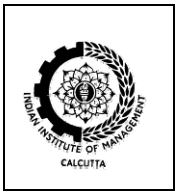

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Leadership and Creativity in Research and Development Laboratories: A New Scale for Leader Behaviours

by

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LEADERSHIP AND CREATIVITY IN REASERACH AND DEVELOPMENT LABORATORIES: A NEW SCALE FOR LEADER BEHAVIOURS

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ABSTRACT

Using a qualitative approach Gupta and Singh (in press) developed an inventory of leader behaviors that promote employee creativity. In this study, we construct and validate scales that can measure the leader behaviors proposed by Gupta and Singh (in press) quantitatively. We surveyed 584 scientists working in 11 Indian R&D laboratories for this purpose. Exploratory and confirmatory factor analyses revealed five creativity enhancing leader behaviours - task-oriented, recognising and inspiring, empowering, team-building and developing, and leading-by-example. We discuss the implications of the study findings for future research and management practices.

Keywords: Leadership; leader behaviours; employee creativity; R&D management.

INTRODUCTION

Research and Development (R&D) work is a driving force of the global economy and the main source of scientific breakthroughs (Dewett, 2007). R&D teams provide an organisation with competitive advantage by generating, deploying, transferring, and integrating new technological knowledge (Ángel & Sánchez, 2009). Employee creativity, typically defined as the production of novel and useful ideas for organisational products, services, or processes (Amabile, 1983; Zhang & Bartol, 2010), has become one of the key drivers of growth, performance, and valuation in organisations today. Engaging in behaviours that drive creative process and outcomes is an integral part of an R&D professional's role requirement (Montag, Maertz & Baer, 2012). The identification of key factors that can foster and sustain R&D professionals' engagement in creative behaviours carries significant implications for enhancing organisational competitiveness (Manolopoulos, 2006; Zheng, Khoury & Grobmeiher, 2010). In recent years, research on knowledge workers and knowledge-intensive firms such as R&D firms is proliferating (Khatri, Baveja, Agrawal & Brown, 2010). Alvesson (2000) defines knowledge-intensive firms as firms where most work can be said to be of an intellectual nature and where well-educated employees form the major part of the workforce. Scholars argue that knowledge workers, such as R&D professionals, cannot be managed effectively by employing the same leadership and management practices that are used to manage factory workers (Khatri et al., 2010).

In R&D teams, leaders manage more educated and creative employees. They deal with uncertain goals and performance targets and often have more experience in technical rather than managerial tasks (Elkins & Keller, 2003). The self-image of R&D employees is usually that of individuals who make things work, avoid waste of time, capital, and labour, and are independent in thought and action. When an occupational group sees itself, and is seen by others, as playing

the critical role in the achievement of broader societal goals, it tends to demand quite different kind of authority relationships as compared to those that are seemingly performing less critical roles (Clarke, 2002; Elkins & Keller, 2003; Kakar, 1971). These characteristic of R&D professionals pose unique challenges to leadership. There is, however, little empirical research about the skills necessary to lead R&D professionals (Berson & Linton, 2005). The purpose of the present study is to examine the behaviours of R&D leaders and to establish an empirical basis for understanding their effectiveness in today's R&D organisations. We build on a set of studies that were carried out in government-owned R&D laboratories in India and develop scales to measure leadership that is sensitive to the requirements of R&D professionals, teams, and departments. Specifically, the study aims to identify the important leader behaviours that encourage creativity in a R&D work environment.

LITERATURE REVIEW

Measuring Leadership in R&D Environments

Researchers studying the impact of leader behaviours on employee creativity continue to use an available, "validated" questionnaire for their research without careful consideration about the relevance of the content for their research question and sample (e.g. Gong, Huang & Farh, 2009; Jung, Chow & Wu, 2003; Zhang & Bartol, 2010). Most of the studies testing the impact of leadership on employee creativity are inspired by the popular two-factor behavioural conceptualisations (e.g. initiating structure/task-oriented and consideration/relation-oriented – Blake & Mouton, 1964; Fleishman, 1953; transformation and transactional – Bass, 1985). The apparent differences between the leadership requirements of traditional and R&D environments suggest that conventional measures of leadership may apply only partially to empowered environments (i.e. R&D) (Arnold, Arad, Rhoades & Drasgow, 2000; Khatri, 2005; Yukl, 1999,

2008). For example, Yukl (1999) observed that the transformational leadership, as conceptualized by Bass (1985) and measured by the popular Multifactor Leadership Questionnaire (Bass & Avolio, 1990), does not include behaviours like inspiring, developing, empowering, team building, and leading by example, that may be important for R&D teams. Thus, a new behavioural measure of leadership that is sensitive to the requirements of R&D environment is needed.

