

Regulatory Focus, Ambidextrous Learning, and Opportunity Recognition in New Product Development

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Declarations of interest

None

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Abstract

This study focuses on individual managers' ambidextrous learning and examines its psychological antecedents and consequences in the new product development (NPD) context. Specifically, drawing on the paradox theory and the regulatory focus theory, this study examines the relationship between regulatory focus (i.e., promotion focus and prevention focus), ambidextrous learning, and NPD opportunity recognition, from the individual ambidexterity perspective. Based on survey data of 225 NPD managers in high-tech small and medium-sized enterprises (SMEs) in China, we find that NPD managers' promotion focus and prevention focus, acting as an enabler and a deterrent respectively, affect their ambidextrous learning, which in turn facilitates opportunity recognition in the NPD process. Further analyses reveal that ambidextrous learning mediates the effects of promotion focus and prevention focus on opportunity recognition in the NPD. Our findings offer new insights on the individual ambidexterity research regarding the unique role of ambidextrous learning, manifested as actionable managerial capability. The findings offer novel insights on the role of NPD managers' ambidextrous learning in the NPD process, and practical implications for NPD managers to self-regulate their behavior for the benefit of opportunity recognition.

Managerial relevance statement

This study has several managerial implications, especially for high-tech small and medium-sized enterprises (SMEs). First, this study highlights the importance of selecting and appointing NPD managers with a high level of promotion focus and a low level of prevention focus to boost ambidextrous learning towards opportunity recognition in the NPD process. Second, our findings point to the role of ambidextrous learning in converting NPD managers'

promotion focus towards opportunity recognition in NPD. Their ability to engage ambidextrous learning helps overcome the lack of sufficient resources in SMEs required to structurally or temporally separate exploration from exploitation. Overall, this study suggests that high-tech SMEs can make headway to stimulate exploitative and exploratory learning, and NPD managers should espouse ambidextrous learning, benefiting from the synergy of exploratory and exploitative learning.

I. INTRODUCTION

Organizational ambidexterity refers to a firm's ability to reconcile the tension between exploitation and exploration [1]. To balance the persistent tensions of exploration and exploitation, the existing research on organizational ambidexterity has predominantly focused on the organizational-level solutions. In particular, two distinctive approaches are proposed: the separation-oriented approach, such as structural ambidexterity [2] and temporal ambidexterity [3] where exploration and exploitation are separated structurally or temporally; and the integration-oriented approach, that is, contextual ambidexterity where exploration and exploitation are simultaneously integrated, and individuals are required to make the judgement on how to balance exploration and exploitation [4]. In this context, individual ambidexterity is defined as an individual's simultaneous pursuit of exploratory and exploitative activities, reflecting an individual's capability to engage with and shift between exploration and exploitation [5]. The knowledge on how individual themselves address these tensions to accomplish ambidexterity is still incomplete. Most importantly, the understanding of the antecedents and effects of individual ambidexterity largely remains fragmented [6].

In March's [7] seminal work, exploration and exploitation involve contrasting learning processes that may have the crowding out effects against each other. How exploratory and exploitative learning can be balanced to achieve their synergistic effect and avoid their trade-

off remains under-researched [4], particularly at the individual level. Such neglect is problematic, as it allows neither scholars nor managers to sufficiently understand how to interpret and manage the tension between exploratory and exploitative learning. Indeed, this is especially pertinent for new product development (NPD) project managers in high-tech small and medium-sized enterprises (SMEs). NPD is the lifeline of high-tech SMEs operating in hyper-competitive markets, which involves the interaction of exploratory and exploitative activities to take a new product from its conception to commercialization [8]. Compared with larger organizations, SMEs are often constrained with resources to structurally or temporally separate exploration from exploitation [9, 10]. This poses a great demand for NPD managers' ambidextrous learning in identifying an opportunity and implementing a solution in their SMEs. The existing research has verified that managerial actions could enable project-based ambidexterity [11]. However, the significance of NPD managers' ambidextrous learning in business practice has not been matched with considerable advancement of knowledge.

In this case, our study embraces the integration-oriented approach to define ambidextrous learning as NPD managers' managerial capability to engage with exploratory and exploitative learning in the NPD process. How managers make a judgement on exploratory and exploitative activities is self-regulated [9], especially in the SMEs where roles and responsibilities are more flexible than in large corporations [12]. We argue that the paradox theory offers a valuable lens to research on individual ambidexterity [13], and for "exploring cognitive and behavioral aspects of how individuals may deal with contradictory demands" [5, p.144]. Further, this study also builds on the regulatory focus theory, which explains "how people self-regulate their behaviors towards goals and standards" [14, p.512]. We distinguish two types of regulatory focus - promotion focus and prevention focus to shed light on psychological antecedents to managers' ambidextrous learning [15], which is paramount for recognizing opportunities. We, thus, aim to answer two research questions: *To*

what extent does NPD managers' regulatory focus affect their ambidextrous learning? How do prevention focus and promotion focus affect opportunity recognition in the NPD context?

Drawing on the paradox theory and regulatory focus theory, this study focuses on NPD managers' ambidextrous learning, from the individual ambidexterity perspective, and examines its psychological antecedents and its effects on opportunity recognition, using survey data of 225 NPD managers in high-tech SMEs in Shanghai, China. This study makes contributions to the individual ambidexterity literature in two ways. First, this study unpacks how individuals engage in ambidextrous learning, by examining the individual-level psychological antecedents to managers' ambidextrous learning, a missing link in ambidexterity research [16], [17]. In so doing, we address a call by Schnellbacher *et al.* [6] for more psychological antecedents of individual ambidexterity. Second, this study contextualizes ambidextrous learning in the NPD context, a hotbed for managerial ambidexterity [11]. We thus contribute to the ambidexterity-as-a-paradox research by exploring NPD managers' ambidextrous learning in high-tech SMEs. It is a step forward toward understanding the integration-oriented approach to ambidexterity and extends our understanding of individual ambidexterity in practice.

