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S&T innovators' sense of work gain: scale development and validation

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Abstract

Background Enhancing the sense of work gain serves as a crucial approach to invigorating S&T innovators. However, there is currently a lack of specialised instruments for measuring S&T innovators' sense of work gain (STISWG), thus limiting the progress of empirical research in this field. Consequently, this study aims to develop and validate the STISWG scale based on the Existence, Relatedness and Growth theory to address this issue.

Methods The development and validation of the STISWG scale spanned four stages and cumulatively used valid questionnaire data from 1,597 S&T innovators. The analysis methods encompassed item analysis, exploratory factor analysis (EFA), confirmatory factor analysis (CFA), reliability analysis, and assessment of the external predictive validity by using the Employee Innovative Behaviour Scale and the Paternalistic Leadership Scale.

Results The STISWG scale and three subscales had satisfactory reliability across all stages. EFA indicated that the 11-item STISWG scale comprised three dimensions: existence gain, relatedness gain and growth gain. CFA confirmed that the three-factor structure of the STISWG scale was the most optimal. The results of the predictive validity revealed that all three dimensions of the STISWG were good predictors of innovative behaviour. Three dimensions of paternalistic leadership moderated the above relationships, with authoritarian leadership weakening them and benevolent and moral leadership strengthening them.

Conclusions This study provides an effective and specialised instrument for assessing S&T innovators' sense of work gain. Moreover, it offers practical implications for enhancing the sense of work gain and innovative behaviours of S&T innovators.

Keywords S&T innovators, Sense of work gain, ERG theory, Scale development, Innovative behaviour, Paternalistic leadership

Introduction

With a new round of scientific and technological revolution and industrial transformation sweeping the world, scientific and technological innovation has become a "decisive factor" in the game of international scientific and technological competition, and talented people are the key to promoting scientific and technological innovation [1, 2]. S&T innovators have a wealth of professional knowledge or specialised skills, strong innovation consciousness and innovation ability, are principally engaged in creative science and technology activities, and make contributions to science and technology and economic and social development [2–4]. These people are critical

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innovation resources for organisations to grow rapidly, achieve breakthrough innovation, and maintain competitive advantage [4]. How to attract and retain S&T innovators and fully stimulate their innovation potential has become a topic of great interest [2, 4, 5].

Some scholars have started from a macro perspective, proposing that the urban ecological attraction (e.g., level of economic development and quality of living environment) and talented person ecological development attraction (e.g., level of science and technology development, realisation of the value of the talented person) are important external factors for China's developed cities to attract and motivate S&T innovators [2]. Some scholars have also focused on employees' needs from a micro perspective and argued that there are important means to motivate S&T innovators, such as helping them achieve career success [5] and increasing their perceived organisational support [4] and sense of gain [3]. S&T innovators need to invest a considerable amount of resources and bear a large risk of failure when they engage in creative science and technology activities [4]. Therefore, organisations need to provide S&T innovators with sufficient resources and emotional support [5] so that they can obtain returns that match their contributions [3], thus effectively enhancing their sense of gain and stimulating their intrinsic motivation for continuous innovation.

Sense of work gain (SWG) is the comprehensive evaluation of various objective benefits obtained by employees through their efforts in the workplace [6, 7]. Prior research has shown that SWG, as a positive psychological experience for employees [7], has a significant effect on employees' performance, behaviours and attitudes [3, 7]. Specifically, employees who have better emotional experiences and a higher SWG tend to be more engaged in their work and exhibit greater creativity [8], thereby increasing innovative behaviours [9], innovative performance [10] and task performance [3]. It can be seen that improving the sense of gain can serve as an effective means to stimulate S&T innovators' vitality.

Although S&T innovators' sense of work gain (STISWG) has attracted extensive attention from industry and academia, the lack of measurement instruments has kept research in this field at the level of qualitative research only. To strengthen the science of this field, it is imperative to conduct empirical research. However, the development of measurement instruments is an important foundation and basic prerequisite for empirical research, which is precisely the current bottleneck in this field. This is because previous studies on the structure and measurement instruments of SWG have focused on migrant workers [11], university students [12], and general employees [6, 7]. There is a lack of clarity on what the STISWG encompasses, and thus a lack of specialised measurement instruments. Therefore, considering the current research progress in this field, there is an urgent need to develop a new scale for scientifically assessing S&T innovators' sense of work gain.

The current study aims to develop and validate the STISWG scale based on the Existence, Relatedness and Growth theory (ERG theory) and the steps of scale development [13], thus answering a series of basic questions:"What is the STISWG? What does it contain? How to measure it?". Specifically, the development and validation of the STISWG scale is divided into four stages. In the first stage, we constructed the initial scale based on the Better Life Index and the expert group approach. The content validity of the scale was subsequently assessed. In the second stage, based on 683 valid questionnaires, we employed item analysis and exploratory factor analysis to optimise the 20-item initial scale and retained 11 items. In the third stage, we employed 340 valid questionnaires for confirmatory factor analysis to confirm the structural validity (including convergent and discriminant validity) of the 11-item scale and for the reliability testing. In the first three stages, we repeatedly validated the internal reliability and validity of the scale. In the fourth stage, we selected innovative behaviour and paternalistic leadership as related criteria and employed 574 valid questionnaires to further examine the reliability and external validity of the 11-item scale in the empirical study.

Literature review and theoretical basis

The connotations of related concepts

SWG is a specific application of the sense of gain in organisational contexts [6, 7, 11] and is a new indicator reflecting employees' perceptions at work [6, 14]. Other common indicators that describe employees' positive perceptions at work are work well-being and job satisfaction, but the three have different emphases. Work well-being focuses on employees' inner emotional perception [14] and positive spiritual experience [3, 11], while SWG is an organic combination of objective acquisition and subjective perception, emphasising the objective acquisition of employees at work [6, 7, 14], which is the material and psychological basis for the generation of work well-being [7]. Job satisfaction emphasises the comparison between personal acquisition and psychological expectation, while SWG reflects the comparison between personal actual contribution and objective acquisition [3, 11, 14].

Prior scholars have focused on the SWG among different groups. For example, Yang and Wang [11] argued that migrant workers' SWG was the comprehensive feeling and evaluation of employees on the return of actual effort and value realisation at work, reflecting the degree

to which the returns brought by work meet individual needs. Gu et al. [6], on the other hand, focused on all employees in the organisation and proposed that employees' SWG was the subjective feeling that individuals obtain various objective benefits through their efforts at work. Zhu and Liu [7] emphasised that employees' SWG was the material and psychological satisfaction of employees through labour. It can be seen that the SWG highlights the premise of actual effort and participation, the basis of multifaceted objective acquisition, and the core of subjective feelings [6, 7, 11]. S&T innovators in this study are not only members of the organisation staff but also primarily engaged in unconventional and creative science and technology activities [2, 4]. Therefore, following prior scholars' exploration of the connotation of the SWG, this study drew on Gu et al. [6] to argue that the STISWG is the subjective feeling of employees who obtain a variety of objective benefits due to their efforts in creative science and technology activities.

Structure and measurement

SWG is a multidimensional, comprehensive concept closely related to work [11]. Regarding the job content, it includes job income, job safety, the working environment, working hours and job promotion [11]. Regarding the content of gain, it contains the a sense of material gain and spiritual gain [6]. Regarding the time of gain, it consists of the present gain and future gain [7].

Although previous studies have explored the dimensions of the SWG from different perspectives, measurement instruments for quantitative research are rare. Two scales are commonly used: one is the Employee Sense of Gain Scale developed by Gu et al. [6]. This scale was based on the Better Life Index in the China Economic Life Survey (2017–2018) and was composed of two dimensions and 14 items. Among them, there are five items for the sense of material gain and nine items for the sense of spiritual gain. The other scale is the Employee Sense of Work Gain Scale developed by Zhu & Liu [7]. This scale was rooted in employees in organisational contexts. The initial items were formed through structured interviews, and a quantitative study was used to form a scale containing four dimensions and 13 items. Among them, job dignity, salary satisfaction and career aspirations have three items each, and ability improvement has four items.