Gupta and Singh (in press) identified a set of leader behaviours that may impact employee creativity in the R&D context. The item inventory was derived through an inductive, or bottom-up, investigation of leadership behaviour in R&D laboratories across India. Such an approach circumvents the difficulties associated with a reliance on possibly incomplete or poorly integrated theory and research, and should improve the comprehensiveness and validity of a leader behaviour instrument (Arnold et al., 2000; Khatri, Templer, & Budhwar, 2012). The study was based on in-depth interviews conducted with 52 scientists of five Indian R&D labs located in different parts of India. The interview transcripts were content coded and a list of behaviour items were generated. The list of items was given to five doctoral students to sort them into different behaviour categories. Each incident was coded using a modified version of the leader behaviour taxonomy presented in the Managerial Practices Survey (MPS) (Yukl, Wall & Lepsinger, 1990). Based on the consistency score, a final list of 52 behaviour items representing 13 behaviour categories was generated. The leader behaviours identified included the following: clarifying, problem-solving, monitoring, buffering, inspiring, supporting, developing, informing, recognising, consulting, delegating, team building, and leading by example. The identified leader behaviours along with their definitions are presented in Table 1.

Table 1. Leader Behaviours Identified by Gupta and Singh (in press)

Behaviour	Definition
Task-OrientedBehaviours	
Clarifying	Assigning tasks, providing directions about how to do the work, and communicating a clear understanding of job responsibilities, task objectives, deadlines, and performance expectations.
Problem Solving	Identifying work-related problems, pointing out problems and giving suggestions to improve, and acting decisively to implement solutions to resolve important problems or crises.
Monitoring	Gathering information about work activities and external conditions affecting the work, checking on the progress and quality of the work, evaluating the performance of individuals through regular meetings.
Buffering	Serving as the main buffer between their teams and the labs, in order to filter down unnecessary administrative duties to protect staff time, while ensuring communication between the lab and the members.
EmpoweringBehaviours	
Consulting	Checking with people before making changes that affect them, encouraging suggestions for improvement, inviting participation in decision making, and incorporating the ideas and suggestions of others in decisions.
Empowering	Allowing subordinates to have substantial responsibility and discretion in carrying out work activities, handling problems, and making important decisions.
Relation-OrientedBehaviours	
Inspiring	Using influence techniques that appeal to emotion or logic to generate enthusiasm for the work, commitment to task objectives, and compliance with requests for cooperation, assistance, support, or resources.
Supporting	Acting friendly and considerate, being patient and helpful, showing sympathy and support when someone is upset or anxious, and being like a friend.
Developing	Shows concern for development, helps identify skill deficiencies, does things to facilitate a person's skill acquisition, professional development, and career advancement, and allows access to resources and facilities.
Recognising	Providing praise and recognition for effective performance, significant achievements, and special contributions, and expressing appreciation for someone's contributions and special efforts.
Informing	Disseminating relevant information to people who need it to do their work, providing written materials and documents, and answering requests for technical information.
Team BuildingBehaviours	
Team Building	Facilitating the constructive resolution of conflict, and encouraging cooperation, teamwork, and identification with the work unit.
Leading by ExampleBehaviours	
Leading by Example	Sets high standards of behaviours, works hard, and leads by example in terms of punctuality, doing work, meeting deadlines, and optimization of time.

In the present investigation, we describe the validation of the item inventory developed by Gupta and Singh (in press) for measuring effective leadership in R&D environments. We perform a quantitative analysis of the behavioural items to provide evidence regarding the underlying factor structure and assess the psychometric properties using data collected from professionals working in 11 R&D laboratories across India.

METHOD

Participants

The research study was conducted in 11 R&D labs of the largest civilian research organization in India. With 37 laboratories and more than 5,000 researchers, the organisation is one of the world's largest collections of industrially-oriented public research labs and is India's main producer of scientific and technical publications and patents (Dahlman, Dutz & Goel, 2007). The laboratories were sampled from the set of 37 R&D labs such that at least two labs operating in each of the major research domains of the organisation, namely, biological sciences, chemical sciences, physical sciences, and engineering sciences were selected. The data were collected using a survey questionnaire. One of the researchers stayed at each laboratory for about one week. The survey was distributed to the scientists who were present during the period the researcher visited the laboratories. Anonymity of responses was ensured as respondents were not asked to write their names or any other identifiable information. Respondents were assured that the data will be kept confidential and only a consolidated report will be submitted to the management. Each respondent was given an envelope where he/she could seal the filled form and return the sealed envelope to the researcher. Name or any other specific details were not asked to be mentioned on the envelope. Out of 1,260 distributed surveys, 584 usable surveys were returned. All cases where subordinates had been associated with a senior for less than 2

years were dropped from the sample to ensure that subordinates knew their leader's leadership style very well. Table 2 presents the demographic details of the sample.