II. THEORY AND HYPOTHESES

A. Ambidexterity as a Paradox

The concept of ambidexterity assumes that organizations pursue complementary yet contradictory goals of exploitation and exploration [5]. Exploitation refers to “refinement, choice, production, efficiency, selection, implementation, execution”, and exploration entails “search, variation, risk-taking, experimentation, play, flexibility, discovery” [7, p.71]. It is widely acknowledged that organizational ambidexterity can take three forms [12]: exploration and exploitation can be structurally separated between business units (i.e.,

structural ambidexterity), temporally separately in different times (i.e., temporal ambidexterity), or simultaneously in the same business unit at the same time (i.e., contextual ambidexterity). The first two forms take the separation-oriented approach to ambidexterity. Although structurally or temporally separately ambidexterity helps avoid the potential tension between exploratory and exploitative learning, switching between them can be challenging. In high-tech SMEs, it may not be feasible to take this approach due to the resource constraints and the shortened lead time required to recognize an NPD opportunity and develop it into a commercially viable product. Indeed, high-tech SMEs may have no choice but to pursue contextual ambidexterity [4]. But contextual ambidexterity is challenging to implement as it requires individuals to make judgement on how to balance exploration and exploitation according to the circumstances [12]. The paradox theory provides insights on how to implement contextual ambidexterity.

A paradox is defined as “contradictory yet interrelated elements that seem logical in isolation but absurd and irrational when appearing simultaneously” [18, p. 760]. A paradox is usually illustrated by the Taoist symbol of ‘Yin and Yang’, a Chinese traditional philosophy, which explains how we use a both/and framework to foster reconciliation of the interdependent opposites [19]. Thus, a paradoxical view of ambidexterity offers a promising perspective for explaining individual ambidexterity, which moves beyond separation and proposes integration as an alternative way of managing tensions [5]. Scholars informed by the paradox theory consider the tensions between exploration and exploitation as duality [20, 21]. For example, Farjoun [20] suggests that the duality view in which change and stability are oppositional but mutually enabling and interconnected, rather than mutually exclusive and incompatible. Further, the ambidexterity-as-a-paradox perspective conceptualizes “exploration and exploitation tensions not as necessarily mutually exclusive but as dynamic, interwoven polarities” [5, p.144].

Although existing literature has systematically reviewed the conceptualization, antecedents, forms, and consequences of individual ambidexterity [9], it is dominated by the separation-oriented prescriptions, and we are still unclear about how ambidexterity can be achieved at the managerial level [11]. This challenge is amplified for managers who bear a high level of responsibilities of resolving the tension between exploration and exploitation arising from the management at the top and the employees on the shop floor. However, the empirical studies have largely ignored how managers address the exploration-exploitation tensions within everyday business practice [5]. Understanding how ambidextrous behavior emerges helps to illuminate how organizations can manage such individual ambidexterity [15]. Drawing insights from the paradoxical view of ambidexterity, this study proffers that individual ambidexterity could be accomplished through paradoxical practice such as ambidextrous learning in the NPD process, which is elaborated in the following section.

B. Ambidextrous Learning in the NPD Process

Prior literature has discussed the respective roles of exploitative and exploratory learning in NPD [22-24] and recognizes the fact that exploration and exploitation can complement and often mutually support each other in practice [9, 25]. For example, in the NPD context, as project managers perform repetitive tasks such as upgrading existing products, they also engage in some experimentation; when performing creative tasks such as developing new products, they often use established procedures. Especially, facing the escalating hyper-competition in a dynamic business environment, successful NPD must engage with both exploratory and exploitative learning successfully [24].

Specifically, within high-tech SMEs, the NPD process poses challenges for NPD managers. For example, Research & Development requires both exploratory research in the conception phase and exploitative development in the execution phase [7]. High-tech SMEs,

given the shortened product life cycle and heightened competition, often have no choice but to exploit existing competences for short-term commercial benefits and simultaneously explore new competences for long-term success [26]. In this case, NPD managers must be equipped with the ability to exploit existing competences to capitalize on commercial benefits and explore new competences to enhance the potential for recognizing new opportunities.

Questions remain on what motivates individual managers to engage in ambidextrous learning [27]. Research on ambidextrous learning has predominantly focused on organizational antecedents, such as the organizing paradox [28] and collaborative innovation [29], leaving a glaring research gap on individual ambidexterity. As Raisch *et al.* [30] assert, not only organizational factors, but most importantly individual characteristics, determine individual ambidexterity. A small number of studies have explored micro-level drivers of individual ambidexterity, but most of them, from human resource management, focuses on the organizational systems that enable individual to act ambidextrously [31]. Notably, recent studies have started to investigate psychological factors of individual ambidexterity, which combine traits associated with exploitation and exploration respectively, such as assessment orientation and locomotion orientation [15], or prevention focus and promotion focus [17]. However, these studies only focus on individuals' exploration and/or exploitation activities and have ignored how they address the tensions between these dual activities such as ambidextrous learning. The lack of understanding of individual-level antecedents to ambidexterity, especially psychological antecedents, is problematic, creating a vacuum in the understanding of ambidextrous learning. Below, we draw on the regulatory focus theory to understand how individuals' regulatory focus influences their ambidextrous learning.

C. Regulatory Focus Theory

Existing studies highlight the role of self-regulatory mechanisms on exploration and exploitative separately [16, 17] in individual ambidextrous behaviors. Kauppila and Tempelaar [32] stress the importance to improve the understanding of individuals' self-regulatory mechanisms and how they serve the roles of the motivational underpinnings that shape individuals' ambidextrous behavior. Hence, this prompts us to pursue regulatory focus theory, as a motivational theory of goal attainment, to shed light on how NPD managers self-regulate themselves to engage in ambidextrous learning and thus optimize their learning potential towards recognizing opportunities in the NPD process.

Regulatory focus theory explains how individuals self-regulate their behaviors towards future self-states [33]. Regulatory focus can take place as a chronic trait or situational tendency [14], which has been applied to explain individual motivational tendencies [15]. In line with Tumasjan and Braun [34], this study focuses on the chronic trait of regulatory focus, as its stable nature has been empirically verified [35, 36]. In particular, this study focuses on two dimensions of regulatory focus: promotion and prevention focus [33]. Individuals with a high level of promotion focus are primarily concerned with advancement, growth, and accomplishment and therefore motivated to seek gains and new achievements [34, 37]. In contrast, individuals with a high level of prevention focus are primarily concerned with protection, safety, and responsibility, and thus tend to be motivated to avoid losses [34, 37]. Promotion focus and prevent focus can coexist, independent of each other [35]; they are not the "opposite ends of a single continuum" [14].