Although these two commonly used scales have good reliability and validity [6, 7] and have been widely used in empirical studies related to employees' SWG [8, 10, 14], they have obvious limitations in measuring special groups' SWG. There are two main reasons for this. First, the measurement content of both scales focuses on the universal needs of general employees in the organisation and cannot be used to portray the differences in the SWG of different types of employees in detail. However, previous studies have shown that there are significant differences in the needs and motivations of different populations [3, 6, 7, 11]. This has also contributed to the growing research on the sense of gain in different populations, such as migrant workers [11] and college students [12]. Second, both scales are developed for general employees and have not been validated in special group samples. Overall, these two scales are more suitable for measuring general employees' SWG and have limited applicability in testing special groups' SWG (such as S&T innovators). As representatives of high knowledge, high skills, and high contributions in the organisation, S&T innovators are responsible for promoting organisational innovation [4]. Their needs and motivations are different from those of general employees who need to complete only routine tasks [3, 7, 11]. Therefore, this study focused on S&T innovators, combined their job characteristics and needs and specifically explored the structural dimensions of the STISWG, accordingly developing a scale to assess it.

ERG theory

SWG, which is closely related to personal needs, is the subjective feeling that personal needs are satisfied through the benefits brought by work [7, 11]. Previous studies have primarily discussed the structure or measurement scale of the SWG in compliance with Maslow's hierarchy of needs theory. For example, Yang and Wang [11] proposed that migrant workers' SWG contained basic needs (e.g., job income and safety), intermediate-level needs (e.g. the working environment and hours) and high-level needs (e.g., job promotion) and that these three levels were characterised by a sequential transformation from low to high. Gu et al. [6] divided employees' SWG into material gain and spiritual gain from a macro perspective. However, S&T innovators have a complex demand structure and stress the pursuit of the satisfaction of both low-level needs (e.g., money and materials) and higher-level needs (e.g., respect and self-worth realisation), which do not always transform from a low level to a high level [2, 5]. Doubtlessly, it is difficult to highlight the special needs of S&T innovators (e.g., being recognised and achieving personal growth) only from the material and spiritual perspectives, and Maslow's hierarchy of needs theory, which emphasises a strict hierarchical progression, can no longer explain the STISWG well.

The ERG theory is an optimisation of Maslow's hierarchy of needs theory and has been widely used in organisational management research [15]. Compared with Maslow's hierarchy of needs theory, the ERG theory prioritises individual differences [16]. Therefore, the ERG

theory is more suitable for the study of certain special groups. S&T innovators have three primary needs: first, material incentives and the accumulation of psychological capital; second, a good organisational atmosphere and interpersonal relationships; and third, personal growth and self-worth realisation [2, 3, 5]. These needs are consistent with the three core needs (i.e., existence, relatedness and growth) that employees have in management practice, as proposed in Alderfer's [16] ERG theory. Among them, existence needs refer to various needs that are closely related to human survival, corresponding to physiological needs and safety needs in Maslow's hierarchy of needs. Relatedness needs refer to the desire to maintain friendly relationships with others, corresponding to social needs and the external part of respect needs in Maslow's hierarchy of needs. Growth needs refer to the individual's desire to develop, corresponding to the intrinsic part of respect needs and self-actualisation needs in Maslow's hierarchy of needs [15, 16]. In addition, the ERG theory suggests that individuals have a dynamic and complex demand structure, allowing them to pursue multiple needs simultaneously, and the importance of the three needs varies from person to person [16]. Therefore, according to the ERG theory, this study proposed that the STISWG contained three dimensions: existence gain (EG), relatedness gain (RG) and growth gain (GG).

Initial scale generation

Indicator selection

Indicators of the STISWG were derived from the Better Life Index jointly published by the Chinese National School of Development at Peking University and the Chinese Academy of Social Sciences in March 2018. The index contains 38 indicators extracted from a survey of 100,000 Chinese households and big data model tests. This is the most authoritative database of indicators on the sense of gain, and the current research on the sense of gain uses these 38 indicators to develop the initial scale. We thus incorporated these indicators into the initial item base of the STISWG. These indicators were examined one by one based on the ERG theory and the expert group approach. Finally, 20 retained indicators met the following conditions (see Fig. 1): (1) whether they belong to the organisational context and (2) whether they can reflect the needs of S&T innovators in terms of existence, relatedness and growth.

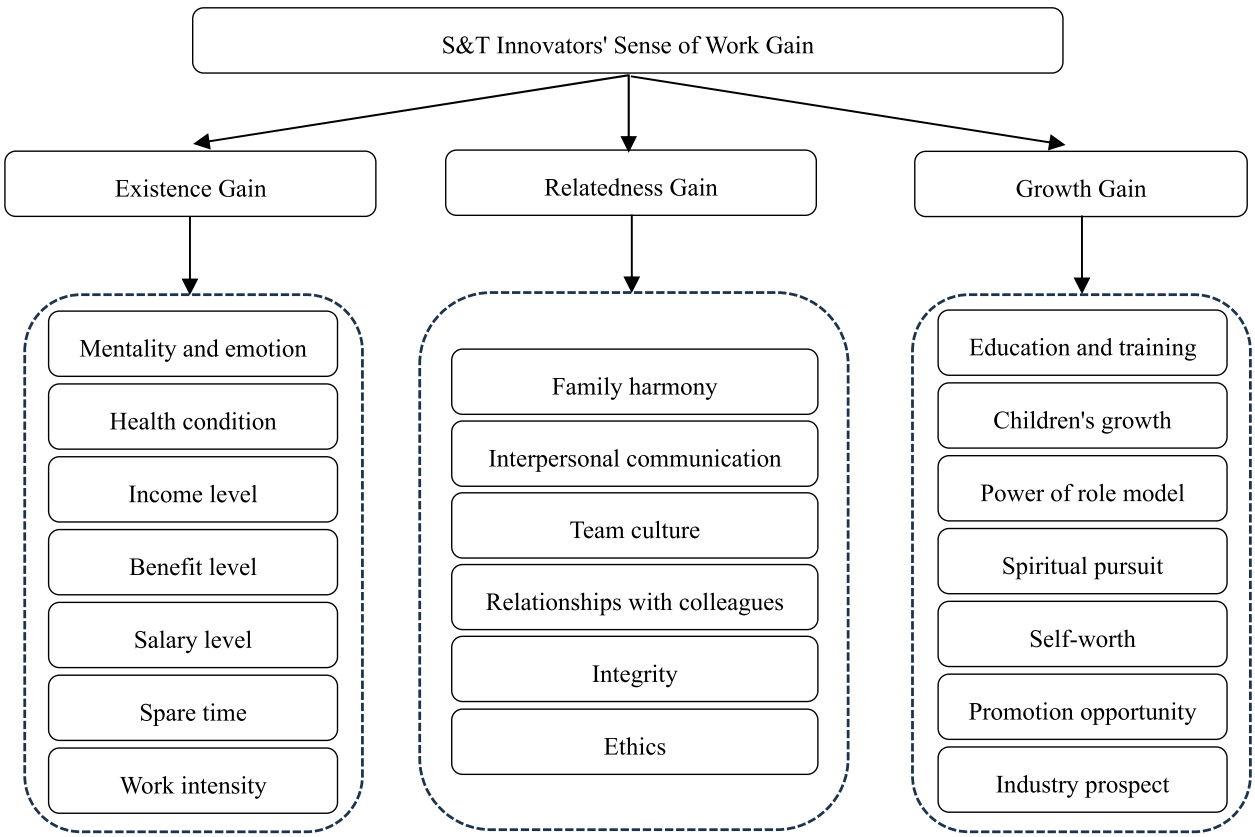

Fig. 1 Structural dimensions of the STISWG

Dimension division

Five management experts (Men = 2, Women = 3) were invited to categorise the 20 indicators in a back-to-back procedure, and each indicator could be selected in only one of the three dimensions of the EG, RG and GG. A total of 17 indicators were incorporated into the same dimension by four or more experts, so the dimensionality of these indicators was directly determined. The categorisation of the three indicators of spare time, integrity and ethics was highly divergent. Therefore, they were recategorised through adequate discussions until an agreement was reached. The final categorisation of indicators is presented in Fig. 1.