Table 2. Demographic Details of the Study Sample

Variable	M	SD
Years of service (in years)	13.4	10.5

Variable	Percentage (%)
Gender	
Male	75%
Female	25%
Education	
Graduation	5%
Post-graduation	33%
PhD/Post-doc/MD	62%
Job level[a]	
Junior-level scientist	41%
Middle-level scientist	39%
Senior-level scientist	20%
N=584	

Measure

R&D Leader Behaviours

R&D leader behaviours were measured using the 55 item inventory developed by Gupta and Singh (in press) based on in-depth interviews carried out at R&D laboratories in India. Each scientist was asked to rate how frequently his/her leader exhibited the listed behaviours. The responses were measured using a 5-point Likert scale (1 = *not at all*, 5 = *great extent*). Before conducting the large sample survey, the leader behaviour items were tested for their clarity and redundancy. The survey was administered in 3 of the 11 R&D laboratories chosen for the study. One hundred and seven responses were collected. Scientists were given an option of marking '?' (*not applicable*)against the leader behaviour items that they felt were not applicable in their organizational context or whose meaning was ambiguous. The items that were marked as 'not applicable' most number of times within a behaviour category were dropped from the item list.

Doing this reduced the list of behaviour items from 55 to 39. The list of retained and dropped items is provided in Table 3. The remaining 39 items were then used in the final survey.

Table 3. Pilot Testing of Leader Behaviour Questionnaire

Item	Number of times reported "not applicable (?)"	Dropped / Modified
1. Empowers juniors to resolve problems on their own if they have a good solution.	4	Modified
2. Encourages juniors to determine themselves how to carry out a task or assignment.	5	Dropped
3. Allows substantial responsibility and discretion in carrying out work activities, handling problems, and making important decisions.	4	Modified
4. Provides decision-making autonomy.	4	No change
5. Incorporates the ideas and suggestions of others in decisions.	4	Modified
6. Allows voice in decision-making process.	5	Dropped
7. Listens to my ideas and suggestions seriously.	3	Modified
8. Gives all team members a chance to voice their opinions.	3	Modified
9. Invites participation in decision making.	3	Modified
10. Encourages and facilitates social interaction.	4	Modified
11. Increases incentives for mutual cooperation.	22	Dropped
12. Emphasizes common interests and values.	5	No change
13. Facilitates constructive resolution of conflict and encourages cooperation and teamwork.	5	Modified
14. Has taught me the necessary skills required for my job.	14	Dropped
15. Shows concern for each individual's development.	5	Modified
16. Allows me to use the lab's facilities (e.g. equipments, hardware, software, chemicals, manpower, other similar resources)	8	Dropped
17. Helps me find ways to acquire necessary skills.	7	No change
18. Nominates me for training, conferences, membership of professional bodies and awards.	5	Modified
19. Is polite and considerate, not arrogant and rude.	3	No change
20. Is like a friend to me.	6	Modified
21. Shows acceptance and positive regard.	3	No change
22. Provides sympathy and support when the person is anxious or upset.	12	Dropped
23. Reduces unnecessary paperwork.	7	No change
24. Arranges for the funding and resources required for the project.	10	No change
25. Serves as the main buffer between individuals and seniors to filter down	19	Dropped

	unnecessary political interference.		
26.	Avoids unnecessary administrative duties to protect productive time.	6	No change
27.	Clarifies priorities and deadlines.	9	No change
28.	Assigns work carefully depending on each employee's strengths.	9	Dropped
29.	Clarifies the person's responsibilities and his/her scope of authority.	8	No change
30.	Clearly explains the assignment to me.	9	No change
31.	Points out possible problems in my ideas.	8	No change
32.	Handles work-related problems in a decisive and confident way.	6	Dropped
33.	Takes the initiative in identifying and resolving work-related problems.	6	Modified
34.	Resolves work-related problems quickly to prevent unnecessary costs or delays.	8	Modified
35.	Is an expert in his/her field.	4	No change
36.	Works as hard as he/she can.	5	No change
37.	Accepts failures and does not blame juniors for them.	5	No change
38.	Leads by example in terms of abiding by the rules of the institute.	5	Dropped
39.	Sets high standards for performance by his/her own behaviour.	5	Dropped
40.	Observes operations directly when it is feasible.	6	Dropped
41.	Asks specific questions about the progress of work.	4	No change
42.	Conducts periodic progress review meetings.	3	No change
43.	Monitors key process variables as well as outcomes.	3	No change
44.	Gives credit (e.g. name in the journal publication) to people involved in a project based on their contributions.	5	Dropped
45.	Appreciates specific contributions and achievements.	3	No change
46.	Provides recognition that is timely.	4	No change
47.	Praises improvements in performance.	3	Modified
48.	Says things that make me feel proud to be part of this research group.	5	No change
49.	Develops in me proud feeling of giving something back to the society.	5	No change
50.	Expresses confidence in me when there is a difficult task.	7	Dropped
51.	Encourages me to see the situation as one full of opportunities.	6	No change
52.	Provides written materials and documents, and answers requests for technical information.	13	Dropped
53.	Disseminates relevant information to people who need it to do their work.	7	Modified
54.	Provides constructive feedback about effective and ineffective behaviours exhibited by the person.	12	No change
55.	Freely discusses problems and issues with juniors.	4	No change