Regulatory focus has been found to influence exploitation and exploration respectively at the firm level [36, 38] and the individual level [16, 17]. Besides, research has paid particular attention to the effect of regulatory focus on exploration [39, 40]. These studies have shed lights on the psychological role of regulatory focus, as the powerful enablers and deterrents, in exploratory and exploitative activities, respectively. However, this provides an

incomplete understanding of how regulatory focus works in specific contexts such as NPD, where ambidextrous learning is required. This has largely restricted our understanding of how NPD manager's regulatory focus affects their ambidextrous learning in the NPD process.

D. Regulatory Focus and Ambidextrous Learning

The paradox research asserts that managing ambidexterity tension in daily work could be seen as a paradoxical cognitive practice [5], which varies in individuals depending on their self-regulatory traits. Indeed, Tuncdogan and Dogan [17] find that managers' exploration-exploitation activities are affected by their regulatory focus. In the NPD context, our study argues that NPD managers' promotion and prevention focus, served as distinct self-regulatory mechanisms, have contrasting effects on their ambidextrous learning in the NPD process.

First, promotion focus and prevention focus are associated with different sensitivity to potential outcomes incurred by ambidextrous practice [38]. Promotion-focused individuals are motivated by the potential gains and keen to pursue such gains [37], and therefore promotion focus is associated with "keeping their head in the sky" [14, p.509]. Promotion-focused NPD managers are motivated to pursue goals such as improving their projects' competitive position to the best possible level. While refining existing knowledge toward improvement, promotion-focused NPD managers are not risk-averse when it comes to developing new knowledge. Therefore, they would embrace ambidextrous learning to refine and extend the existing competencies, technologies, and paradigms [6], and adopt considerable experimentation with new alternatives in developing new products [22]. Indeed, Zhao and Thompson [13] find that, to work towards goals, promotion-focused managers in SMEs are more likely to invest in a variety of managerial approaches, which may contain exploitative and exploratory learning. On the contrary, prevention focus is described as "keeping their feet on the ground" [14, p.509], using careful avoidance means to mitigate

potential losses [37]. Prevention-focused NPD managers strive to fulfil their minimal goals, which typically relate to improving product or service quality according to customer requests or their own needs for security and responsibility. Due to their basic need for responsibility, prevention-focused individuals are intrinsically motivated to continuously reduce error rates [41]. The substantial risks and the potential NPD failure would take prevention-focused managers out of their comfort zone. Thus, compared with promotion-focused managers, prevention-focused managers are less likely to engage in ambidextrous learning in the NPD.

Second, promotion- and prevention-focused NPD managers differ in their attitudes towards learning opportunity. When facing the same stimuli, promotion-focused individuals, given their risk-taking tendency, usually set lower thresholds for a potential learning opportunity and are more willing to work on this opportunity than prevention-focused individuals [42]. They are more prone to be open-minded and willing to consider a wide range of information relating to NPD; such traits allow them to actively find solutions and generate a high number of alternative NPD ideas. In contrast, prevention-focused individuals set higher thresholds for a potential learning opportunity due to fear of loss and act more cautiously. The contrasting approaches to learning opportunities suggest that promotion-focused managers are more likely to engage in ambidextrous learning in the NPD process.

Third, promotion- and prevention-focused NPD managers vary in their attitudes towards NPD project failure and their behavior of learning from failure. Failure is inherent to innovation projects [32]. Specifically, NPD projects, especially those that serve as the foundations of high-tech ventures [33], are associated with high risks and hence a high likelihood of failure [34]. NPD managers endeavor to prevent project failures in the first place, but if and when a failure occurs, they vary in their attitudes towards failure and their behavior of learning from failure [35]. Promotion-focused managers generally focus on attaining gains [37]. This means, when encountering frequent NPD project failure,

promotion-focused managers, despite a setback, can remain focused on the task at hand and open-minded to new information [34], which increases the likelihood of engaging in more thorough information processing facing project failure. They may regard the failure as another learning opportunity for searching for new solutions or new development direction. They follow the law of ‘trial and error’ and hold the idea that success comes after learning from failure [43]. Thus, promotion-focused managers tend to continuously focus on ambidextrous learning in the NPD process. In contrast, prevention-focused managers tend to concentrate on avoiding losses [37]. When encountering frequent NPD project failures, they are more hesitant to spend time on processing novel information and are thus more likely to discount signals of a potential learning opportunity. They are thus expected to accept the NPD failure with a negative emotion and regard it as just a failure, which decreases the likelihood of ambidextrous learning in the NPD process. Hence:

H1: Promotion focus has a positive effect on ambidextrous learning in the NPD process.

H2: Prevention focus has a negative effect on ambidextrous learning in the NPD process.

E. Ambidextrous Learning and Opportunity Recognition

Up to now, very few researchers argue for the roles of exploratory and exploitative learning independently in opportunity recognition (e.g., [44]), but in a general entrepreneurial context. The NPD process often involves high risks with high potential rewards, and NPD managers have high stakes in the success and failure of NPD projects [8]. More importantly, the intense competition has driven managers to explore new competences and exploit existing competences simultaneously, especially in high-tech firms [4]. Thus, in the context of NPD in high-tech SMEs, managers’ ambidextrous learning is paramount to opportunity recognition. Lumpkin and Lichtenstein [45] presume that various types of organizational learning enhance firms’ ability to recognize opportunities by creating new specific knowledge. In a similar vein,

this study argues that NPD managers' ambidextrous learning facilitates opportunity recognition through simultaneous knowledge accumulation and creation in high-tech SMEs.

In the NPD process, exploitative learning facilitates information collection with a well-defined product or market solution space, while exploratory learning works well in an ill-defined solution space that covers a heterogeneous knowledge domain [22]. The NPD process often involves a combination of well-defined and ill-defined solutions regarding products and markets, where the interaction of exploitative and exploratory learning is argued to provide complementary resources for knowledge accumulation, refinement, renewal, and creation, as well as learning towards new product and market opportunity recognition [46]. Indeed, the beneficial effect of ambidextrous learning on NPD performance through knowledge refinement and renewal has been empirically verified [47]. Thus, ambidextrous learning is a viable option for the high-tech firms to recognize NPD opportunities especially in an emerging economy such as China where the product life cycle is shortened [47].

