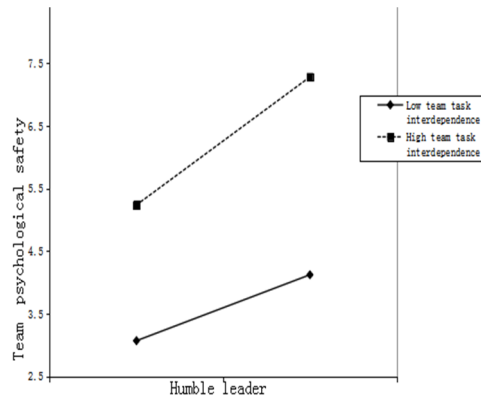


Figure 2. The Moderating Role of Team task interdependence in the Relationship between Humble leadership and Team psychological safety

To test H4, as shown in Table 6, we utilized the methods of Hayes to test H4 in an integrative fashion at one standard deviation above and below the mean of the moderator (i.e., team task interdependence) [20]. When team task interdependence was high, the mediated model was significant (conditional indirect effect = .32, 95% CI = .14 to .53). When team task interdependence was low, however, the mediated model was not significant (conditional indirect effect = .05, 95% CI = -.05 to .18). As shown in Table 7, the index of moderated mediation was likewise significant (Index = .14, 95% CI = .06 to .26). Thus, H4 was supported.

Table 6. Moderated Effect Test Moderated Mediation Test

	Effect	BootSE	95%CI
	.05	.06	[-.05,.18]
Team psychological safety	.19	.07	[.07,.34]
	.32	.10	[.14,.53]

Table 7. Moderated Mediation Test

	Index	Boot SE	95%CI
Team psychological safety	.14	.52	[.06,.26]

4. Discussion

Drawing from the social information processing theory, team climate theory and the contingency model, and constructs a moderated mediation model. The study found that humble leadership have a significant positive impact on team psychological safety, and team psychological safety plays a partial mediation role in the relationship between humble leadership and R&D team innovation performance. Team task interdependence moderated the relationship between the humble leadership and the team psychological safety. In addition, team task interdependence plays a moderating role in the overall

model; that is, high task interdependence will strengthen the relationship between humble leadership and team psychological safety; on the contrary, the effect is not significant.

4.1 Theoretical Implications

Our findings provide several theoretical implications. First, we found that humble leadership was positively related to R&D team innovation performance. The study also enriches the empirical research of humble leadership, the study of the antecedent variables of creativity, and advances the development of social information processing theory. Second, this study emphasizes that the impact that humble leadership have on individual emerges at the group level. This research found new antecedent variable of team psychological safety and a new perspective for humble leadership research. Third, the impact of humble leadership on the R&D team innovation performance is moderated d by team task interdependence. The study found that a new situation factors that influence the relationship between humble leadership and R&D team innovation performance, which enriched the related research of contingency theory.

4.2 Practical Implications

Our findings also have practical implications. First, through the training of humble leadership behavior, leader demonstrate humble behavior properly and drive subordinates to follow, and improve the innovation performance of R&D team ultimately. Second, managers should be aware that team psychological safety is an important component of the team climate. Leader must establish a harmonious relationship with their subordinates, which is helpful of team innovation. For example, leaders need to accept employees' trials and create a safe team atmosphere for innovation. In addition, managers need to meet the employees' work needs and psychological needs, enhance their psychological safety, and enable them to reach their full creative potential. Finally, managers should improve task interdependence in the process of task setting and goal setting, which is conducive to R&D personnel interaction and knowledge sharing.

4.3 Limitations and Future Research

Although the results are generally consistent with all predictions in our study, it is important to note some limitations that present opportunities for future research. First, the data collected by the questionnaire investigation, which may be affected by the common method variance. Future work can use vertical design or experimental methods. Second, the sample was from the R&D team of a Shandong enterprise, which decreased the external validity of the study. The study was conducted in the context of Chinese culture and lacked cross-cultural applicability. Future research can increase sampling flexibility. Third, researchers can explore other boundary conditions, such as the leader-member exchange in the contingency model.

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