N=107

RESULTS

Exploratory Factor Analysis

Exploratory factor analysis (EFA) is a widely used and broadly applied statistical technique in the social sciences. The primary purpose of EFA is to arrive at a more parsimonious conceptual understanding of a set of measured variables by determining the number and nature of common factors needed to account for the pattern of correlations among the measured variables. That is, EFA is used when a researcher wishes to identify a set of latent constructs underlying a set of measured variables (Fabrigar, Wegener, MacCallum & Strahan, 1999). In the present study, EFA of the leader behaviour items was conducted to understand the latent constructs that significantly explain the variance in the data and condense the items into a more limited number of underlying dimensions.

EFA is based on the common factor model that postulates that each measured variable is a linear function of one or more common factors (unobservable latent variables). The goal of the common factor model is to understand the structure of correlations among measured variables by estimating the pattern of relations between the common factor(s) and each of the measured variables (i.e., as indexed by factor loadings) (Fabrigar et al., 1999). Among common factor models, maximum likelihood (ML) and principal axis factoring (PAF) give the best results, depending on whether the data are generally normally-distributed or non-normal (Conway & Huffcutt, 2003; Costello & Osborne, 2005). If the data are relatively normally distributed, maximum likelihood is a good choice because it allows for the computation of indexes of the goodness of fit of the model and permits statistical significance testing of factor loadings and correlations among factors and the computation of confidence intervals. However, if the assumption of multivariate normality is violated, the PAF method should be used (Fabrigar et al.,

1999). As is typically the case with discrete item responses, the individual items do not necessarily satisfy the normality assumption of maximum likelihood estimation methods (Arnold et al., 2000). Since all of the leader behaviour items did not satisfy the normality assumption, we chose to use PAF as the extraction method for this study.

The goal of rotation is to simplify and clarify the data structure. Two basic types of analytical rotations can be used to reach a more interpretable solution: orthogonal rotations, forcing uncorrelated factors, and oblique rotations, allowing correlated factors. If factors really are correlated (a likely situation), then orthogonal rotation forces an unrealistic solution that will probably distort loadings away from simple structure, whereas an oblique rotation will better represent reality and produce better simple structure (Conway & Huffcutt, 2003). Even if factors really are uncorrelated or show a low correlation, the oblique rotation gives a factor correlation of about zero and loadings that are similar to those from an orthogonal rotation (Costello & Osborne, 2005; Fabrigar et al., 1999). In the present study, we have used PAF extraction method with oblique (promax) rotation.

The sample of 584 respondents was divided into two roughly equal parts using a random variable. EFA was performed on cases for which the random variable had a value of 1. The size of the sample on which EFA was performed was 304. Table 4 lists the factor labels, item loadings, and the reliability of each factor.