Further, the paradoxical view of ambidexterity argues that paradoxical behavior could mitigate the inertial risk of established cognitive frames [5]. Indeed, ambidextrous learning mitigates the risks arising from an overemphasis on exploratory learning which may increase marginal risk and opportunity cost, or an overemphasis on exploitative learning which might incur organizational inertia, decreasing adaptability to new opportunities [47]. Indeed, prior research has alluded to the fact that managers' ambidextrous behavior would facilitate new opportunity identification [48]. This study thus argues that ambidextrous learning enhances NPD managers' opportunity recognition by replicating their prior technological and market knowledge and adding new variants of knowledge to their knowledge repertoire. Hence:

H3: Ambidextrous learning positively affects opportunity recognition in the NPD process.

F. The Mediating Role of Ambidextrous Learning

Further to the hypotheses of prevention focus and promotion focus as the psychological antecedents to NPD managers' ambidextrous learning, and opportunity recognition as the consequence of ambidextrous learning, this study argues that ambidextrous learning mediates the relationship between regulatory focus and opportunity recognition in the NPD process. Existing literature provides evidence on the direct effect of regulatory focus on opportunity evaluation [49], recognition [34] and exploitation [50]. Specifically, Kushev *et al.* [49] find that dispositional prevention focus is negatively related to opportunity attractiveness, while the positive effect of dispositional promotion focus is not significant. Further, in the pre-firm stage, promotion focus is found to be positively related to opportunity recognition, while prevention focus is not related to opportunity recognition [34].

Regulatory focus represents individuals' chronic traits [35, 36]. While individual traits and information search are influential factors of opportunity recognition [46], it is the cognitive and learning process that shapes individuals' opportunity recognition [51]. It is widely acknowledged that traits alone do not always explain behaviors. Indeed, scholars have long warned the danger of focusing on individual traits alone and precluding individuals' ability to learn, develop and change. The related research also illustrates that learning styles mediates the relationship between personality traits and individual achievement [52].

The paradoxical view of ambidexterity regards ambidexterity as a dynamic duality between exploration and exploitation that individuals could engage with through their daily actions [5]. Our study argues that NPD managers' promotion focus and prevention focus provide a basic psychological precursor to their behavior of engaging in different types of learning [16, 17], as this study previously discussed. It is through ambidextrous learning that NPD managers accumulate information, assimilate it with existing knowledge and create new knowledge required to recognize new product and market opportunities [44]. Ambidextrous

learning thus serves as a mechanism that translates NPD managers' regulatory focus to their ability to recognize opportunities in the NPD process. Hence:

H4: Ambidextrous learning mediates the positive effect of promotion focus on opportunity recognition in the NPD process.

H5: Ambidextrous learning mediates the negative effect of prevention focus on opportunity recognition in the NPD process.

III. METHODOLOGY

A. Sample

Survey data were collected from high-tech SMEs in Shanghai, China. High-tech firms rely on NPD to obtain competitive advantage, especially in turbulent emerging markets such as China [53]. They must consolidate existing competences and explore new competences simultaneously [4], providing a suitable setting for ambidexterity research [26]. High-tech SMEs in China experience accelerated growth, accompanied by an increasing demand for ambidextrous activities [26]. This study focuses on high-tech SMEs in Shanghai, one of the most high-tech cities in China, with a high concentration of high-tech industries.

The initial sample frame consisted of 1812 high-tech SMEs with innovative technology-based projects that were recorded by the *Science and Technology Committee of Shanghai Municipality*. The contact information of the executives from the firms' registration information on China's *National Enterprise Credit Information Publicity System* (NECIPS) was obtained. The executives were asked to recommend NPD project managers to take part in this study, as they were the projects' key resource providers and final decision-makers with comprehensive knowledge of the NPD process [54]. This complies with the research practice of previous studies [47, 26].

This study finally received 225 usable responses (an effective response rate of 12.42%) after quality control screening¹. For example, we only included the high-tech SMEs which had fewer than 300 employees according to the *Law of the People's Republic of China on the Promotion of Small and Medium-sized Enterprises (2017)*. Most of the sample firms were privately held (i.e., 84%) and from electronic information industry (i.e., 43.1%). Besides, 86.7% of them were established for less than 10 years. Regarding the respondents, most of them obtained a Bachelor degree (i.e., 70.7%), while 52.9% were male and 51.1% were under 40 years old. To address the potential risk of non-response bias, this study compared responding and nonresponding firms provided in the NECIPS following Armstrong and Overton [55]. The t-test of the average firm age ($t = -0.81$) and the average firm size ($t = 1.10$) of the participating firms and non-participating firms did not reveal significant differences between the two groups.

B. Measures

The survey questionnaire was first developed in English, followed by a rigorous and iterative back-translation process. The questionnaire was pre-tested with two UK professors with expertise in entrepreneurship and innovation, and expert knowledge in cross-cultural questionnaire surveys. It was then piloted with 10 NPD project managers in high-tech SMEs in Shanghai. Feedback from the pre-test and the pilot study was fully incorporated in the final questionnaire. This study used established measures wherever possible, to maximize construct validity.

Regulatory focus. Referring to Tumasjan and Braun [34], this study adapted the wording of questions from an academic context [56] to the NPD context. This study used 7-point Likert scales with nine items to assess promotion focus (e.g., “My major goal in NPD

¹ A table of the profile of sample is available upon request.

right now is to achieve my career ambitions”) and prevention focus (e.g., “My major goal in venture right now is to avoid becoming a career failure”).

Opportunity recognition. Referring to Ozgen and Baron [51], we measured opportunity recognition using three items (e.g., “I have a special alertness or sensitivity towards new NPD opportunities”) with 7-point Likert scales focusing on the self-perceived ability to recognize opportunities and alertness to present opportunities. The self-reported measures were appropriate to gauge the ability to recognize opportunities, in line with recent studies [57, 58].

Ambidextrous learning. Measures of ambidexterity, especially ambidextrous learning are incongruent in the prior literature. For instance, at the managerial level, it is mainly measured as multiplicative ambidexterity [59], additive ambidexterity [60], subtractive ambidexterity [61]. However, the balance dimension (BD, calculated through subtraction) and combined dimension (CD, calculated through addition or multiplication) could not illustrate ambidexterity fully [29]. The paradox perspective of individual ambidexterity should consider both the balanced and combined dimensions. Thus, this study incorporated these two dimensions together to measure ambidextrous learning, in line with prior studies [e.g., 29].

First, this study used separate scales with five items developed and validated by Atuahene-Gima and Murray [22] in the context of NPD projects in Chinese high-tech SMEs to measure exploitative learning (e.g., “I emphasized the use of knowledge related to our existing NPD project experience.”) and exploratory learning (e.g., my aim was to collect new information that forced us to learn new things in the NPD project), respectively.