Initial scale and content validity

In combination with the organisational context, 20 indicators were described to form the initial items of the STISWG scale. For example, the initial item formed by the indicator "mentality and emotion" was stated as "I have a good mood while working in this organisation". Subsequently, five experts (Men = 2, Women = 3; Human resource management expert = 1, Doctoral student of management = 2, Master of management students = 2) revised the initial items repeatedly and finally formed the initial STISWG scale with a total of 20 items in three dimensions. Next, a panel of seven experts were invited (Men = 4, Women = 3; Entrepreneur = 2, Management teachers = 2, Doctoral student of management = 2, Master of management students = 1) to evaluate the content validity of the items. After understanding the definition of each dimension, every expert evaluated the relevance of each item on a scale ranging from one (Very irrelevant) to four (Very relevant). The item-level content validity indices were above 0.86, and the scale-level content validity index was 0.94, reaching acceptable values [17].

Data analysis

SPSS 26.0 was employed for item analysis, exploratory factor analysis, reliability testing, descriptive statistics, correlation analysis and hypothesis testing. Confirmatory factor analysis was carried out with AMOS 26.0.

Exploratory factor analysis

Sample and procedure

In this study, the initial scale of 20 items was used to issue the first batch of questionnaires to S&T innovators from 38 high-tech companies in China. Firstly, we communicated with the human resources managers of each company. After obtaining permission from the company, the managers randomly distributed questionnaires to the employees engaged in creative science and technology activities in the organisation. Finally, a total of 781 questionnaires were collected, and 683 were valid (the effective recovery rate was 87.45%). The questionnaires were scored on a five-point Likert scale ranging from "1 = Disagree strongly" to "5 = Agree strongly". The demographic distribution of the valid questionnaires was as follows: in terms of gender, 402 (58.86%) males and 281 (41.14%) females were included. In terms of age, 24 (3.51%) were 25 years old or younger, 342 (50.07%) were 26 to 35 years old, 191 (27.96%) were 36 to 45 years old, 112 (16.40%) were 46 to 55 years old, and 14 (2.05%) were 56 years old or older. In terms of education, 546 (79.94%) held a bachelor's degree and 137 (20.06%) held a master's degree. In terms of job tenure, 37 (5.42%) people were less than 1 year, 38 (5.56%) people were 1–2 years, 101 (14.79%) people were 3–5 years, 168 (24.60%) people were 6–10 years, 124 (18.16%) people were 11–15 years, and 215 (31.48%) people were more than 15 years. In terms of job grade, 108 (15.81%) employees were senior managers or senior titles, 261 (38.21%) employees were middle managers or intermediate titles, 211 (30.89%) employees were low-level managers or junior titles, and 103 (15.08%) employees had no title.

Item analysis

To further improve questionnaire quality and reduce item redundancy, this study analysed 20 items via six indicators (e.g., the critical ratio and item-total correlation) [18]. The results of the item analysis are presented in Table 1. Firstly, according to the method of item discrimination analysis, the subjects were sorted from high to low according to the total score of 20 items, and the top 27% were identified as the high group and the bottom 27% were identified as the low group. An independent samples *t test* was employed to evaluate the scores of the two groups in 20 items. The results demonstrated that the scores of the two groups were significantly different for all the items (t values ranging from 15.902 to 27.864, $p < 0.001$). The item-total correlation before correction ranged from 0.623 to 0.814 ($p < 0.001$), and the mean value was 0.729. Further investigation of the corrected item-total correlation (CITC) of each item revealed that the CITC values of the 20 items ranged from 0.589 to 0.789, with a mean value of 0.695. Moreover, the Cronbach's α value after any item was deleted did not exceed that of the whole scale, which was 0.953. In addition, regarding homogeneity, the communality of the 20 items ranged from 0.382 to 0.673 with a mean value of 0.536, and the factor loadings ranged from 0.618 to 0.820 with a mean value of 0.730. The six indicators of the 20 items have reached the corresponding standards, so all the items were retained.

Table 1 Item analysis results of the STISWG scale

Indicators and Standards	Extreme Group Comparison	Item-Total Correlation		Homogeneity Testing			Number	Choice
	Critical Ratio	Pre-correction	Post-correction	Cronbach's α if Item Deleted	Communality	Factor Loading		
Items	≥ 3.000	≥ 0.400	≥ 0.400	≤ Scale's Cronbach's α	≥ 0.200	≥ 0.450		
S11 I have a good mood while working in this organisation	23.859***	0.753**	0.721	0.950	0.568	0.820	0	Remain
S12 Working in this organisation is good for my physical and mental health	24.741***	0.768**	0.737	0.950	0.585	0.820	0	Remain
S13 I gain the satisfactory income in this organisation	24.178***	0.701**	0.661	0.951	0.475	0.799	0	Remain
S14 I gain satisfactory benefits in this organisation	21.384***	0.685**	0.643	0.951	0.458	0.790	0	Remain
S15 I gain the satisfactory salary in this organisation	25.278***	0.714**	0.676	0.951	0.494	0.782	0	Remain
S16 I have plenty of spare time in this organisation	17.997***	0.640**	0.589	0.952	0.382	0.765	0	Remain
S17 I am satisfied with the work intensity of this organisation	20.041***	0.683**	0.641	0.951	0.446	0.754	0	Remain
S21 Working in this organisation is conducive to my family's harmony	21.142***	0.714**	0.673	0.951	0.491	0.753	0	Remain
S22 I have a good relationship with my supervisor in this organisation	15.902***	0.623**	0.589	0.952	0.404	0.751	0	Remain
S23 I am satisfied with the team culture of this organisation	24.653***	0.774**	0.745	0.950	0.612	0.740	0	Remain
S24 I have good relationships with colleagues in this organisation	16.177***	0.644**	0.618	0.952	0.438	0.734	0	Remain
S25 I am satisfied with the integrity of this organisation	19.557***	0.741**	0.709	0.950	0.563	0.730	0	Remain
S26 I am satisfied with the ethical climate of this organisation	18.991***	0.726**	0.697	0.951	0.547	0.703	0	Remain
S31 The training provided by this organisation is conducive to my growth	21.538***	0.749**	0.716	0.950	0.568	0.701	0	Remain

Table 1 (continued)

Indicators and Standards	Extreme Group Comparison	Item-Total Correlation		Homogeneity Testing			Number	Choice
	Critical Ratio	Pre-correction	Post-correction	Cronbach's α if Item Deleted	Communality	Factor Loading		
Items	≥ 3.000	≥ 0.400	≥ 0.400	≤ Scale's Cronbach's α	≥ 0.200	≥ 0.450		
S32 Working in this organisation is conducive to promoting my child's development	22.413***	0.735**	0.699	0.950	0.533	0.689	0	Remain
S33 I get strength from role models in this organisation	23.240***	0.783**	0.754	0.950	0.625	0.677	0	Remain
S34 Working in this organisation inspires my spiritual pursuit	26.548***	0.814**	0.787	0.949	0.673	0.668	0	Remain
S35 Working in this organisation is conducive to realising my self-worth	27.864***	0.814**	0.789	0.949	0.672	0.662	0	Remain
S36 This organisation offers good promotion opportunities	26.425***	0.796**	0.766	0.949	0.638	0.636	0	Remain
S37 I am confident about the industry prospect of this organisation	20.371***	0.726**	0.693	0.950	0.539	0.618	0	Remain

N = 683, *S1* = Existence Gain, *S2* = Relatedness Gain, *S3* = Growth Gain. The Cronbach's α value in Table 1 is 0.953. The number represents the frequency with which each item did not meet the standard

*** $p < 0.001$, ** $p < 0.01$

Results

SPSS 26.0 software was employed for exploratory factor analysis. The results showed that the Kaiser–Meyer–Olkin was 0.954, and the Bartlett's sphericity chi-square approximation was 9753.005 ($df = 190$, $p < 0.001$). This finding indicated that the data were suitable for exploratory factor analysis [19].