Table 4. Results of Exploratory Factor Analysis

Factor Label, Reliability and Items	Factor				
	1	2	3	4	5
Factor 1 – Task-oriented behaviour (Cronbachα = .94)					
1. Monitors key process variables as well as outcomes.	**.95**	.07	.07	-.18	-.07
2. Conducts periodic progress review meetings.	**.82**	.07	.06	-.17	-.02
3. Asks specific questions about the progress of work.	**.79**	.04	-.02	-.09	.10
4. Clarifies priorities and deadlines.	**.73**	-.12	-.04	.08	.14
5. Resolves work-related problems quickly to prevent unnecessary costs or delays.	**.64**	-.03	.00	.12	.12
6. Points out possible problems in my ideas.	**.64**	-.13	-.03	.35	-.04
7. Provides suggestions to resolve my work-related problems.	**.60**	-.01	-.04	.30	.02
8. Clarifies my responsibilities and scope of authority.	**.59**	.02	.01	.27	-.02
9. Clearly explains the assignment to me.	**.59**	.05	-.03	.25	.01
10. Arranges for the funding and resources required for the project.	**.53**	.02	-.08	.15	.12
11. Avoids unnecessary administrative duties to protect productive time.	**.47**	-.06	.01	-.03	.34
12. Provides constructive feedback about my performance.	***.42***	*.40*	*-.03*	*.13*	*-.05*
13. Reduces unnecessary paperwork.	***.39***	*.01*	*.09*	*-.06*	*.32*
14. Disseminates relevant information related to work.	***.36***	*.33*	*.02*	*.13*	*-.01*
Factor 2 – Recognising and Inspiring behaviour (Cronbachα = .94)					
1. Develops in me proud feeling of giving something back to the society.	.08	**.86**	-.02	-.04	-.02
2. Says things that make me feel proud to be part of this research organization.	-.03	**.86**	-.03	.01	.08
3. Encourages me to see the situation as one full of opportunities.	.17	**.70**	-.01	.13	-.12
4. Provides recognition that is timely.	.01	**.67**	.04	.07	.16
5. Praises commendable efforts that failed.	-.04	**.65**	.09	.10	.08
6. Appreciates specific contributions and achievements.	-.05	**.64**	.07	.07	.15
7. Freely discusses problems and issues with me.	*.24*	***.35***	*.05*	*.26*	*-.06*
Factor 3 – Empowering behaviour (Cronbach α = .88)					
1. Allows me substantial freedom in making important decisions.	-.12	.09	**.87**	-.15	.05
2. Provides me decision-making autonomy.	.01	.03	**.86**	-.10	-.03
3. Empowers me to resolve problems on my own.	-.08	.01	**.72**	-.05	.05
4. Incorporates my suggestions into decisions.	.22	-.04	**.62**	.08	-.10
5. Listens to my ideas seriously.	.14	-.05	**.60**	.22	-.04
6. Gives me a chance to voice my opinions.	.08	-.11	**.53**	.34	.01

Factor 4 – Team building and developing behaviour (Cronbachα = .91)					
1. Emphasizes common interests and values.	.04	.01	-.04	**.78**	-.02
2. Encourages interaction amongst colleagues.	.01	.04	.02	**.69**	.03
3. Encourages cooperation and teamwork.	.07	.09	-.03	**.64**	-.02
4. Helps me find ways to acquire necessary skills.	.20	.12	-.08	**.63**	-.07
5. Shows concern for my development.	.12	.14	.03	**.61**	-.04
6. Provides support for my work.	.07	.05	-.04	**.53**	.23
7. Nominates me for relevant training courses.	.15	.15	.04	**.51**	-.06
Factor 5 – Leading by Example behaviour (Cronbachα = .86)					
1. Works as hard as he/she can.	.29	.04	.01	-.19	**.67**
2. Is an expert in his/her field.	.17	.15	-.07	-.15	**.64**
3. Is polite and considerate, not arrogant and rude.	-.18	-.08	.06	.36	**.60**
4. Accepts failures and does not blame others for them.	.06	.09	.01	.08	**.58**
5. Shows acceptance and positive regard.	*-.10*	*-.01*	*.13*	*.44*	***.47***

a. **Extraction Method:** Principal Axis Factoring; **Rotation Method:**Promax with Kaiser Normalization.
b. Items in *italics* have loadings with a differential of less than 0.10
c. N = 584

Five factors met the selection criteria of eigenvalues greater than 1 and existence of at least three items. The five factors together accounted for 66.5% of the total variance. Internal consistency was assessed by means of the Cronbach alpha coefficient. The Cronbach alpha coefficient ranged from .86 to .94, so the results attested to the high internal consistency of the instrument in which all values were above the suggested .70 level for scale robustness (Nunnally & Berstein, 1994).

Factor 1, labelled as *task oriented behaviour*, comprised of the leader behaviour items of clarifying, monitoring, problem solving, and buffering categories. Factor 2 consisted of items of recognising and inspiring behaviours and was labelled as *recognising and inspiring behaviour.* Factor 3 consisted of items of delegating and consulting behaviour categories and was labelled as *empowering behaviour.* Factor 4 consisted of items of team building and developing behaviours and was labelled as *team building and developing behaviour*. Factor 5 consisted of items of

leading by example and supporting behaviour categories. The factor was labelled as *leading by example* behaviour.