Second, this study used the absolute difference between exploitative and exploratory learning to represent the BD and calculated the product of exploitative and exploratory learning to represent the CD. To keep the final score of ambidextrous learning in accordance with the 7-point Likert scale in our questionnaire, this study further used 7 minus the BD, taking the square root of the CD, and divided the final product by 7. Finally, referring to Xie

et al. [29], this study used the following formula to measure ambidextrous learning by reflecting both indispensable dimensions:

$$\textit{Ambidextrous learning} = f(\textit{BD}, \textit{CD}) = \frac{(7 - \textit{BD}) * \sqrt{\textit{CD}}}{7}$$

Control variables. As managers' human capital has a potential influence on their ambidexterity and opportunity recognition [62], this study controlled for respondents' age (1= 29 or less, 2 = 30 to 40, 3 = 41 to 50, 4 = 51 and above), gender (male = 1; female = 0), and education (1 = below bachelor, 2 = bachelor, 3 = master, 4 = PhD). As Ozgen and Baron [51] argue that entrepreneurs with high entrepreneurial efficacy are more likely to adopt proactive search for opportunities, this study controlled for entrepreneurial self-efficacy. Empirical evidence from Ucbasaran *et al.* [63] shows that the extent and nature of an individual's prior experience affect opportunity identification. The NPD managers were asked to indicate "the total number of NPD projects they had managed while at their current position" (hereafter labelled as prior managing experience) as well as what the "overall number of failures they had experienced with those projects" (hereafter labelled as prior failure experience). Two other control variables relating to current NPD projects, namely the number of NPD projects currently managed by the respondents (hereafter labelled as currently managed projects) and the total number of ongoing NPD projects in the respondent firms (hereafter labelled as currently ongoing projects) were also included. As the firm size and industry type may affect NPD in Chinese technology ventures [53], all of them were controlled. The firm size was measured by the current number of full-time employers in the firm. The other industry type was set as dummy variables.

This study rigorously purified and validated the measurement items² following Hair *et al.*, [64]. All the item factor loadings were greater than 0.6, the cut-off point, and loaded

² A table of the CFA results of our main constructs is available upon request.

cleanly onto the expected factors, showing no significant cross-loadings. Using a series of fit indices, the CFA resulted in satisfactory model fit (namely, $\chi^2(424) = 561.153$; CFI = 0.976; TLI = 0.974; SRMR = 0.049; RMSEA = 0.038; $p = 0.000$).

Coefficient alpha reliability (α) and composite reliability (CR) indices exceeded the accepted 0.7 threshold [64]. To be specific, prevention focus ($\alpha = 0.973$; CR = 0.973), promotion focus ($\alpha = 0.957$; CR = 0.957), exploitative learning ($\alpha = 0.820$; CR = 0.823), exploratory learning ($\alpha = 0.847$; CR = 0.848) and opportunity recognition ($\alpha = 0.793$; CR = 0.793). Two methods were used to assess convergent validity. First, the calculated average variances extracted (AVE) of prevention focus (AVE = 0.802), promotion focus (AVE = 0.714), exploratory learning (AVE = 0.528) and opportunity recognition (AVE = 0.561) were greater than the minimum threshold of 0.5 [65], except for exploitative learning (AVE = 0.483). However, the composite reliability of exploitative learning was higher than 0.6; thus, the convergent validity was still adequate [66]. Second, the path coefficients from latent constructs to their corresponding items were all statistically significant (i.e., $t > 2.0$). All items loaded significantly onto their corresponding latent constructs, with the lowest $t = 9.101$, providing evidence of convergent validity [67]. All the square roots of AVEs were higher than the correlations (see Table 1), thus discriminant validity was also satisfactory [65].

Insert Table 1 here

This study integrated both procedural methods and statistical techniques to reduce common method bias. Respondents were assured of confidentiality and that there were no right or wrong answers to reduce evaluation apprehension. Statistically, Harman's one-factor test was performed. The exploratory factor analysis for all the multiple-item constructs resulted in the expected factor solution, which accounted for 72.653% of the total variance, with the first factor only accounting for 10.353%. Further, CFA results showed that the

model fit of alternative models, particularly the five-factor model ($\chi^2(425) = 619.424$, CFI = 0.966, TLI = 0.963, SRMR = 0.546, RMSEA = 0.045, $p = 0.000$), and the one-factor model ($\chi^2(434) = 748.205$, CFI = 0.945, TLI = 0.941, SRMR = 0.816, RMSEA = 0.057, $p = 0.000$) were significantly worse than the research model. This provided further evidence of the lack of common method bias in this study.

IV. ANALYSIS AND RESULTS

A. Main Results

This study used structural equation modelling in Mplus 7.0 to test hypotheses. The standardized path estimates from promotion focus and prevention focus to ambidextrous learning were both significant: 0.408 ($p < 0.001$) and -0.082 ($p < 0.05$). Thus, H1 and H2 were supported: promotion focus has a positive effect on ambidextrous learning, while prevention focus has a negative effect. Further, a standardized path estimate from ambidextrous learning to opportunity recognition was also significant: 0.560 ($p < 0.001$), supporting H3: ambidextrous learning has a positive effect on opportunity recognition.

To test the mediating effects, a bootstrapping method was applied, as it does not require a normal sampling distribution, and can eliminate the potential risk of a Type I error and low statistical power [68]. The original sample ($N=225$) was replaced with 3000 bootstrap samples to repeatedly calculate the unstandardized indirect effect as well as the 95% bias-corrected and accelerated confidence intervals (CIs) for the mediation analyses. As this approach produced an asymmetrical confidence interval, an exact p -value is unable to be calculated. Instead, the significance level was provided as the bias-corrected bootstrap CIs for the mediating effects based on 3000 bootstrap samples did not include zero [58]. The results for H4 were: indirect effect: 0.229, 95th percentile, CI [0.122, 0.379]. Hence, H4 was supported: ambidextrous learning mediates the positive effect of promotion focus on

opportunity recognition. The results for H5 were: indirect effect: -0.046, 95th percentile, CI [-0.098, -0.007], suggesting that H5 was supported: ambidextrous learning mediates the negative effect of prevention focus on opportunity recognition. All the results are summarized in Figure 1.