Principal component analysis and varimax rotation were then employed for exploratory factor analysis. The items with factor loadings greater than 0.50 were retained, and the items with factor loadings greater than 0.40 on two or more factors (cross-factor) were excluded. After multiple rounds of factor analysis, nine items, S32, S12, S34, S21, S37, S16, S17, S23 and S11, were excluded, and three common factors were ultimately extracted, totalling 11 items. The results of the exploratory factor analysis are illustrated in Table 2. The communality of all the items ranged from 0.592 to 0.871, with a mean value of 0.735. The loading of each item on the corresponding factors ranged from 0.658 to 0.881, and the cumulative variance contribution rate of the three factors reached 73.532%, which was relatively ideal [13].

The results demonstrated that the STISWG presented a three-factor structure, namely, RG (factor 1, four items), GG (factor 2, four items) and EG (factor 3, three items). Among them, the EG reflects the overall perception of individual income level, salary level and welfare benefits obtained by S&T innovators in the organisation. The RG includes the overall evaluation of relationships with supervisors and colleagues, the ethical climate and the integrity of the organisation. The GG reflects the subjective perception of S&T innovators in the aspects of training and education, inspiration by example, self-worth realisation and promotion opportunities. The Cronbach's α value of the STISWG scale was 0.920 and that of each dimension ranged from 0.842 to 0.885.

Confirmatory factor analysis

Sample and procedure

The participants were S&T innovators from 16 high-tech companies in China, and the collection process was the

Table 2 Exploratory factor analysis results of the STISWG scale

Item	Factor 1	Factor 2	Factor 3	Communality	Cronbach's α if Item Deleted
S26 I am satisfied with the ethical climate of this organisation	**0.794**	0.294	0.215	0.762	0.913
S24 I have good relationships with colleagues in this organisation	**0.769**	0.236	0.179	0.679	0.917
S25 I am satisfied with the integrity of this organisation	**0.748**	0.293	0.282	0.725	0.912
S22 I have a good relationship with my direct supervisor in this organisation	**0.699**	0.301	0.110	0.592	0.918
S36 This organisation offers good promotion opportunities	0.273	**0.782**	0.311	0.783	0.909
S35 Working in this organisation is conducive to realising my self-worth	0.327	**0.758**	0.306	0.775	0.909
S33 I get strength from role models in this organisation	0.357	**0.731**	0.275	0.737	0.910
S31 The training provided by this organisation is conducive to my growth	0.370	**0.698**	0.250	0.687	0.911
S13 I gain the satisfactory income in this organisation	0.183	0.248	**0.881**	0.871	0.914
S15 I gain the satisfactory salary in this organisation	0.203	0.257	**0.873**	0.869	0.913
S14 I gain satisfactory benefits in this organisation	0.246	0.339	**0.658**	0.608	0.915
Eigenvalue (after rotation)	2.850	2.768	2.470		
Variance (%)	25.909	25.166	22.457		
Cumulative variance (%)	25.909	51.075	73.532		
Cronbach's α	0.855	0.842	0.885		

The item loadings on their respective factors are shown in bold

N = 683, *S1* = Existence Gain, *S2* = Relatedness Gain, *S3* = Growth Gain

same as before. Finally, a total of 366 questionnaires were collected, with 340 valid questionnaires (the effective recovery rate of 92.90%). There were 193 (56.76%) males and 147 (43.24%) females. Regarding age, 10 (2.94%) were 25 years old or younger, 148 (43.53%) were 26 to 35 years old, 106 (31.18%) were 36 to 45 years old, 67 (19.71%) were 46 to 55 years old, and 9 (2.65%) were 56 years old or older. Regarding education, 265 (77.94%) held a bachelor's degree and 75 (22.06%) held a master's degree. Regarding job tenure, 19 (5.59%) were less than 1 year, 16 (4.71%) were 1–2 years, 39 (11.47%) were 3–5 years, 83 (24.41%) were 6–10 years, 60 (17.65%) were 11–15 years, and 123 (36.18%) were more than 15 years. Regarding job grade, 59 (17.35%) employees were senior managers or senior titles, 131 (28.24%) employees were middle managers or intermediate titles (38.53%), 96 employees were low-level management or junior titles, and 54 (15.88%) employees had no title.

Results

AMOS 26.0 software and 340 valid data were employed for confirmatory factor analysis of the STISWG scale. The results are presented in Table 3. Among the first-order models, the fit indices of the three-factor structure model for the STISWG ($\chi^2 = 2.605 < 3$, RMSEA $= 0.069 < 0.08$, SRMR $= 0.051 < 0.08$, CFI $= 0.970 > 0.90$, TLI $= 0.961 > 0.90$, IFI $= 0.970 > 0.90$, NFI $= 0.952 > 0.90$, GFI $= 0.944 > 0.90$) were satisfactory. Moreover,

Table 3 Confirmatory factor analysis results of the structure of the STISWG scale

Models	χ^2	*df*	χ^2/df	RMSEA	SRMR	CFI	TLI	IFI	NFI	GFI
Three-factor model: EG, RG, GG	109.423***	42	2.605	0.069	0.051	0.970	0.961	0.970	0.952	0.944
Two-factor model: EG + RG, GG	455.491***	44	10.352	0.166	0.107	0.816	0.771	0.817	0.802	0.787
Two-factor model: EG, RG + GG	245.829***	44	5.587	0.116	0.066	0.910	0.887	0.910	0.893	0.866
Two-factor model: EG + GG, RG	357.902***	44	8.134	0.145	0.093	0.860	0.825	0.861	0.844	0.835
Single-factor model: EG + RG + GG	522.084***	45	11.602	0.177	0.113	0.787	0.740	0.788	0.773	0.771
Second-order, three-factor model: STISWG, EG, RG, GG	105.470***	41	2.572	0.068	0.053	0.971	0.961	0.971	0.954	0.946

N = 340, *EG* = Existence Gain, *RG* = Relatedness Gain, *GG* = Growth Gain, *STISWG* = S&T Innovators' Sense of Work Gain, χ^2 = Chi-square, *df* = Degrees of Freedom, χ^2/df = Chi-square to Degree of Freedom, *RMSEA* = Root Mean-Square Error of Approximation, *SRMR* = Standardised Root Mean-Square Residual, *CFI* = Comparative Fit Index, *TLI* = Tucker-Lewis Index, *IFI* = Incremental Fit Index, *NFI* = Normed Fit Index, *GFI* = Goodness of Fit Index. + represents factor merging

*** $p < 0.001$

attempts were made to scale down the factors, and the fit indices of the three-factor model were significantly superior to those of the two-factor and single-factor models. Therefore, the first-order three-factor model had a better structure, and it was an optimal model for dividing the STISWG into three dimensions: EG, RG and GG.

In addition, the standardised factor loadings of the 11 items of the three-factor model ranged from 0.642 to 0.917 (see Fig. 2), which could explain the observed variables well [18].

Furthermore, from the fit indices of the first-order three-factor model, the correlations among the dimensions, and the previous theoretical study, there may be a higher-order factor in the three dimensions of the STISWG. The correlations among the dimensions ranged from 0.526 to 0.707 and were significantly correlated at the 0.01 level, indicating that there was indeed a higher-order common factor to the three factors. In the second-order three-factor model (see Fig. 3), the standardised factor loadings of the 11 items on the corresponding factors ranged from 0.618 to 0.912, and the standardised factor loadings of the three dimensions ranged from 0.688 to 0.991. It was thus determined that the STISWG was a second-order structure composed of three first-order factors: EG, RG and GG.