Confirmatory Factor Analysis

The R&D leader behaviour subscales were next analyzed by confirmatory factor analyses (CFA), with LISREL 8.52 (Jöreskog & Sörbom, 1993) to examine the factor structure of the proposed instrument. CFA was also used to check for the discriminant and convergent validity of the five factor model. We followed the test suggested by Bagozzi and Philips (1982) and later by Anderson and Gerbing (1988) to check for the two validities. This test involves comparing the five factor model to a similar model in which the correlations among the factors are all constrained to 1. A significantly lower χ^2 value for the model in which the correlations are not constrained to unity would indicate that the constructs are not perfectly correlated and that discriminant validity is achieved. We considered a number of alternative factor models in the process of evaluating the proposed factor structures. The appropriateness of each model was examined using several indices of fit such as the ratio of chi-square to its degrees of freedom (χ^2/df), the Root Mean-Square Error of Approximation (RMSEA), Standardized Residuals (SRMR), Goodness of Fit Index (GFI), Incremental Fit Index (IFI), and Non-Normed Fit Index (NNFI).

Table 5. Model Fit Indices for Each Model

Model	χ^2	df	χ^2/df	NNFI	IFI	GFI	SRMR	RMSEA	$\Delta\chi^2$
5-factor	1515.26	677	2.24	.99	.99	.86	.042	.051	--
4-factor A	1855.66	681	2.72	.99	.99	.83	.045	.060	340.4**
4-factor B	2300.80	681	3.38	.98	.99	.80	.045	.070	785.54**
3-factor	2676.54	684	3.91	.98	.98	.78	.056	.078	820.88**
2-factor	3220.33	686	4.69	.98	.98	.74	.056	.088	543.79**
1-factor	24939.36	687	36.3	.78	.80	.52	.36	.160	21719.03**

** significant at p<.01 (two-tailed)

CFA was conducted using the second sample (i.e. cases with the random variable equal to 0) having 280 respondents. Table 5 summarises the fit of the competing models. The 5-factor CFA showed very good fit with the data and confirmed the presence of the 5-factor structure. All items had significant loading ($p<.01$) on their respective factors. The five factor model showed significantly high correlation ($r = .76$) between *task-oriented behaviour* and *team building and developing behaviour*, and a high correlation ($r = .73$) between *task-oriented behaviour* and *recognising and inspiring behaviour* (see table 6). Due to these high factor inter-correlations, we examined two four-factor models. In the first four-factor model, model 'A', *task-oriented behaviour* and *team building and developing behaviour* were combined into one factor. In the second four-factor model, model 'B', *task-oriented behaviour* and *recognising and inspiring behaviour* were combined into one factor. Comparisons of the five-factor model and each of the four-factor models showed significant changes in the chi-square to degrees of freedom ratios; model A - $\Delta\chi^2/\Delta df = 85.1$ ($p<.01$), model B - $\Delta\chi^2/\Delta df = 196.4$ ($p<.01$). Ratios of this size provided evidence for the existence of separate factors underlying task-oriented, team building and developing behaviour, and recognising and inspiring behaviour.

Next, a three factor model was tested merging items of *task-oriented behaviour*, *team building and developing behaviour* and *recognising and inspiring behaviour*. The three factor model showed significantly poor fit than the four factor model ($\Delta\chi^2/\Delta df = 273.63$, $p<.01$). A two-factor model, formed by merging of items of task-oriented, team building and developing, recognising and inspiring, and leading by example behaviours also showed significantly poor fit than the three factor model ($\Delta\chi^2/\Delta df = 271.89$, $p<.01$). Finally, a one-factor model showed a very poor fit than the two-factor model ($\Delta\chi^2/\Delta df = 21719.03$, $p<.01$).

The factor means, standard deviations, inter-correlations between factors, Cronbach's alpha reliabilities, composite reliability of the measurement model, and Average Variance Extracted (AVE) are presented in table 6.

Table 6. Descriptive Statistics and Correlations

Leader Behaviours	CR[a]	M	SD	1	2	3	4	5
1. Task-Oriented behaviour	.94	3.55	.88	(.58)	.53	.22	.58	.40
2. Recognising and Inspiring behaviour	.93	3.59	.95	.73**	(.67)	.31	.54	.42
3. Empowering behaviour	.86	3.82	.79	.47**	.56**	(.51)	.39	.31
4. Team Building and Developing behaviour	.90	3.73	.90	.76**	.74**	.62**	(.58)	.44
5. Leading-by-Example behaviour	.85	4.03	.81	.63**	.65**	.56**	.66**	(.54)

a CR: Composite Reliability of the measurement model

Average Variance Extracted (AVE) for each factor is provided in parenthesis along the diagonal; Values above the diagonal (i.e. AVE) are square of correlations; **p<.01(two-tailed); N=584

AVE for each factor is given in the parentheses along the diagonal. The average variance extracted for all the five leader behaviour factors is greater than 0.5, thereby suggesting adequate convergent validity (Fornell & Larcker, 1981; Ping, 2005). Moreover, the square of the correlation between two factors (values given above the diagonal in Table 6) is not greater than either of their individual AVEs, suggesting that the factors each have internal (extracted) variance greater than variance shared between the factors and have adequate discriminant validity (Fornell & Larcker, 1981; Ping, 2005). The internal consistency of the measurement model was assessed by computing composite reliability. These composite reliability coefficients ranged from .85 to .94 and are greater than the benchmark of .60 recommended by Fornell and Larcker (1981). Results in Tables 5 and 6 provide evidence of the convergent and discriminant validities of the R&D leader behaviour instrument. We call the measurement instrument as 'Leader Behaviour Scale for R&D Context' (LBS-RnD), as was done by Gupta and Singh (in press).

