

Article

The Influence of Proactive Personality on Laboratory Safety Behavioral Attitude of Graduate Students: Mediation of Affective/Cognitive Attitude

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Abstract

The study examined the relationships among proactive personality, laboratory safety affective/cognitive/behavioral attitude among graduate students using a questionnaire survey method. The results showed that proactive personality was positively associated with laboratory safety affective/cognitive/behavioral attitude. In addition, laboratory safety affective and cognitive attitude functioned as parallel mediators between proactive personality and laboratory safety behavioral attitude. The results provide fundamental data support for effective laboratory safety management.

Keywords: proactive personality; laboratory safety behavioral attitude; graduate students; laboratory safety affective attitude; laboratory safety cognitive attitude; parallel mediation

1. Introduction

University research laboratories serve as critical hubs for scientific inquiry and technological innovation. In recent years, the number of laboratories in higher education institutions has significantly increased with the diversification of research tasks. Simultaneously, laboratory safety accidents still occur occasionally [1]. In 2008, a research assistant was killed in a laboratory accident at the University of California, Los Angeles [2]. Since 2008, laboratory accidents still occasionally occurred worldwide [3]. The root causes of laboratory accidents are multifactorial, encompassing individual behaviors, laboratory conditions, departmental oversight, institutional frameworks, and discipline-specific hazards [4].

To mitigate such risks, various measures and strategies have been implemented to improve laboratory safety and reduce the occurrence of laboratory safety incidents. For example, twice-daily rotating safety inspections and the mandatory posting of overnight reaction registration forms posted at laboratory entrances have been adopted to improve laboratory safety management [5]. In addition, various safety training courses, even covering industrial hygiene and ergonomics, have been provided to ensure that researchers possess the necessary professional knowledge and safety awareness [6]. Despite these efforts, laboratory incidents persist. Unsafe behaviors, such as improper operations, are major contributors to laboratory incidents [7]. Unsafe behaviors are closely linked to individuals' safety attitudes [8]. Given that graduate students constitute a substantial portion of the research workforce in university laboratories, gaining insight into their safety attitudes is of considerable importance for the effective prevention and reduction of future incidents.



Received: 30 May 2026

Revised: 9 July 2026

Accepted: 13 July 2026

Published: 15 July 2026

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In our previous study, proactive personality was found to have a positive effect on safety attitude [9]. However, the specific pathways through which proactive personality is related to laboratory safety behavioral attitude remain insufficiently understood. It is unclear whether laboratory safety affective/cognitive attitude help to explain the link between proactive personality and laboratory safety behavioral attitude; this remains unclear. Therefore, this study further examines the pathways linking proactive personality to laboratory safety behavioral attitude through laboratory safety affective/cognitive attitude within the university laboratory context.

1.1. Proactive Personality and Laboratory Safety Behavior Attitude

Personality encompasses enduring psychological traits that influence and predict individuals' behaviors across different contexts [10]. The Big Five personality traits constitute one of the most widely adopted frameworks in personality research [11]. Based on the lexical approach, personality traits have been classified into five broad dimensions [12]. However, Bateman and Crant found that the Big Five personality model falls short of accounting for individuals' proactive tendency to adapt to or modify their environment, which subsequently gave rise to the concept of proactive personality [13].

Proactive personality denotes a stable tendency to initiate change and shape the environment without external compulsion [10]. Highly proactive individuals are more inclined to initiate change, identify opportunities, and facilitate change-related behaviors [14]. Low proactive personality tends to accept existing conditions and adapt passively to their environment, even when confronted with unfavorable circumstances [15].

Analysis of data collected from 496 employees across different occupations and organizations revealed that proactive personality exerted significant positive effects on both objective and subjective career success [16]. Moreover, Supervisor-rated data from 126 employees indicated that individuals with proactive personality were more likely to actively develop social networks and accumulate social capital, thereby achieving superior job performance [17]. Within the realm of organizational behavior, previous research has primarily focused on the contribution of proactive personality to positive individual behaviors. Proactive personality promotes high-quality leader–member exchange relationships. These relationships, in turn, enhance job satisfaction and organizational citizenship behavior [18].