Reliability and validity

The results of the reliability and validity tests are presented in Table 4. Firstly, the Cronbach's α value of the STISWG scale was 0.915, and the Cronbach's α values of the subscales ranged from 0.838 (EG) to 0.874 (GG). These findings indicated that the scales had good reliability. Next, the convergent and discriminant validity of the scale was examined through composite reliability (CR) and average variance extracted (AVE) [20]. The CR values of the subscales ranged from 0.867 to 0.882, all of which were greater than 0.80, and the AVE values ranged from 0.621 to 0.696, all of which were greater than 0.60. These findings indicated that the scales had good convergent validity. In addition, the minimum value of 0.788 for the square root of the AVE corresponding to the three factors was greater than the maximum value of 0.707 for the correlation among the factors. This indicated that the scales had good discriminant validity.

External validity

Next, we further tested the reliability and external validity of the STISWG scale in the new sample by examining the relationships among STISWG, innovative behaviour (IB) and paternalistic leadership (PL).

Previous studies have shown that the SWG has a significant effect on employees' innovative performance

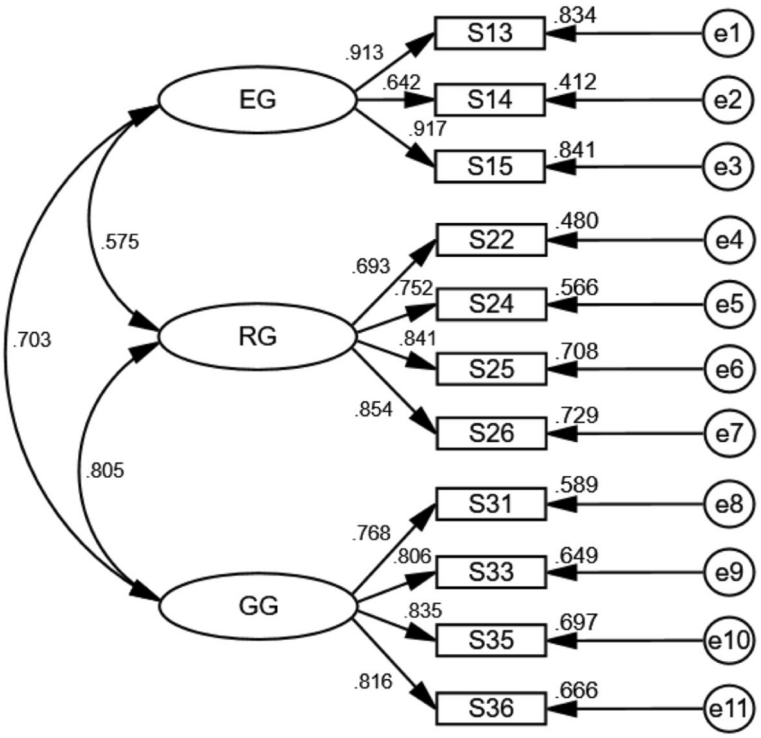

Fig. 2 Confirmatory first-order, three-factor model of the STISWG scale. *Note(s)*. *N* = 340; EG = Existence Gain, RG = Relatedness Gain, GG = Growth Gain

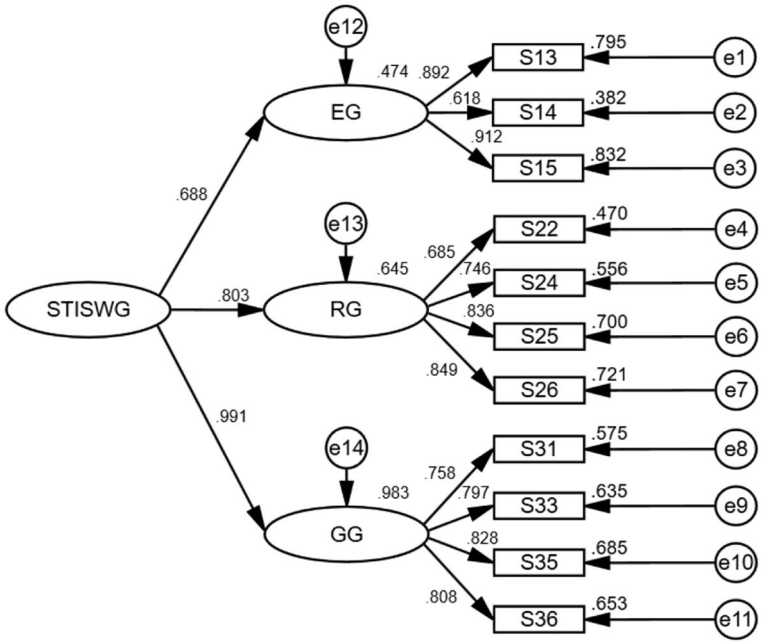

Fig. 3 Confirmatory second-order, three-factor model of the STISWG scale. *Note(s)*. *N* = 340; STISWG = S&T Innovators' Sense of Work Gain, EG = Existence Gain, RG = Relatedness Gain, GG = Growth Gain

Table 4 Reliability and validity results of the first-order three-factor model

Dimensions	Existence Gain	Relatedness Gain	Growth Gain	AVE	CR	Cronbach's α
Existence Gain	0.834			0.696	0.870	0.838
Relatedness Gain	0.526**	0.788		0.621	0.867	0.855
Growth Gain	0.640**	0.707**	0.807	0.651	0.882	0.874

N = 340, *AVE* = Average Variance Extracted, *CR* = Composite Reliability. The diagonal is the square root of AVE

** $p < 0.01$

[10] and creativity [8]. Moreover, different leadership styles also have various effects on employees' SWG [3] and IB [21, 22]. Therefore, this study combined the previous analysis of the connotations and dimensions of the STISWG and concluded that the STISWG might have a positive effect on IB and that the relationship between the two might be moderated by leadership style.

Theory and Hypothesis

S&T innovators' sense of work gain and innovative behaviour

IB is the process of a series of actions in which employees adopt novel ideas and solutions to solve problems at work [23, 24] and is closely related to an individual's psychological perceptual state and emotional experience at work [4, 8, 25]. According to the Organisational Support theory, the organisation provides more resources for S&T innovators to support their existence, relatedness and growth, which helps enhance employees' positive perception of actual acquisition and emotional attachment to the organisation, which in turn prompts them to actively adopt IB to give back to the organisation [26]. Specifically, employees with a high level of SWG are more likely to activate their own positive emotions and creative cognitive resources [8], which promotes the generation of IB. Moreover, the acquisition and accumulation of resources such as existence, relatedness and growth can enhance employees' psychological security, which prompts them to be more engaged in their work and generate IB [9]. In addition, there is a significant positive effect of work well-being on employees' IB [25], and work well-being is a form of expression of an individual's SWG after a certain degree of realisation [8]. Therefore, the STISWG may positively influence IB to a certain extent. Therefore, this study proposed the following hypotheses:

Hypothesis 1
EG (1a), RG (1b) and GG (1c) of S&T innovators have a significant positive effect on their IB.

The moderating effect of paternalistic leadership

According to the Organisational Support theory, employees who perceive that the organisation values and cares about them will generate more positive behaviours to give back to the organisation [4, 26]. Employees often personify the organisation and equate leader behaviours with organisational behaviours [26, 27]. Thus, support from both the organisation and the leader will jointly influence the employee's subsequent behaviours. SWG reflects support from the organisational system as well as coworkers, etc., while leadership style reflects support from leaders [14, 22]. Therefore, the interaction effect of various leadership styles with perceived SWG may differentially affect employees' IB. PL is one of the most typical leadership styles in Chinese organisational contexts [28, 29] and involves three dimensions: authoritarian leadership (AL), benevolent leadership (BL) and moral leadership (ML). Under the influence of these three leadership styles, the perceived level of the STISWG and its contribution to IB may differ.