DISCUSSION

Consistent with the purpose of the study, the categories of R&D leader behaviours were analysed and validated leading to the development of a new measurement instrument assessing leader behaviours for the R&D context. The results of the study suggest that the data and the conceptual judgement of the items provide support for five factors: task oriented, recognising and inspiring, empowering, team building and developing, and leading by example. The study found support for the behaviour categories that had been suggested by Gupta and Singh (in press) in their qualitative study of R&D leaders with only one difference: the items of developing and team building behaviours loaded on a single factor rather than loading on two separate factors. Team refers to a work group comprising of individuals having complementary skills, interdependent roles, and a common purpose. Cohesive teams can also have a developmental impact on the team members. Members who share and constructively criticize each other's ideas are more likely to be creative and have superior performance (Amabile, 1997). Tasa, Taggar, and Seijts (2007) showed that, in self-managing teams, the development of collective efficacy is an emergent process that is derived from the observed behaviours and interactions that occur among team members. Members of coherent teams tend to have greater perceptions of self-efficacy and other psychological capacities (Caza, McCarter, Hargrove & Wad, 2009). Through team building behaviour a leader can enhance trust and collective identification, thereby leading to more open flow of information and ideas between team members. Through developing behaviours a leader shows concern for the development of subordinates and helps them acquire the necessary skills. Both these behaviours are perceived by subordinate to have a common purpose: his/her development and success at work. The items of these two behaviours loaded onto a single factor, labelled as *team building and developing behaviour*.

Task-oriented behaviour is primarily concerned with accomplishing a task in an efficient manner. The category includes clarifying roles and objectives, monitoring, problem solving and buffering behaviours. *Recognising and inspiring behaviour* is primarily concerned with the providing praise and recognition for effective performance and using influence techniques that appeal to emotion or logic to generate enthusiasm for the work.

Involving subordinates in the decision-making process often leads to better acceptance of decisions and increases the chance of getting them implemented in organisations. In line with the findings of previous researches on leadership and creativity (e.g. Zhang & Bartol, 2010), *empowering behaviour* emerged as a significant behavioural dimension. Leaders can set standards of high performance by their own behaviour. By doing so they motivate their subordinates to emulate them and also show them how to be successful at work. Leaders who lead by example are considered to be more charismatic and transformational and can influence followers to internalise attitudes and beliefs that subsequently serve as a source of intrinsic motivation to carry out organisational mission (Shalley & Perry-Smith, 2001). *Leading by example* is the fifth behaviour dimension that emerged from the study.

Regardless of the particular behavioural category, subordinates' ratings were either consistently favourable or unfavourable. As suggested by Arnold et al. (2000), the moderate to high correlations among the behaviour dimensions may be a property of leader behaviour rating scales. These results demonstrate a 'halo effect', or subordinates' tendency to have a holistic perception, favourable or unfavourable, of their leader that affects their ratings and should not be taken as evidence that these categories are essentially redundant.

R&D Leader Behaviours and Creativity

The componential theory of individual creativity mentions three major ingredients of creativity: expertise, creative-thinking skill, and intrinsic task motivation (Amabile, 1983, 1997). The expertise component includes memory for factual knowledge, technical proficiency, and special talents in the target work domain. Creative skills include a cognitive style favourable to taking new perspectives on problems, an application of techniques (or "heuristics") for the exploration of new cognitive pathways, and a working style conducive to persistent, energetic pursuit of one's work. Task motivation determines the extent to which an employee will fully engage his/her expertise and creative thinking skills in the service of creative performance. A highly intrinsically motivated person is likely to draw skills from other domains, or apply great effort to acquiring necessary skills in the target domain (Amabile, 1997).