Proactive personality positively affects safety attitude and, consequently, safety behavior [19]. Among construction workers, low proactive personality reduced safety citizenship behavior by diminishing safety responsibility and organizational belonging [20]. In the oil and gas industry, proactive personality was positively associated with safety participation behavior [21]. In the healthcare sector, findings from 449 nurses in clinical settings in Türkiye suggested that proactive personality positively contributed to safety attitude, which subsequently promoted nurses' safety behavior [22]. Similarly, in the aviation industry, it was found that safety attitude mediated the relationship between proactive personality and safety behavior [23].

Laboratory safety attitude represents a context-specific manifestation of the safety attitude within laboratory settings. Comparisons across academic, governmental, and industrial laboratories suggest that laboratory safety attitude reflects individuals' psychological orientations toward laboratory safety regulations, potential hazards, and protective measures, directly influencing compliance with safety-related behaviors [24]. Laboratory safety attitude is generally considered to comprise safety-related affective/cognition/safety behavioral attitude. The safety affective attitude refers to the emotional experience and affective evaluation that laboratory personnel hold in response to laboratory safety-related issues. Safety cognitive attitude reflects laboratory personnel's knowledge, beliefs, and understanding of laboratory safety, including their recognition and evaluation of hazardous

factors, safety regulations, and incident consequences. Safety behavioral attitude is regarded as individuals' psychological tendencies and behavioral intentions to engage in or refrain from safety-related behaviors when confronted with laboratory safety situations.

Research laboratory safety is dependent not only on codified regulations, protective equipment, and institutional oversight, but also on individuals' interpretation of safety requirements, appraisal of potential hazards, and commitment to embed safety awareness into daily experimental practice. Because laboratory work is highly operator-dependent and often involves dynamic risk conditions, individual psychological characteristics may offer a useful perspective for understanding variation in laboratory safety attitudes. Proactive personality, characterized by the tendency to anticipate problems, seek relevant information, and initiate constructive change, may therefore be particularly relevant to the affective, cognitive, and behavioral dimensions of laboratory safety attitude.

Our previous research indicated that proactive personality was positively associated with laboratory safety affective/cognition/behavioral attitude. In addition, proactive personality has been found to be associated with laboratory safety behavior attitude through self-efficacy and safety motivation [25]. However, the pathways through which proactive personality is related to laboratory safety behavior attitude remains insufficiently understood.

1.2. Mediation of Safety Affective Attitude

The mediating role of safety affective attitude has been well documented across multiple research domains. Within construction settings, for instance, direct incident experience was shown to influence unsafe behavioral intentions through workers' safety affective and behavioral attitudes [26]. In the aviation industry, safety affective attitude has been reported to mediate the association between proactive personality and safety behavior [23]. In the field of occupational safety and health management, the affective commitment has also been identified as a significant mediator linking health management with corporate sustainability [27]. Existing studies have demonstrated that affective attitude not only reflects individuals' emotional experiences and subjective evaluations of safety issues, but also influences their risk perception, sense of safety responsibility, and safety behavioral attitude. As an important psychological mechanism linking individual psychological characteristics with safety behavior, safety affective attitude thus plays a significant mediating role across different occupational safety contexts.

Within university laboratory settings, safety affective attitude exhibits more context-specific characteristics. As graduate students constitute the primary workforce in university research activities, investigating their safety affective attitude is of considerable importance for preventing unsafe laboratory behavior. Compared with industrial production environments, university research activities are characterized by greater uncertainty. Most experiments conducted in research laboratories—particularly those in chemistry-related majors—are exploratory in nature, which inherently entails unknown risks and unanticipated outcomes. Not only are laboratory personnel required to navigate complex and dynamic experimental procedures, but they also face unfamiliar hazards. In addition, research pressure and the uncertainty associated with scientific innovation may amplify emotions such as anxiety and concern among laboratory personnel. These emotional fluctuations may further influence individuals' affective evaluations of laboratory safety, making laboratory safety affective attitude more susceptible to the influence of individual personality traits.

Although direct evidence regarding the mechanism through which laboratory safety affective attitude links proactive personality with laboratory safety behavior attitude remains limited, our previous research has demonstrated that fear associated with research-related risks directly affects laboratory safety affective attitude and additionally exerts an indirect

effect through risk preference [28]. These findings suggest that risk-related factors exert significant influences on laboratory safety affective attitude. However, the manner in which laboratory safety affective attitude influences laboratory safety behavior attitude remains insufficiently understood.