Authoritarian leaders emphasise absolute authority and require employees to obey their instructions completely [28], which makes it difficult for employees to improve their work or develop innovative ideas [22]. Moreover, this type of leaders also shows the characteristics of hiding information, ignoring employees' suggestions, belittling subordinates' abilities and being unwilling to authorise [28, 29], which may result in a depressing and fear of making mistakes atmosphere in the organisation [21], thus reducing the SWG and innovation willingness of S&T innovators. In contrast, benevolent leaders usually provide comprehensive and long-term care and support to employees [28, 29]. According to the Organisational Support theory, various types of resource support provided by such leaders increase employees' sense of gain and make them feel grateful [22, 28], thus displaying more positive behaviours (such as IB) in return for leaders [26]. In addition, benevolent leaders are more tolerant of employees and give them opportunities for trial and error [21, 22], which helps stimulate the innovative vitality of S&T innovators. Moral leaders are honest and disinterested and are moral models in the organisation [28, 29]. Employees will have more sense of identity with such leaders [22, 29] and emulate leaders to show more positive behaviours such as dedication and innovation [21, 22]. Moreover, moral leaders pay attention to the overall interests of the organisation and treat each employee fairly, which easily stimulates employees' sense of responsibility and enthusiasm for innovation [22, 29]. Therefore, this study proposed the following hypotheses:

Hypothesis 2
AL negatively moderates the positive effects of EG (2a), RG (2b) and GG (2c) on IB of S&T innovators.
Hypothesis 3
BL positively moderates the positive effects of EG (3a), RG (3b) and GG (3c) on IB of S&T innovators.
Hypothesis 4
ML positively moderates the positive effects of EG (4a), RG (4b) and GG (4c) on IB of S&T innovators

In summary, the theoretical model of this study is shown in Fig. 4.

Measures

STISWG

STISWG was measured with an 11-item scale developed in this study (Cronbach's $\alpha = 0.909$; see the supplementary file), containing three dimensions: EG, RG and GG. The EG had three items and a sample item was "I gain the satisfactory income in this organisation"(Cronbach's $\alpha = 0.833$). The RG had four items and a sample item was "I have a good relationship with my direct supervisor in this organisation"(Cronbach's $\alpha = 0.817$). The GG had four items and a sample item was "The training provided by this organisation is conducive to my growth"(Cronbach's $\alpha = 0.853$).

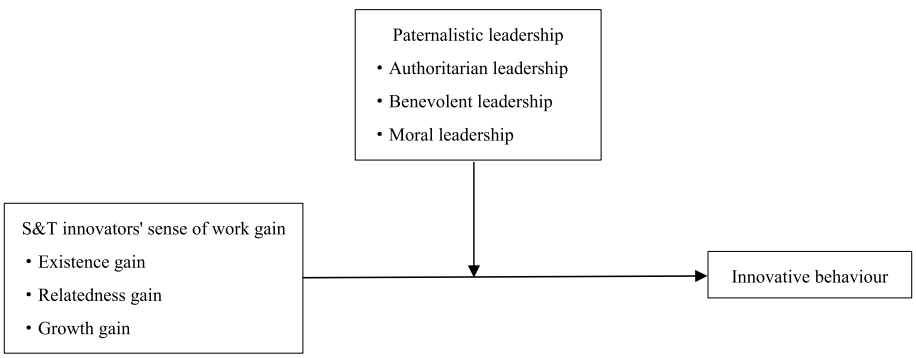

Fig. 4 Theoretical model

IB

IB was measured with Scott and Bruce's [23] six-item scale. A sample item was "Overall, I'm an innovative person"(Cronbach's α = 0.899).

PL

PL was measured with Cheng et al.'s [29] 15-item scale, containing three subscales: AL, BL and ML. There are five items per subscale. Sample items were "My supervisor scolds us when we cannot accomplish our tasks"(AL; Cronbach's α = 0.824),"When I am in trouble, my supervisor will help me promptly"(BL; Cronbach's α = 0.890), and "My supervisor can lead by example"(ML; Cronbach's α = 0.944).

In accordance with previous studies (e.g., Gu et al., 2020; Yao & Hao, 2023), we controlled for five demographic variables: gender, age, education, job tenure and job grade.

Sample and procedure

The participants were S&T innovators from 29 high-tech companies in China, and the collection process was the same as before. Finally, a total of 617 questionnaires were collected, with 574 valid questionnaires (the effective recovery rate was 93.03%). In terms of gender, male = 347 (60.45%) and female = 227 (39.55%). In terms of age (M = 36.46, SD = 9.04), 25 years old or younger = 33 (5.75%), 26–35 years old = 287 (50.0%), 36–45 years old = 144 (25.09%), 46–55 years old = 99 (17.25%) and 56 years old or older = 11 (1.92%). In terms of education, bachelor's degree = 524 (91.29%) and master's degree = 50 (8.71%). In terms of job tenure (M = 10.26, SD = 5.69), less than 1 year = 29 (5.05%), 1–2 years = 33 (5.75%), 3–5 years = 94 (16.38%), 6–10 years = 139 (24.22%), 11–15 years = 101 (17.60%) and more than 15 years = 178 (31.01%). In terms of job grade, senior management or senior title = 81 (14.11%), middle management or intermediate title = 208 (36.24%), low-level management or junior title = 195 (33.97%) and no title = 90 (15.68%).

Results

The descriptive statistical analysis of the variables and the correlations among the variables are presented in Table 5. The results demonstrated that EG (r = 0.202, p < 0.01), RG (r = 239, p < 0.01), and GG (r = 0.284, p < 0.01) were significantly and positively correlated with IB, which preliminarily validated the hypotheses proposed in this study.

Furthermore, AMOS 26.0 software was employed for confirmatory factor analysis to test the discriminant validity of the seven variables. As illustrated in Table 6, the fit indices of the seven-factor model (χ^2 = 2.536 < 3, RMSEA = 0.052 < 0.08, SRMR = 0.049 < 0.05, CFI = 0.943 > 0.90, TLI = 0.937 > 0.90, IFI = 0.943 > 0.90, NFI = 0.910 > 0.90) were acceptable. Moreover, the fit indices of the seven-factor model were significantly superior to those of the competing models. Therefore, the seven variables had good discriminant validity.

Next, Harman's single factor test and confirmatory factor analysis were employed to test the common method bias. Firstly, the results of Harman's single

Table 5 Means, standard deviations and correlations

Variables	1	2	3	4	5	7	8	9	10	11	12	13
1 Gender	1											
2 Age	−0.025	1										
3 Education	0.066	0.042	1									
4 Job tenure	−0.007	0.796**	0.022	1								
5 Job grade	0.084*	−0.533**	−0.226**	−0.579**	1							
7 EG	0.030	−0.051	−0.042	−0.053	0.045	1						
8 RG	−0.003	−0.087*	0.006	−0.092*	0.005	0.518**	1					
9 GG	−0.014	−0.114**	−0.025	−0.125**	0.052	0.676**	0.691**	1				
10 AL	−0.142**	0.037	−0.066	0.076	−0.061	−0.240**	−0.439**	−0.385**	1			
11 BL	−0.049	−0.178**	0.040	−0.217**	0.109**	0.403**	0.567**	0.530**	−0.409**	1		
12 ML	0.007	−0.098*	0.079	−0.125**	0.035	0.390**	0.663**	0.562**	−0.491**	0.705**	1	
13 IB	−0.173**	−0.005	0.006	0.035	−0.128**	0.202**	0.239**	0.284**	0.028	0.264**	0.254**	1
Mean	1.395	36.458	1.087	10.263	2.512	2.849	3.916	3.314	2.917	3.258	3.772	3.724
SD	0.489	9.040	0.282	5.687	0.920	0.907	0.682	0.857	0.810	0.857	0.864	0.703