Insert Figure 1 here

B. Robustness Checks

To eliminate the potential bias of different measurements of ambidexterity, this study further calculated ambidextrous learning by the sum of, the product of, and the difference between exploitative and exploratory learning, resulting in additive, multiplicative, and subtractive ambidexterity respectively [36]. All the variables were mean centered to minimize potential multicollinearity. To test if the results were sensitive to the model's specification, the method based on maximum likelihood was replaced with OLS parameter estimation. The robustness checks suggest that the magnitudes, directions, and the sizes of the results were stable.

This study further controlled for potential endogeneity. Regulatory focus is a stable characteristic [35, 36], acting as a trait-like influencer of opportunity recognition [34] and individual ambidexterity [15]. Thus, conceptually, it makes the reverse direction between regulatory focus and ambidextrous learning or opportunity recognition unlikely. To assess endogeneity pertaining to the complex nature and influence of ambidextrous learning on opportunity recognition, the instrumental variables approach based on EndoS, an SPSS macro developed by Daryanto [69] was employed. This study used organizational tenure (i.e., the number of months spent in the firm) and functional tenure (i.e., the number of months spent in the current NPD project) as the independent variables, as they could predict managerial ambidexterity [70] but were not correlated with opportunity recognition. EndoS conducted two-stage OLS regression using residuals as the independent variables and produced a joint F

test in the case of multiple endogenous variables. Based on the Hausman's specification test, the result illustrated that the F statistic is insignificant ($F = 0.385$, $p > 0.1$); and thus, the instruments are exogenous [69]. Overall, with theoretical and empirical supports, it could assume that endogeneity was not a concern in this study.

Additionally, to test the potential difference of results caused by the self-reported scale, we operationalized the measurement of opportunity recognition in terms of *the number of opportunities recognized*, in line with previous studies (e.g., [34, 63]). We asked the respondents to indicate "how many opportunities for developing a new product have you recognized since you joined the latest NPD project". The answers ranged from "0" to "18". As the uneven answers might affect the results of ordered logistic regression in small samples, we followed Ucbasaran *et al.* [63] and collapsed the answers into four categories with more evenly distributed answers³. By following the steps for testing the mediation model with ordinal outcome variable [71], the results illustrated that: prevention focus was significantly negatively associated with opportunity recognition ($b = -0.293$, $SE = 0.110$, $p < 0.01$). In contrast, promotion focus ($b = 0.477$, $SE = 0.156$, $p < 0.01$) and ambidextrous learning ($b = 0.547$, $SE = 0.286$, $p < 0.05$) were significantly positively related to opportunity recognition. Further, based on the Sobel test, we found that the mediating effects of ambidextrous learning from promotion focus and prevention focus to opportunity recognition were both significant: $t = 1.991$ ($p < 0.05$) and $t = 1.731$ ($p < 0.1$). Thus, all the hypotheses were supported with the additional measurements of opportunity recognition.

C. Additional Analysis

³ The answers of "0" and "1" were allocated into a new score of "1" (accounting for 28 (11.8%) respondents) and the answered numbers more than three are allocated into a new score of "4" (accounting for 28 (21.5%) respondents). The answers of "2" and "3" are allocated into "2" (accounting for 71 (30.0%) respondents) and "3" respectively (accounting for 87(36.7%) respondents).

As the prevention focus and promotion focus are independent traits [35], the managers may host both of them with different levels [14]. Informed by Kammerlander *et al.* [36], this study further explored the potential interactive effect of prevention and promotion focus. Referring to the taxonomy provided by Markovits [72], this study used the median of prevention focus (median = 4.22) and promotion focus (median = 5.44) to split the sample into four groups: Indifferentists (low prevention focus and low promotion focus); Achievers (low prevention focus and high promotion focus); Rationalists (high prevention focus and high promotion focus); and Conservatives (high prevention focus and low promotion focus). The mean values of ambidextrous learning for the groups were: Achievers engaged in the highest level of ambidextrous learning (mean = 5.461), followed by Rationalists (mean = 5.220) and Indifferentists (mean = 4.848). Conservatives had the lowest level (mean = 4.629). Contrast analysis results (see Table 2) provided evidence that the four groups varied significantly relating to their levels of ambidextrous learning, except Indifferentists and Conservatives (contrast value = 0.219, $p = 0.139$). Notably, the result of contrast analysis between Achievers with the highest level of ambidextrous learning and Conservatives with the lowest ambidextrous learning was statistically significant (contrast value = 0.832, $p < 0.001$). This results not only further supported the significant results of H1 and H2 but also clarified the complexity of the relationship between regulatory focus and ambidextrous learning.

Insert Table 2 here

V. DISCUSSION AND CONCLUSION

A. Theoretical contributions

Based on the analysis and results, we have answered the research question: To what extent does NPD managers' regulatory focus affect their ambidextrous learning? How do prevention

focus and promotion focus impact upon opportunity recognition in the NPD context? We find that NPD managers' ambidextrous learning is motivated by promotion focus and prevention focus in a positive and a negative way respectively. We also find that NPD managers' ambidextrous learning also mediates the relationship between regulatory focus and opportunity recognition in the NPD context. By doing so, this study thus makes contributions to the individual ambidexterity and ambidexterity-as-a-paradox research.

First, this study contributes to the knowledge of individual managers' ambidextrous learning by clarifying its psychological antecedents and its consequences in the NPD process. To date, studies have investigated the organizational antecedents of ambidextrous learning, while the research on the individual implications of ambidextrous learning is largely neglected. Prior research has predominantly approached ambidextrous learning at the firm level; however, more theoretical advancement and empirical evidence is needed to understand how ambidextrous learning works [27, 52]. What is missing is the understanding of how individuals' psychological antecedents affect ambidextrous learning. Informed by the regulatory focus theory, this study finds that NPD managers' promotion and prevention focus, as psychological traits, have opposing effects on ambidextrous learning: promotion focus positively affects ambidextrous learning, while the effect of prevention focus is negative. These findings shed lights on the debate on what makes an individual ambidextrous [30].

Further, informed by the paradox theory, this study explores the duality and paradoxical tensions between promotion focus and prevention focus. The results of post-hoc analysis illustrates that those individuals who are Achievers (high promotion focus and low prevention focus) host the highest level of ambidextrous learning, while the Conservatives (low promotion focus and high prevention focus) have the lowest level. This study thus has deepened the understanding of the powerful psychological enablers and deterrents of antecedents to individual ambidexterity: NPD managers' promotion focus and prevention

focus are a fruitful starting point to predict their ambidextrous learning, from which to build capability in recognizing opportunities in the NPD process.