1.3. Mediation of Safety Cognitive Attitude

The mediating role of safety cognitive attitude has also been widely examined across diverse research domains. In aviation research, for example, perceived stress was found to indirectly influence safety attitude through cognitive flexibility among civil aviation pilots [29]. Within cybersecurity education, cybersecurity cognition was shown to mediate the effects of cybersecurity education on cybersecurity attitudes and behaviors [30]. In the context of public transportation, poorer traffic safety cognition among older adults was positively associated with unsafe behavior [31].

Taken together, existing evidence indicates that safety cognitive attitude serves as an important psychological mechanism through which external influences are translated into safety-related outcomes across diverse populations. Within university laboratory settings, the development of safety cognition is further shaped by the complexity of experimental procedures, the innovative nature of research activities, and other context-specific characteristics. University laboratories typically involve more diverse experimental tasks, innovative and uncertain research outcomes, and a more dynamic research workforce. Laboratory safety relies more heavily on individuals' cognitive processing of safety-related information than on mere compliance with established safety management systems. Consequently, laboratory personnel are required not only to comply with established safety regulations but also to independently identify potential hazards, continuously assess operational risks, and make appropriate safety judgments throughout the experimental process. As a result, laboratory safety cognitive attitude plays a particularly important role in transforming safety knowledge into safety-related decision-making and behavioral attitudes.

From a theoretical standpoint, both the Theory of Planned Behavior and the Health Belief Model suggest that personality traits may indirectly influence behavioral tendencies through cognitive and attitudinal processes [32]. In line with this reasoning, proactive personality—characterized by the tendency to anticipate problems, seek relevant information, and initiate constructive change—has been consistently associated with more positive safety attitudes, as proactive individuals tend to engage more actively in situational evaluation and problem-solving activities. However, whether laboratory safety cognitive attitude serves as a mediating mechanism linking proactive personality to laboratory safety behavioral attitude remains an open question that warrants empirical investigation.

1.4. Research Objective and Hypothesis

Based on the above, this study develops a conceptual model to examine the associations among proactive personality and laboratory safety affective/cognitive/behavior attitude. In particular, the mediating roles of laboratory safety affective attitude and laboratory safety cognitive attitude are examined to better understand the psychological mechanisms underlying laboratory safety attitudes and provide evidence to inform laboratory safety management and education.

To investigate these questions, we clarify the concepts and propose the relationships among these variables. Based on this, the following hypotheses are therefore proposed:

H1. *Proactive personality is positively associated with laboratory safety behavior attitude.*

H2. *Laboratory safety affective attitude mediates the relationship between proactive personality and laboratory safety behavior attitude.*

H3. *Laboratory safety cognitive attitude mediates the relationship between proactive personality and laboratory safety behavior attitude.*

The hypothesized model for this study is illustrated in Figure 1.

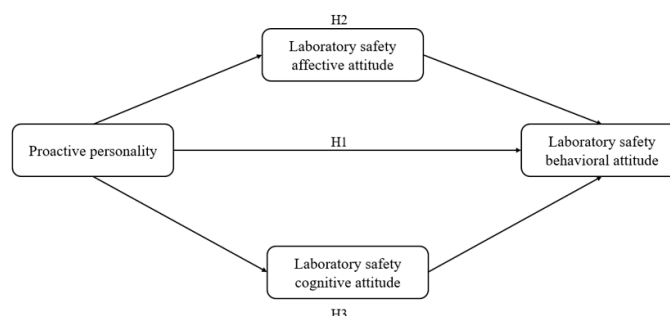


Figure 1. Parallel mediation hypothesis.

2. Methods

Demographic variables included gender and educational level. The 17-item Proactive Personality Scale proposed by Bateman and Crant was used [13], with minor wording modifications introduced to improve contextual suitability in Chinese laboratory settings. The proactive personality items were rated 7-point Likert scale. Laboratory safety affective/cognitive/behavior attitude was measured using a 5-item instrument, respectively. Items assessing affective/cognitive attitude were reverse-scored due to negative wording, whereas behavioral attitude items were positively phrased. All laboratory safety attitude items were rated on 5-point Likert scale.