N = 574, *EG* = Existence Gain, *RG* = Relatedness Gain, *GG* = Growth Gain, *AL* = Authoritarian Leadership, *BL* = Benevolent Leadership, *ML* = Moral Leadership, *IB* = Innovative Behaviour, *SD* = Standard Deviation

** p < 0.01, * p < 0.05

Table 6 Results of the confirmatory factor analysis of the distinguishing variables

Models	χ^2	*df*	χ^2/df	RMSEA	SRMR	CFI	TLI	IFI	NFI
Seven-factor model (EG, RG, GG, AL, BL, ML, IB)	1125.972***	444	2.536	0.052	0.049	0.943	0.937	0.943	0.910
Six-factor model (EG + RG, GG, AL, BL, ML, IB)	1692.308***	450	3.761	0.069	0.074	0.896	0.886	0.897	0.865
Five-factor model (EG + RG + GG, AL, BL, ML, IB)	1754.984***	455	3.857	0.071	0.076	0.892	0.882	0.892	0.860
Four-factor model (EG + RG + GG + AL, BL, ML, IB)	2507.084***	459	5.462	0.088	0.095	0.829	0.816	0.830	0.799
Three-factor model (EG + RG + GG + AL + BL, ML, IB)	3271.129***	462	7.080	0.103	0.109	0.766	0.749	0.767	0.738
Two-factor model (EG + RG + GG + AL + BL + ML, IB)	4004.691***	464	8.631	0.115	0.113	0.705	0.685	0.706	0.680
Single-factor model (EG + RG + GG + AL + BL + ML + IB)	5660.059***	465	12.172	0.140	0.143	0.567	0.538	0.568	0.547
Eight-factor model (EG, RG, GG, AL, BL, ML, IB, CMV)	1111.374***	443	2.509	0.051	0.047	0.944	0.938	0.945	0.911

N = 574, *EG* = Existence Gain, *RG* = Relatedness Gain, *GG* = Growth Gain, *AL* = Authoritarian Leadership, *BL* = Benevolent Leadership, *ML* = Moral Leadership, *IB* = Innovative Behaviour, *CMV* = Common Method Variance, χ^2 = Chi-square, *df* = Degrees of Freedom, χ^2/df = Chi-square to Degree of Freedom, *RMSEA* = Root Mean-Square Error of Approximation, *SRMR* = Standardised Root Mean-Square Residual, *CFI* = Comparative Fit Index, *TLI* = Tucker-Lewis Index, *IFI* = Incremental Fit Index, *NFI* = Normed Fit Index. + represents factor merging

*** $p < 0.001$

factor test demonstrated that a total of five factors with eigenvalues greater than 1.0 were extracted, and the unrotated first principal component explained 36.350% of the variance, which did not exceed 40%. Secondly, the results of the confirmatory factor analysis (see Table 6) revealed that the fit indices of the single-factor model (χ^2 = 12.172, RMSEA = 0.140, SRMR = 0.143, CFI = 0.567, TLI = 0.538, IFI = 0.568, NFI = 0.547) were inadequate. Moreover, compared with the seven-factor model, the increases in CFI and TLI in the eight-factor model with the common method bias factor were less than 0.10 (ΔCFI = 0.001, ΔTLI = 0.001), and the decreases in RMSEA and SRMR were less than 0.05 (ΔRMSEA = 0.001, ΔSRMR = 0.002). Therefore, there was no serious common method bias in this study.

Finally, the hierarchical multiple regression method was employed for hypothesis testing. As shown in Model 2, Model 3 and Model 4 in Table 7, after adding control variables, the effects of EG, RG and GG on IB of S&T innovators were 0.211 ($p < 0.001$), 0.235 ($p < 0.001$) and 0.286 ($p < 0.001$), respectively. Therefore, Hypothesis 1a, Hypothesis 1b and Hypothesis 1c were supported. Moreover, when no control variables were included in the regression model, EG ($\beta = 0.202$, $p < 0.001$), RG ($\beta = 0.239$, $p < 0.001$) and GG ($\beta = 0.284$, $p < 0.001$) had significant and positive effects on IB. Compared with the results when the control variables were entered into the model, the results did not change substantially, which indicated that the results of this study had good robustness.

Furthermore, the moderating effects of three dimensions of PL were examined. As presented in Model 5, Model 6, and Model 7 in Table 7, AL significantly and negatively moderated the relationships between EG ($\beta = -0.113$, $p = 0.005 < 0.01$), RG ($\beta = -0.181$, $p < 0.001$), GG ($\beta = -0.166$, $p < 0.001$) and IB, thereby supporting Hypothesis 2a, Hypothesis 2b and Hypothesis 2c. Model 8, Model 9 and Model 10 exhibited that BL significantly and positively moderated the relationships between EG ($\beta = 0.119$, $p = 0.003 < 0.01$), RG ($\beta = 0.259$, $p < 0.001$), GG ($\beta = 0.221$, $p < 0.001$) and IB. Therefore, Hypothesis 3a, Hypothesis 3b and Hypothesis 3c were supported. Similarly, Model 11, Model 12 and Model 13 exhibited that ML significantly and positively moderated the relationships between EG ($\beta = 0.141$, $p < 0.001$), RG ($\beta = 0.283$, $p < 0.001$), GG ($\beta = 0.221$, $p < 0.001$) and IB, thereby supporting Hypothesis 4a, Hypothesis 4b and Hypothesis 4c.

Discussion

On the basis of the literature analysis, the Better Life Index and the ERG theory, we analysed and summarised the three dimensions of the STISWG, namely, the EG, RG, and GG. An initial scale of the STISWG with 20 items was then formed. Subsequently, item analysis, exploratory factor analysis, confirmatory factor analysis, reliability and validity tests and other methods were employed to optimise and validate the scale, and a scale containing 11 items in three dimensions was generated. In addition, a theoretical model was constructed and tested to further verify the external validity of the

Table 7 Results of the regression analysis

Variables	Innovative Behaviour												
	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13
Control variables													
Gender	−0.161***	−0.168***	−0.162***	−0.158***	−0.153***	−0.134**	−0.134**	−0.140***	−0.127**	−0.136***	−0.156***	−0.147***	−0.149***
Age	−0.130	−0.126	−0.117	−0.117	−0.116	−0.093	−0.103	−0.115	−0.101	−0.103	−0.109	−0.100	−0.107
Education	−0.015	−0.007	−0.014	−0.007	0.001	0.003	0.011	−0.016	−0.011	0.001	−0.021	−0.024	−0.010
Job tenure	0.045	0.052	0.068	0.077	0.038	0.060	0.071	0.090	0.093	0.106	0.072	0.085	0.098
Job grade	−0.161**	−0.161**	−0.142**	−0.148**	−0.161**	−0.118**	−0.136**	−0.160**	−0.139**	−0.137**	−0.155**	−0.124*	−0.136**
Independent variables													
EG		0.211***			0.231***			0.116**			0.109*		
RG			0.235***			0.357***			0.211***			0.177***	
GG				0.286***			0.376***			0.249***			0.204***
Moderating variables													
AL					0.038	0.127**	0.105*						
BL								0.259***	0.247***	0.228***			
ML											0.268***	0.277***	0.256***
Interactions													
EG × AL					−0.113**								
RG × AL						−0.181***							
GG × AL							−0.166***						
EG × BL								0.119**					
RG × BL									0.259***				
GG × BL										0.221***			
EG × ML											0.141***		
RG × ML												0.283***	
GG × ML													0.221***
F	6.052***	9.881***	11.091***	14.224***	8.667***	12.016***	14.344***	12.204***	15.980***	16.537***	12.252***	15.899***	15.685***
R^2	0.051	0.095	0.105	0.131	0.109	0.145	0.169	0.147	0.185	0.190	0.148	0.184	0.182
ΔF	6.052***	27.609***	34.503***	52.350***	7.876**	18.545***	16.793***	8.610**	36.326***	27.334***	11.095***	41.265***	25.179***
ΔR^2	0.051	0.044	0.054	0.080	0.012	0.028	0.025	0.013	0.052	0.039	0.017	0.060	0.036

N = 574, *EG* = Existence Gain, *RG* = Relatedness Gain, *GG* = Growth Gain, *AL* = Authoritarian Leadership, *BL* = Benevolent Leadership, *ML* = Moral Leadership, *IB* = Innovative Behaviour

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

STISWG scale. The results demonstrated that the EG, RG and GG of S&T innovators could effectively improve IB. Moreover, AL weakened these positive relationships, whereas BL and ML strengthened them.