Second, this study contextualizes ambidextrous learning in the NPD process in high-tech SMEs, providing a detailed understanding of how individual ambidexterity is enabled and thus affects opportunity recognition in the NPD. The current ambiguity in individual ambidexterity not only stems from the personal characteristics, but also varies in the contexts faced by the individuals [9]. Recent research has drawn attention to the role of regulatory focus on exploration alone [39] or exploration and exploitation separately [16, 17] and exploratory and exploitative learning respectively affects opportunity recognition [44]. However, these findings provide an incomplete understanding of the NPD process that requires ambidextrous learning. This study builds on this body of knowledge, but further differentiates itself by focusing on NPD managers' ambidextrous learning in high-tech SMEs, to illuminate how managerial ambidexterity is enacted by NPD managers to recognize opportunities. Drawing on a paradoxical view of ambidexterity, this study finds that ambidextrous learning mediates the effects of promotion and prevention focus on opportunity recognition. This finding not only helps us move beyond the separation-oriented approaches to accomplish ambidexterity [12] but extends our understanding of the pursuit of individual ambidexterity in practice [21, 73].

Finally, this study adds new insights to the ongoing question of why some individuals are more able to recognize opportunities than others [46]. In answer to such an individual - opportunity nexus question, prior studies have primarily focused on either the individual differences [58] or the nature of opportunities [74]. However, most of them overwhelmingly focus on the opportunities for creating a business, and rarely consider the opportunities recognized in the NPD process. For example, several studies have advocated the respective roles of prevention and promotion focus on opportunity recognition [34, 50], but all in a

generic context. In fact, opportunity recognition has been regarded as a key factor for the product innovation particularly in high-tech ventures [75]. This study finds that ambidextrous learning positively prompts opportunity recognition in the NPD process. It thus provides a novel explanation to the individual - opportunity nexus question through contextualizing ambidextrous learning in the NPD process of high-tech SMEs and adds new knowledge of opportunity recognition regarding paradoxical practice [76].

B. Managerial implications

This study also has managerial implications, especially for high-tech SMEs. Individual ambidexterity is a self-regulated activity in such a way that individuals make their own decisions on how to best distribute their resources over explorative and exploitative tasks [9]. As the SMEs usually find it hard to achieve structural or temporal ambidexterity due to a lack of sufficient resources, managers must pursue ambidextrous learning towards opportunity recognition. The results highlight the positive effect of promotion focus on ambidextrous learning and subsequent opportunity recognition in the NPD process. Tuncdogan *et al.* [16, p.841] argue, “without knowledge of the psychological antecedents, we can deduce little about the differences in these individuals’ habitual tendencies, which is of crucial importance when selecting individuals for formal leadership roles”. As regulatory focus is a stable characteristic [35, 36], based on the results of contrast analysis, this study suggests that firms hire and appoint NPD managers with a high level of promotion focus and a low level of prevention focus (i.e., Achievers) by referring to the adapted questionnaire from Lockwood *et al.* [56]. Further, unlike the traditional separation-oriented practice which assumes a trade-off between exploitative and exploratory learning [77], our findings call for such paradoxical practices as ambidextrous learning in the NPD process which promotes opportunity recognition.

C. Limitations and Future Research

This study has several limitations that open up opportunities for future research. First, this study, based on the individual level, may not fully reflect complex organizational reality. Organizational ambidexterity, as a nested construct, requires multiple-level analysis [78]. For example, Zhang *et al.* [79] find the multilevel mediating role of ambidexterity in the relationship between paradoxical leadership and innovation in work teams. Kauppila and Tempelaar [32] find paradoxical leadership at the group level moderates the relationship between learning orientation and individual-level ambidexterity. Future research may investigate the various antecedents of ambidextrous learning from a multilevel perspective.

Second, this study focuses on the psychological traits as the antecedents of ambidextrous learning, while some latest studies have highlighted that the interaction of individual differences and contextual factors also affect ambidexterity. For instance, Tempelaar and Rosenkranz [59] find that the relationship between employees' role segmentation and individual-level ambidexterity depends on the cross-functional coordination mechanism in the firm. Klonek *et al.* [25] argue that the positive relationship between paradoxical leadership behavior and individual-level ambidexterity is stronger in the start-up firms and weaker in growth firms. Further, Zhang and Sun [79] highlight that organizational architecture, particularly self-organizing teams, has complete independence in decision rights, which could offer the individuals flexibility and rapidity to address the tension in innovation ambidexterity. Thus, future studies could incorporate personal and contextual factors to investigate the antecedents of individual ambidexterity [9].

Third, self-regulatory focus reflects both a trait (chronic focus) and a state (situational focus), leading to differences in their temporality and flexibility [14]. This study approaches regulatory focus as individual traits, as they are stable over time within a specific context [35]. Future research may examine regulatory focus as a situational state such as behavioral

orientations that change over time and influenced by other multiple level factors. Potential avenues include the paradoxical management of promotion-prevention by adding the dynamic lens of time and context [14]. Referring to Caniëls and van Assen [15] the future study could apply polynomial regression and response surface methodology to further elaborate how the fit between promotion and prevention focus affect ambidextrous learning.

Lastly, the methodological limitations include the threat of common method bias caused by the self-reported measurements despite the best effort using procedural and statistical methods to minimize such risks. Future studies can collect data from multiple respondents [80]. Moreover, this study tried but could not rule out the reverse causality due to the cross-sectional design. Although regulatory focus is regarded as a stable influencer of opportunity recognition [34] and could determine behaviors such as ambidextrous learning [15], longitudinal designs are recommended by the paradox view for future research to track the dynamic interrelationship between the tensions of the paradox [12].