We conducted this study according to the guidelines set by the Declaration of Helsinki and approved by the Institutional Review Board of Tianjin University (Approval No. TJUE-2022-044). Participants were recruited from first-year graduate students at a university through an online questionnaire distributed via the MyCOS Teaching Quality Management Platform. The final sample comprised 111 valid responses, including 46 males and 65 females, of whom 78 were candidates for a master's degree and 33 for a Ph.D. Most of them are majoring in environmental science and engineering.

AMOS 24.0 is employed to test model fit, while SPSS 27.0 is used for reliability/validity tests, descriptive analysis, and correlation analysis. Mediation effects are generally analyzed using the PROCESS 4.1 macro in SPSS 27.0. Specifically, 5000 bootstrap resamples were used to estimate the indirect associations. An indirect association was considered statistically supported when the 95% bootstrap confidence interval did not include zero.

3. Results

3.1. Reliability, Descriptive and Correlation Analysis

Table 1 lists the results of reliability and descriptive and correlation analysis. Cronbach's α values for proactive personality and laboratory safety affective/cognitive/behavioral attitude were 0.869, and 0.869/0.850/0.749, respectively. All values exceeded the recommended criterion of 0.7, demonstrating acceptable reliability of the scales. For the validity of the questionnaire, the Kaiser–Meyer–Olkin (KMO) test was applied, with values of 0.838, 0.806, 0.876, and 0.722 for each dimension, respectively. All values were above 0.7. In addition, Bartlett's test of sphericity was significant ($p < 0.001$), indicating that the data were suitable for factor analysis.

Table 1. Reliability, descriptive statistics and Spearman correlations.

Dimensions	Cronbach's α	M $\pm$ SD	1	2	3	4
1. Proactive personality	0.869	5.064 $\pm$ 0.490	1			
2. Laboratory safety affective attitude	0.850	4.400 $\pm$ 0.277	0.310 **	1		
3. Laboratory safety cognitive attitude	0.915	4.470 $\pm$ 0.259	0.287 **	0.682 **	1	
4. Laboratory safety behavioral attitude	0.749	4.310 $\pm$ 0.050	0.282 **	0.565 **	0.559 **	1

** $p < 0.01$.

The Mean $\pm$ SD of proactive personality averaged 5.064 $\pm$ 0.490. Laboratory safety affective attitude, laboratory safety cognitive attitude, and laboratory safety behavior attitude averaged 4.400 $\pm$ 0.277, 4.470 $\pm$ 0.259, and 4.310 $\pm$ 0.050, respectively.

Prior to correlation analysis, distributional normality was examined using the Kolmogorov–Smirnov test. Except for proactive personality ($p = 0.200$), significance values for all remaining variables fell below 0.05, indicating deviations from normality. Spearman correlations are used and results also reported in Table 1. Proactive personality showed positive associations with laboratory safety affective attitude ($r = 0.310$), laboratory safety cognitive attitude ($r = 0.287$), and laboratory safety behavior attitude ($r = 0.282$). Positive associations ($r = 0.682, 0.565, 0.559$) were additionally observed among the safety affective/cognitive/behavioral attitudes.

3.2. Mediating Role of Safety Affective Attitude

Before hypothesis testing, confirmatory factor analysis (CFA) was conducted using AMOS 24.0 to evaluate the measurement model and assess its goodness fit. According to the recommended threshold values, a CMIN/DF between 1 and 3 indicates an acceptable level of model fit, an RMSEA below 0.08 indicates an acceptable fit, and IFI, TLI, and CFI values above 0.8 indicate an acceptable level of fit [33]. The proposed model yielded a CMIN/DF value of 1.640, an RMSEA value of 0.076, and IFI, TLI, and CFI values of 0.839, 0.808, and 0.833, respectively. Overall, these results supported an acceptable level of model fit.

AMOS 24.0 was used solely to evaluate the goodness-of-fit of the measurement model. This study employed the PROCESS macro (version 4.1) in SPSS to conduct the mediation effect analysis. The simple mediation model (Model 4) was employed to examine the mediating role of laboratory safety affective attitude in the relationship between proactive personality and laboratory safety behavior attitude. The results are presented in Table 2.