Theoretical implications

Firstly, the connotation and structural dimensions of the STISWG were clarified. Previous studies have focused mainly on migrant workers [11] and college students [12] and have less explored employees (especially S&T innovators) in the organisation. Existing studies on SWG in organisational contexts have also focused on the universal needs of all employees in the organisation [6, 7], which cannot reflect the complex need structure of S&T innovators in detail. This study focused on S&T innovators, defined the SWG of this specific group and proposed that the STISWG contained three dimensions (i.e., EG, RG and GG) based on the ERG theory. It further enriches the knowledge and understanding of the STISWG.

Secondly, the STISWG scale was developed and validated. This study developed an SWG scale specifically for the group of S&T innovators through item analysis, exploratory factor analysis, confirmatory factor analysis, and reliability and validity tests. The results of exploratory and confirmatory factor analyses exhibited that the STISWG had a clear three-dimensional structure with a cumulative variance contribution rate of 73.532%. Among them, the EG had three items, and RG and GG had four items each. The results of reliability and validity analyses demonstrated that the STISWG scale with three dimensions, had satisfactory reliability and validity. This provides a quantitative, operational and effective measurement instrument for subsequent empirical research on the STISWG.

Thirdly, the relationship model between STISWG and IB was constructed. Previous research has shown that organisational support and leadership style have important impacts on employees' IB [9], which provides the basis for the construction of the theoretical model in this study. Based on the Organisational Support theory, this study explored the influence mechanism of S&T innovators' IB from both organisational and leadership perspectives. Moreover, the reliability and validity of the STISWG scale was further verified in the empirical testing process. The enhancement of the EG, RG and GG of S&T innovators prompted them to produce more IB, which was consistent with the findings of previous studies [8, 10]. In addition, this study revealed that AL weakened the promotional effects of the three dimensions of the STISWG on IB, whereas BL and ML strengthened the promotional effects. This further expands the boundary conditions under which STISWG affects IB.

Managerial implications

Given the above analysis, the following managerial implications are proposed, with the aim of guiding organisations to enhance S&T innovators' SWG and IB.

Firstly, organisations can dynamically monitor the level of the STISWG. The STISWG scale developed in this study has good psychometric properties and thereby provides a reliable and valid measurement instrument for organisations to dynamically assess the current status of the STISWG. On this basis, organisations can provide employees with targeted resource support to meet their differentiated needs, thus enhancing their SWG and stimulating their intrinsic motivation for innovation.

Secondly, organisations should meet the differentiated needs of S&T innovators. SWG is closely related to employees' needs [7, 11]. Thus, meeting the diverse needs of S&T innovators helps to enhance their SWG and thereby stimulates their innovative vitality. First of all, the existence needs of S&T innovators should be met. Organisations should give employees the resources they need to survive, including equal and fair wages and warm welfare policies, which can stimulate their creative vitality. Next, the relatedness needs of S&T innovators should be met. Organisations can regularly organise company team-building activities [14] to strengthen the communication between leaders and subordinates, bring colleagues closer, and improve the quality of employee relationships. It should also create a pleasant, honest and ethical working atmosphere, laying a good foundation for the generation of IB. Finally, the growth needs of S&T innovators should be met. Organisations should increase the investment in employee education and training and provide them with growth resources and fair promotion opportunities. Moreover, organisations can stimulate employees' intrinsic motivation to pursue self-worth realisation by setting a working example.

Thirdly, leaders should cultivate and demonstrate an appropriate paternalistic leadership style. This study found that under different paternalistic leadership styles, there was a difference in the promotion effect of the STISWG on IB. Therefore, leaders should adopt an appropriate paternalistic leadership style. On the one hand, leaders need to avoid authoritarian leadership as much as possible. They can communicate more with employees, share information, appropriately affirm employees' abilities and authorise employees [3], thus stimulating employees' intrinsic motivation for innovation. On the other hand, leaders should adopt more benevolent and moral leadership styles. For example, leaders should support employees with necessary work and emotional resources in both work and nonwork domains and allow them to make mistakes [21, 22], which helps alleviate their psychological burdens when

they innovate. Meanwhile, leaders should lead by example in their work and be dedicated to the overall interests of the organisation and the fair growth of employees, which makes it easier to stimulate employees' dedication and sense of responsibility [22] and thereby promote innovation.

Limitations and outlook

This study still suffers from the following shortcomings. Firstly, both scale development and validation employed cross-sectional data. Future researchers can consider adopting either a longitudinal research design or a combination of cross-sectional and longitudinal approaches, which will help test the test–retest reliability of the scale and the dynamic relationships among the variables. Secondly, the study sample came from the same country. Follow-up studies can select survey samples in multiple countries or regions to make the research sample more representative and extensive. Thirdly, only employee innovative behaviour and paternalistic leadership were selected as related criteria, but STISWG, as a positive perceived emotion, can affect employees' attitudes, behaviours, performance and other aspects. Subsequent studies can further explore the relationships between the STISWG and other variables from multiple perspectives and at multiple levels, thereby testing the criterion-related validity of the scale in greater depth.

Conclusion

This study defined the concept and structural dimension of the STISWG and developed a measurement scale on this basis. There were 11 items on the scale, including three items for the EG and four items for the RG and GG. The empirical results demonstrated that the STISWG scale had satisfactory psychometric properties. Specifically, the scale had a clear three-factor structure, and the Cronbach's α values of the whole scale and three subscales were greater than 0.8. Moreover, the predictive validity demonstrated that the STISWG was an effective predictor of IB. In general, the scale developed in this study provides an effective instrument for academia to carry out empirical research on the STISWG and industry to dynamically monitor the status quo of the STISWG.

Abbreviations

SWG	Sense of Work Gain
STISWG	S&T Innovators' Sense of Work Gain
ERG	Existence, Relatedness and Growth
EG	Existence Gain
RG	Relatedness Gain
GG	Growth Gain
PL	Paternalistic Leadership
AL	Authoritarian Leadership
BL	Benevolent Leadership
ML	Moral Leadership
IB	Innovative Behaviour
EFA	Exploratory Factor Analysis
CFA	Confirmatory Factor Analysis
CITC	The Corrected Item-Total Correlation
CMV	Common Method Variance
χ^2	Chi-square
df	Degrees of Freedom
χ^2/df	Chi-square to Degree of Freedom
RMSEA	Root Mean-Square Error of Approximation
SRMR	Standardised Root Mean-Square Residual
CFI	Comparative Fit Index
TLI	Tucker-Lewis Index
IFI	Incremental Fit Index
NFI	Normed Fit Index
GFI	Goodness of Fit Index
AVE	Average Variance Extracted
CR	Composite Reliability

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Authors' contributions

YL, YG and YH conceived and designed this study, and collected the different data. YL and TL analysed the data and drafted the manuscript. YL, YG and YH and provided substantial revisions or suggestions for the manuscript. All authors have read and approved the final manuscript.

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Data availability

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

According to Article 32 of the "Measures for Ethical Review of Life Sciences and Medical Research Involving Human Beings" issued by China in 2023, ethical review can be exempted. This study was carried out in compliance with the Helsinki Declaration. The participants provided their written informed consent to participate in this study.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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