Leaders, by displaying suitable behaviours, can impact all three components of creativity. *Task-oriented behaviour* can help the subordinates acquire the necessary skills and expertise in task. *Empowering behaviour* fulfils the need for autonomy, an essential pre-requisite of intrinsic motivation (Deci & Ryan, 1985). Choice, acknowledgement of ideas and suggestions, and opportunities for self-direction are vital preconditions for intrinsic motivation and can significantly promote employee creativity at work (Bakker & Demrouti, 2008; Charbonneau, Barling & Kelloway, 2001; Yperen & Hagedoorn, 2003). Reward and recognition for creative ideas, clearly defined overall project goals, and frequent constructive feedback on the work either confirm competence or provide important information on how to improve performance; these are called *informational extrinsic motivators* and can help in enhancing employee intrinsic motivation at work (Amabile, Conti, Coon, Lazenby & Herron, 1996). Job resources such as social support from colleagues and supervisors, performance feedback, skill variety, autonomy,

and learning opportunities are positively associated with work engagement (Bakker, 2010), an important antecedent of creativity (Bakker & Demerouti, 2007) .

Creativity is often enacted in teams and teams that seek information, address their differences of opinion, and question problem-solving assumptions engage in greater learning (Ángel & Sánchez, 2009; Hirst, Van Knippenberg & Zhou, 2009). Leaders, by emphasizing team work, can increase the frequency of interactions between the team members (Mumford, Scott, Gaddis & Strange, 2002) thereby leading to a greater understanding of the problem and to its creative solution (Hoegl, Weinkauf & Gemuenden, 2004). Work groups should be composed of diversely skilled individuals and led by supervisors who clearly set overall goals for projects but allow operational autonomy in achieving those goals (Amabile, 1997). Leaders, through developing and task-oriented behaviours, can ensure that their subordinates have the expertise to carry out their work, and at least minimally sufficient time to consider alternative approaches.

According to Bandura (1997), learning can take place vicariously by modelling and self-control processes. Individuals are more likely to perform a work after a visual demonstration of a successful behaviour or through the transmission of examples of appropriate rules and thought processes (Shalley & Perry-Smith, 2001). Employees who work under leaders who are expert in their work and who lead by example are bound to be subjected to much more modelling experience that can enhance subordinates' competence and eventually creativity at work.

Implications for Practice

The behaviours identified in the study have important implications for leadership training and development. This list of behaviours can help practitioners who often wrestle with the task of identifying appropriate behaviours that can ensure leader effectiveness. Development of training

modules around these behaviours should lead to better return on investment on training for the organisations and will make the training programs more useful for managers and employees.

The set of behaviours identified can also be used as a metric to judge the suitability of a leader for the R&D department. Leaders who exhibit such behaviours while managing a R&D team may have a higher chance of producing better results. Alternatively, list of behaviours presented here can help managers in understanding the reasons of their failure and in determining remedial steps. Managers can go through the leader behaviour inventory themselves or ask their subordinates to provide feedback on how often they display each of these behaviours. This can then help them in understanding areas where they can improve.

The application of this instrument for assessment, training, or performance evaluation would benefit from more, rather than fewer behavioural categories. The information included in each category can be useful for assessing and improving leadership effectiveness as well as evaluating the effectiveness of leader training programs. Collapsing categories together, due to their moderate to high correlations, could decrease the quantity and quality of information that can be provided by the instrument.

Directions for Future Research

This paper provides one of the first empirical accounts of leadership required in the R&D context. There is clearly a further need for continued refinement and validation of the LBS-RnD. Future studies should examine the role of R&D work characteristics in shaping and constraining R&D leader behaviour. This research should also explore theoretical and empirical relationships between the behaviours of LBS-RnD, processes, and outcomes of R&D departments. A nomological framework that relates R&D leadership, employee perceptions (e.g. justice perceptions, psychological capacities), job attitudes (e.g. engagement, creative performance

behaviours), and work outcome variables (e.g. creative performance, quality) should be empirically examined. This process of construct validation would improve our understanding of the effectiveness and potential use of this leader behaviour inventory. A greater understanding of R&D leadership has implications for both theory and the practice of R&D management.

CONCLUSION

The apparent differences between the leadership requirements of traditional and R&D environments suggest that traditional measures of leadership may not be applicable to R&D work environments. In this study, we extend the behavioural leadership theories to R&D context and develop a leader behaviour scale that can be used to gauge the effectiveness of R&D managers and leaders. The leader behaviours that are found to be important are *task-oriented*, *recognising and inspiring*, *empowering*, *team-building and developing*, and l*eading by example*. The identified behaviours can be useful to practitioners who often wrestle with the task of identifying appropriate behaviours that can ensure leader effectiveness in R&D departments. Studies that evaluate comprehensive view of these behaviours and where subordinates are provided an opportunity to rate many leader behaviours will yield information on the behaviours that are most desirable to employees, and therefore most likely to encourage creative behaviour in R&D contexts. This is the first study of its type and promises to provide significant insights into the management of R&D professionals.

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