Table 2. Mediation analysis results of laboratory safety affective attitude.

Regression Equation		Overall Fitting Coefficient			Regression Coefficient Significance		
Dependent Variable	Predictor Variables	R	R ²	F	β	SE	t
Laboratory safety affective attitude	Proactive personality	0.3258	0.1062	12.8279 ***	0.0926	0.0259	3.5816 ***
Laboratory safety behavioral attitude	Proactive personality	0.3360	0.1129	13.7450 ***	0.0848	0.0212	3.7074 ***
	Laboratory safety affective attitude	0.5691	0.3239	25.6261 ***	0.4315	0.0747	5.7780 ***

*** $p < 0.001$.

Proactive personality showed significant direct associations with both laboratory safety affective attitude ($\beta = 0.0926, t = 3.582, p < 0.001$) and laboratory safety behavior attitude ($\beta = 0.085, t = 3.707, p < 0.001$), providing support for H1.

Significant positive associations were additionally observed between proactive personality and laboratory safety behavior attitude ($\beta = 0.0848, t = 3.707, p < 0.001$), as well

as between laboratory safety affective attitude and laboratory safety behavior attitude ($\beta = 0.4315$, $t = 5.778$, $p < 0.001$). thereby supporting H2.

Table 3 summarizes the path analysis results of laboratory safety affective attitude. The indirect effect transmitted through laboratory safety affective attitude was estimated at $\beta = 0.040$. The direct effect accounted for 52.830% of the total effect, whereas the indirect effect accounted for 47.170%. The relatively comparable proportions of the two pathways suggest that laboratory safety affective attitude contributed substantially to the relationship between proactive personality and laboratory safety behavior attitude, thereby providing empirical support for subsequent intervention strategies.

Table 3. Pathanalysis results of laboratory safety affective attitude.

Dependent Variable	Path	β	Bootstrap SE	LLCI	ULCI
Laboratory safety behavioral attitude	Total effect	0.0848	0.0229	0.0395	0.1302
	Direct effect	0.0448	0.0212	0.0028	0.0870
	Proactive personality → safety affective attitude → safety behavioral attitude	0.0400	0.0125	0.0163	0.0658

3.3. Mediating Role of Safety Cognition Attitude

This study employed the PROCESS macro (version 4.1) in SPSS to conduct the mediation effect analysis. The simple mediation model (Model 4) was further employed to examine the mediating role of laboratory safety cognitive attitude in the relationship between proactive personality and laboratory safety behavior attitude. The corresponding results are presented in Table 4.

Table 4. Mediation analysis results of laboratory safety cognitive attitude.

Regression Equation		Overall Fitting Coefficient			Regression Coefficient Significance		
Dependent Variable	Predictor Variables	R	R ²	F	β	SE	t
Laboratory safety cognition attitude	Proactive personality	0.3416	0.1167	14.2682 ***	0.0948	0.0251	3.7773 ***
Laboratory safety behavioral attitude	Proactive personality	0.3360	0.1129	13.7450 ***	0.0848	0.0212	3.7074 ***
	Laboratory safety cognitive attitude	0.5732	0.3285	26.1768 ***	0.4494	0.0767	5.8620 ***

*** $p < 0.001$.

Proactive personality showed significant positive associations with both laboratory safety cognitive attitude ($\beta = 0.0948$, $t = 3.777$, $p < 0.001$) and laboratory safety behavior attitude ($\beta = 0.0848$, $t = 3.707$, $p < 0.001$), thereby providing partial support for H1.

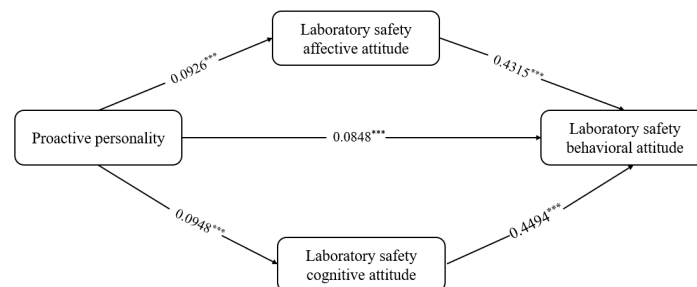
Laboratory safety cognitive attitude was also positively associated with laboratory safety behavior attitude ($\beta = 0.4494$, $t = 5.862$, $p < 0.001$). These findings support the mediating role of laboratory safety cognitive attitude in the relationship between proactive personality and laboratory safety behavior attitude, thereby supporting H3.