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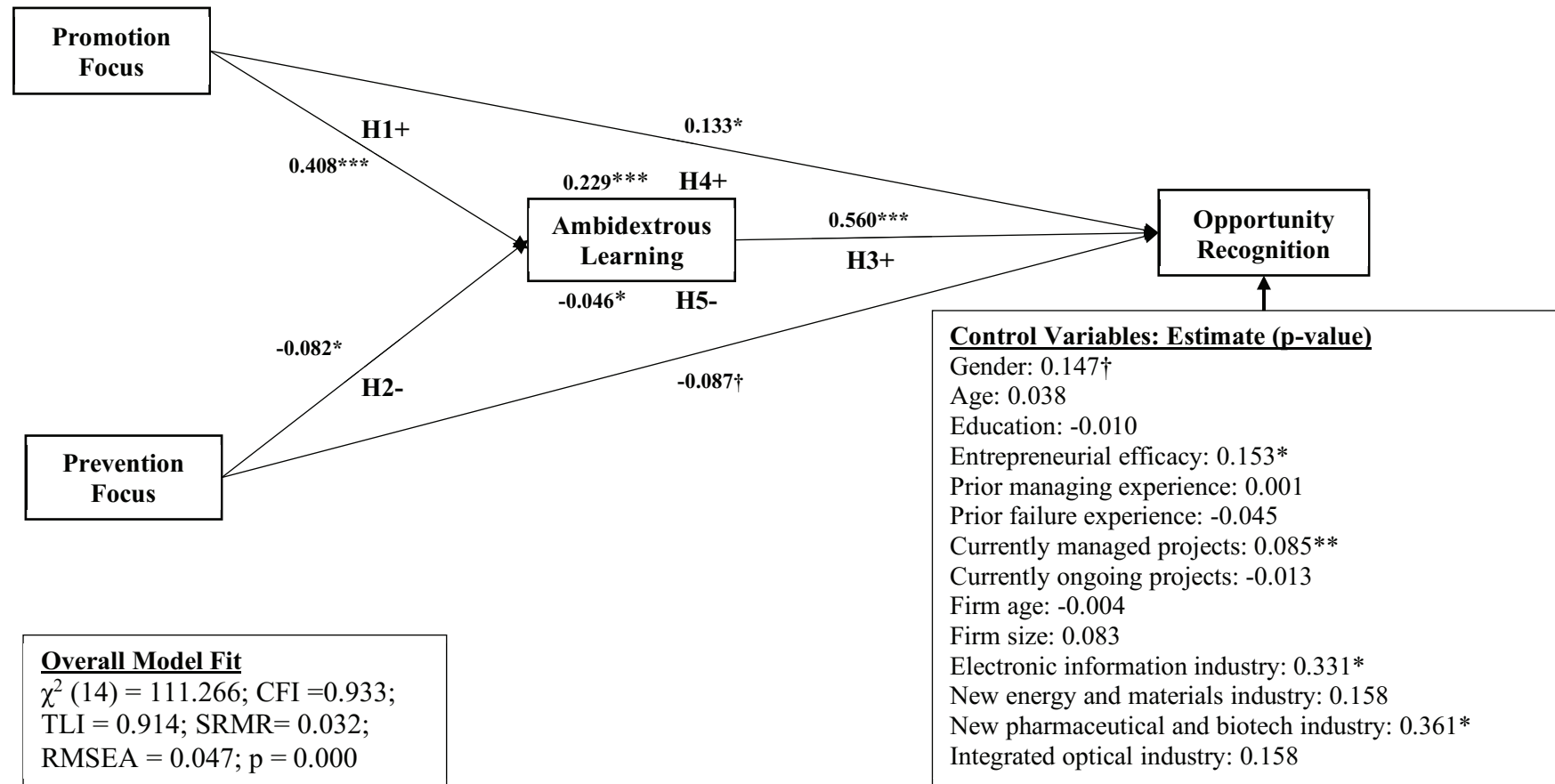
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TABLE 1 DESCRIPTIVE STATISTICS AND CORRELATIONS

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Gender														
2. Age	.021													
3. Education	.038	.069												
4. Firm age	.084	-.043	-.001											
5. Firm size	.025	-.029	.053	.349***										
6. Entrepreneurial efficacy	-.079	-.019	.122†	.077	.005									
7. Prior managing experience	.120†	-.100	-.010	-.083	-.027	.142*								
8. Prior failure experience	.055	-.045	-.028	-.064	.020	-.007	.564***							
9. Currently managed projects	.031	-.059	-.063	-.012	-.054	-.013	.436***	.502***						
10. Currently ongoing projects	.009	.026	.018	-.066	.019	.050	.295***	.370***	.594***					
11. Prevention focus	.032	.029	.034	-.087	.061	-.165*	-.128*	-.040	-.052	.021	.896			
13. Promotion focus	.062	-.087	-.048	.109†	.084	.406***	-.054	-.146*	-.121	-.104	-.115†	.845		
13. Ambidextrous learning	.013	-.037	-.013	.092	-.010	.424***	.093	-.034	.023	-.022	-.185**	.480**		
14. Opportunity recognition	.090	-.002	-.023	.078	.002	.469***	.089	-.040	.103	-.023	-.239***	.398***	.457***	0.748
Mean	0.540	2.414	2.287	6.303	111.084	5.469	5.810	1.793	2.443	6.004	4.170	5.377	5.454	5.295
Standard deviation	0.500	0.832	0.506	4.331	104.839	0.732	4.415	1.784	2.527	7.709	1.100	0.782	0.686	0.866

N = 225; †p < 0.1; *p < 0.05; **p < 0.01; ***p < 0.001(two-tailed p-value). Italic figures on the diagonal are the square root of the average variance extracted for the constructs.



Note: †p < 0.1; *p < 0.05; **p < 0.01; ***p < 0.001 (two-tailed p-value).

FIGURE 1 The RESULTS OF STRUCTURAL EQUATION MODELLING ANALYSIS

TABLE 2 RESULTS OF CONTRAST ANALYSIS

Groups (mean value of learning)	Contrast value	Standard errors	T-value	Df	Significance (2-tailed)
Indifferentists (4.848) vs Achievers (5.461)	-.613	.146	-4.211	221	.000
Indifferentists (4.848) vs Rationalists (5.220)	-.371	.149	-2.492	221	.013
Indifferentists (4.848) vs Conservatives (4.629)	.219	.148	1.483	221	.139
Achievers (5.461) vs Rationalists (5.220)	.242	.140	1.722	221	.087
Achievers (5.461) vs Conservatives (4.629)	.832	.139	5.982	221	.000
Rationalists (5.220) vs Conservatives (4.629)	.590	.143	4.138	221	.000

Note: Indifferentists (low prevention focus and low promotion focus); Achievers (low prevention focus and high promotion focus); Rationalists (high prevention focus and high promotion focus); Conservatives (high prevention focus and low promotion focus).