Table 5 summarizes the path analysis results of laboratory safety cognitive attitude. The direct effect accounted for 52.887% of the total effect, whereas the indirect effect accounted for 47.113%. The relatively balanced contributions of the two pathways suggest that laboratory safety cognitive attitude played a substantial role in linking proactive personality with laboratory safety behavior attitude, thereby providing empirical implications for subsequent intervention strategies.

Table 5. Path analysis results of laboratory safety cognitive attitude.

Dependent Variable	Path	β	Bootstrap SE	LLCI	ULCI
Laboratory safety behavioral attitude	Total effect	0.0848	0.0229	0.0395	0.1302
	Direct effect	0.0422	0.0213	0.0001	0.0844
	Proactive personality → safety cognitive attitude → safety behavioral attitude	0.0426	0.0151	0.0139	0.0737

Based on the above data, two simple mediation pathways were identified: the pathway from proactive personality to laboratory safety behavioral attitude through laboratory safety affective attitude, and the pathway through laboratory safety cognitive attitude. Integration of the two pathways resulted in the overall mediation model presented in Figure 2, which was fully consistent with the proposed hypotheses.

**Figure 2.** The validated hypothesis model. *** $p < 0.001$.

4. Discussion

This study investigated the relationships between proactive personality and laboratory safety affective/cognitive/behavioral attitude. Proactive personality was positively associated with laboratory safety affective/cognitive/behavioral attitude. Elevated safety awareness among highly proactive individuals may contribute to stricter compliance with safety protocols and proactive self-protection during experimental procedures. Moreover, their active engagement in safety management and collaboration with principal investigators may provide opportunities for constructive recommendations that foster a positive laboratory safety climate, thereby potentially encouraging safety participation among less proactive peers. From a practical perspective, laboratory safety management may consider prioritizing the identification and cultivation of highly proactive individuals, particularly for appointed safety roles. Their recommendations may warrant substantial consideration, with appropriate opportunities for participation in safety-related decision-making potentially further supporting the expression of their proactive. Ultimately, their voluntary assistance and systemic involvement may contribute to a robust team safety climate, which may support institutional safety levels and potentially benefit less proactive personnel.

This study found that proactive personality not only directly and positively predicts laboratory safety behavior attitudes, but also exerts an indirect influence through two independent pathways: laboratory safety emotional attitude and cognitive attitude. This provides a more refined perspective for understanding those ‘who are more concerned about laboratory safety’. The core traits of proactive personality lie in individuals’ tendency to take action to change the external environment. In high-risk laboratory situations, highly proactive individuals do not passively comply with rules; instead, they possess stronger risk awareness and a tendency to internalize responsibility. They are more likely to view ‘safety’ as an intrinsic prerequisite for achieving research goals, rather than an externally imposed burden, and thus exhibit more positive attitudes toward safety behaviors [9].

Laboratory safety affective attitude played a mediating role in linking proactive personality with safety behavioral attitude. Individuals with a high proactive personality

often experience stronger feelings of belonging, responsibility, and safety anxiety (positive) toward laboratory environments, and these emotions directly shape behavioral tendencies. The laboratory safety affective attitude not only complements cognitive evaluations but may also dominate behavior under time pressure or emergency situations. Our previous study also demonstrated that the safety responsibility of graduate students positively correlated with their safety voice. In addition, high safety leadership strengthens the positive link between safety responsibility and safety voice [34]; that is, a better safety climate may help strengthen individual safety affective attitude. Encouraging experience sharing among laboratory members and fostering a strong safety culture may be beneficial. Positive feedback may also facilitate the development of positive laboratory safety affective attitude [35]. When individuals receive recognition from supervisors and classmates after following safety regulations, their safety self-efficacy may be enhanced, which may further contribute to their safety behavioral attitude [25]. At the same time, managers may consider using appropriate punishments for unsafe behaviors to increase safety awareness, but excessive punishment should be avoided. Overly harsh management may negatively influence members' affective attitude, which may hinder the development of a positive laboratory safety climate.

Laboratory safety cognitive attitude also played a mediating role between proactive personality and safety behavioral attitude. Individuals with a high proactive personality tend to actively seek out safety information, assess risks, and understand the rationale behind procedures, thereby forming more positive cognitive safety attitudes. Cognitive attitudes are manifested in laboratory settings as 'safety value judgments', 'risk acceptability judgments', and 'prediction of behavioral consequences'. Therefore, strengthening safety training may be one effective approach to improve this cognition, especially by enhancing risk identification skills among laboratory members. In parallel, complete and standard operating procedures may provide an important foundation for safe operations, helping members better understand safety regulations. Additionally, adequate personal protective equipment may enhance individuals to perceive that the laboratory values safety, which may further facilitate the development of their cognitive attitude. Well-structured reward and punishment systems may also contribute to reinforcing safety management. Laboratories may therefore consider establishing scientific incentive and disciplinary mechanisms to continuously strengthen members' safety awareness and responsibility through balanced motivation and restraint.

In sum, proactive personality not only directly promotes safe behavior attitudes but also exerts its influence through two independent and parallel psychological pathways. 'Parallel' implies that these two pathways coexist simultaneously and do not substitute for each other. The absence of either pathway would weaken the transformative effect of the personality trait; that is, the formation of laboratory safety behavior attitudes is not the product of a single psychological process. Proactive personality operates through both the 'rational evaluation' (cognitive attitude) pathway and the 'emotional arousal' (affective attitude) pathway in parallel. This result suggests that our previous research approaches, which view safety attitude as an overall construct, may obscure the unique contributions of different psychological mechanisms. Accordingly, safety interventions should simultaneously include informational (cognitive) and experiential (emotional) modules, rather than being an either/or choice; differentiated intervention strategies can be designed for employees with varying levels of proactivity (e.g., for less proactive individuals, starting with emotional aspects followed by cognitive ones).

5. Limitations

The present study still has several limitations. First, the data were collected primarily from first-year graduate students at a single university in China. The relatively limited sample source may restrict the generalizability and external applicability of the findings to some extent. Future studies should include participants from multiple universities, different academic disciplines, and diverse cultural backgrounds to improve the external validity of the findings. Second, because the questionnaire focused directly on laboratory safety, participants may have been influenced by social desirability bias during the response process and therefore tended to select responses that were more consistent with social norms and safety expectations rather than fully reflecting their actual attitudes and objective behavior. Future research may combine self-report measures with behavioral observations or objective indicators to reduce the potential influence of common method. Finally, the study adopted a cross-sectional design based on a single-wave survey of one student cohort, lacking continuous observation across different time periods. Therefore, causal relationships among the study variables cannot be firmly established. Further research should employ longitudinal or experimental designs to examine the temporal dynamics and causal mechanisms underlying laboratory safety behavior.

6. Conclusions

This study investigated the proactive personality and laboratory safety affective/cognitive/behavioral attitude among graduate students. The results indicated that proactive personality was positively associated with laboratory safety behavioral attitude. In addition, the laboratory safety affective and cognitive attitudes were found to play parallel mediating roles between proactive personality and laboratory safety behavioral attitude. These correlational patterns may offer useful reference points for considering differentiated safety management strategies, though such strategies would need to be evaluated in future longitudinal or experimental research.

Author Contributions: Conceptualization, X.W.; methodology, X.W.; software, Z.Y.; writing—original draft preparation, Z.Y.; writing—review and editing, X.W.; supervision, X.J.; project administration, X.J.; funding acquisition, X.J. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Tianjin University of Technology Teaching and Educational Research and Reform Project, grant number [YBXM2511].

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of Tianjin University (Approval No. TJUE-2022-044).

Informed Consent Statement: Participant consent was waived due to anonymous investigation.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: The authors acknowledge Teaching Reform Project (YBXM2511), the guidance and oversight provided by the Institutional Review Board of Tianjin University of Technology, and the invaluable participation of all individuals who contributed to this study.

Conflicts of Interest: The authors declare no conflicts of interest.

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