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Response model for the psychological education of college students based on non-linear finite element equations

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Abstract

This article proposes a mental health education model for college students based on non-linear finite element equations and explores the concepts, content, methods and approaches for mental health education. After analysing college students' psychological behaviours, the study is based on stressors and stress response models. It specifically explores the psychological and behavioural manifestations of college students with four different attachment types. The research provides a preliminary theoretical basis for the mechanism of the psychological and physical health of college students.

Keywords: college students, non-linear finite element, psychological education, stress response, response model.**AMS 2010 codes:** 34A34

1 Introduction

In 1936, Seley used the classic conditioned reflex 'stimulus–response' model to explore multiple psychosomatic disorders and created a new stress model. This is the stressor–stress response–result model. Later, cognitive psychology research added a 'cognitive evaluation' medium between the stressor and the stress response to improve the stress model gradually. Many physiologists and psychologists have conducted different levels of research on stress mechanisms. Some scholars have explored the harmful effects of stress on individuals' brains.

Over the years, domestic and foreign scholars have studied the multiple factors behind suicide and the inclination to suicide from different perspectives [1]. But the idea of light business before suicide has become a new bright spot for discussion and early warning. How to warn of the idea of light business is of great significance to prevent suicidal impulses and suicidal behaviour. Minor business ambitions are often secondary

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to depressive symptoms. Many life stress factors often induce the symptoms of depression and the idea of neglecting business. However, domestic research uses the ‘Student Life Stress Inventory’ (SLSI) questionnaire proposed by Gadzella to explore undergraduates’ thoughts about business and suicidal tendencies. This study mainly discusses the early-warning stress model of college students’ life stressors and stress responses that induce their depressive symptoms and then induce their light business desires. The research theory provides a basis and reference for crisis psychological intervention of college students.

2 Objects and methods

2.1 Objects

The data comes from the psychological health survey of college students in the second half of 2.19. The total sample consists of 3558 cases. Among them, 2287 cases (64.3%) are males, and 1271 cases (35.7%) are females. Their ages ranged from 16 to 25 years (average age: 19.5 years).

2.2 Methods

We use the ‘College Student Personality Inventory’ (University Personality Inventory [UPI]) revised by Professor Fan Fumin of Tsinghua University as the testing tool. The scale consists of 60 items. This includes four false tests and 56 symptoms [2]. All items are 0/1 binary variables. The test items are symptoms that occurred within 1 year. These include the ‘depressive symptoms’ factor and the ‘light business mind’ project. Reliability test of the scale showed that Cronbach’s $\alpha = 0.843$ and standardised Cronbach’s $\alpha = 0.851$. This shows that the reliability of the scale is relatively high.

The paper uses the SLSI compiled by Gadzella, which uses the revised scale to detect 51 life stresses of college students in the past 3 months. All items have a five-point value (‘1’ means none, ‘2’ means rarely, ‘3’ means occasionally, ‘4’ means often and ‘5’ means always). The scale is divided into two categories comprising nine factors. The five stressors include frustration, conflict, stress, change and self-imposition. The four factors of the stress response are physiological response, emotional response, behavioural response and cognitive response. The reliability of the original scale shows a value of Cronbach’s $\alpha = 0.76$. The reliability of the revised scale of the domestic professor Wang Xin shows a value of Cronbach’s $\alpha = 0.71$. This study tests the reliability of the scale, yielding Cronbach’s $\alpha = 0.892$ and standardised Cronbach’s $\alpha = 0.895$. This shows that the reliability of the scale is relatively high.

2.3 Statistical analysis

We perform regression analysis using the Statistical Package for the Social Sciences software version 13 (SPSS13.0) to fit the early-warning model. The article uses Amos4.0 structural analysis to fit the structural equation model and analyses the direct and indirect influence paths. The balanced equation of the non-linear finite element system is as follows:

$$\psi(\sigma) = P(\sigma) - R = 0 \quad (1)$$

$$P(\sigma) = \sum c_e^T \int_e B^T \sigma dV \quad (2)$$

$$R = \sum c_e^T \int_e N^T p dV + \sum c_e^T \int_{S_e} N^T q dS \quad (3)$$

Here, $P(\sigma)$ and are the equivalent nodal forces of the element stress vector σ and load vectors p, q , respectively; N and c_e are the shape function and selection matrix of the finite element, respectively; B is the conversion matrix between element strain and nodal displacement; $\psi(\sigma) = 0$ means that the element stress and external load are in equilibrium; $\psi(\sigma) \neq 0$ means that the element is in an unbalanced state. We call $-\psi(\sigma) = R - P(\sigma)$ the

unbalanced force vector. The article assumes that the total number of degrees of freedom of the finite element system is N ; then, the system node displacement vector a is an N -dimensional vector:

$$a = [a_1, a_2, \dots, a_N]^T \quad (4)$$

The equivalent nodal forces $P(\sigma)$ and R are also N -dimensional vectors. If the stress σ in Eqs (1) and (2) is expressed as strain ϵ , then, we express it as displacement [3]. In this way, a balanced equation with displacement a as a variable can be obtained:

$$\psi(a) = P(a) - R = 0 \quad (5)$$

The equivalent nodal force $P(\sigma)$ and stress σ have a linear relationship. In the case of linear elastic materials, the relationship between $P(a)$ and a is also linear. $P(a)$ is a non-linear function of a . Eq. (5) is given in the complete form. We usually need to use the Newton iterative algorithm for numerical solution. Newton iteration has the characteristic of local convergence. This requires that the initial displacement value a^0 given by the iteration be closer to the proper solution to ensure that the iterative solution sequence converges to the proper solution. We introduce the load parameter λ and embed it in Eq. (5) to obtain the balance equations with the parameter λ :

$$\psi(a, \lambda) = P(a) - \lambda R = 0 \quad (6)$$

Usually, the parameter λ is specified in advance and gradually increases; we discretise it as follows:

$$\begin{cases} 0 = \lambda_0 < \lambda_1 < \lambda_2 < \dots < \lambda_m < \lambda_{m+1} < \dots < \lambda_M = 1 \\ \Delta\lambda = \Delta\lambda_m = \lambda_{m+1} - \lambda_m \end{cases} \quad (7)$$

Here, m is the number of load steps applied, and $\Delta\lambda$ is the increment of the load parameter. With the increase of λ , we gradually solve the nodal displacement a_{m+1} under λ_{m+1} for each increment $\Delta\lambda$, which is called the load increment method of solving Eq. (6). In each incremental step, we use the Newton iteration format. Its initial value is taken as the solution a_m of the previous incremental step [4]. As long as the incremental step is small enough, the local convergence condition will be satisfied. The Jacobi matrix (i.e. the tangent stiffness matrix of the system) and the Newton iteration formula of Eq. (6) are, respectively, represented as follows:

$$J = \frac{\partial \psi}{\partial a} = \sum c_e^T \int_e B^T D_{ep} B dV c_e \quad (8)$$

$$\begin{cases} \Delta a^0 = 0 \\ \Delta a^{n+1} = \Delta a^n - J^{-1} \psi(a_m + \Delta a^n) \end{cases} \quad (9)$$

Here, D_{ep} is the elastoplastic constitutive matrix. The Jacobi matrix is non-singular ($\det J \neq 0$). The iteration can converge to the proper solution a_{m+1} in the incremental step $\Delta\lambda$. When $m = M$, $\lambda_M = 1$, the solution of the original system of Eq. (5) is obtained. Introducing the load factor λ and using the incremental method to solve the non-linear equations is the idea of the continuation method. The load increment method is the early (or classic) continuation method.

3 Results

3.1 Multivariate linear regression early-warning model for college students' life stressors and stress responses that induce depressive symptoms

We used SLSI five-factor life stressor and four-factor stress response as independent variables and UPI depression symptoms as dependent variables for multiple linear stepwise regression analysis. Two early-warning models were established based on the statistically significant ($p < 0.01$) independent variables that entered the equation at the end.

1) The life stressor factors that induce depressive symptoms include frustration, stress, change and self-imposition (with conflict factors being excluded). Beta coefficient shows that frustration has the top influence on depressive symptoms.

2) The stress response factors that induce depressive symptoms are emotional response, behavioural response, physiological response and cognitive response. Beta coefficient shows that emotional response has a more significant impact on depression symptoms [5]. The two early-warning models were tested for variance, and we found that the goodness of fit was relatively high ($p < 0.01$). The results are shown in Table 1.

Table 1 Multivariate linear regression early-warning model of depressive symptoms induced by the life stressors and stress response factors of college students

Independent variable		Partial regression coefficient		Standard regression coefficient beta	t	p	Model checking
		B	SE				
	(Constant)	−3.005	0.215		−13.949	0	$F = 244.832; p < 0.01$
Stressor factor	Frustration	0.147	0.011	0.248	13.32	0	
	Pressure	0.133	0.015	0.164	8.694	0	
	Variety	0.117	0.02	0.103	5.862	0	
	Self-reinforcing	0.061	0.012	0.087	5.2	0	
	(Constant)	−1.677	0.178		−9.442	0	$F = 263.307; p < 0.01$
Stress response factor	Emotional response	0.219	0.014	0.301	15.203	0	
	Behavioural response	0.086	0.012	0.139	7.248	0	
	Physiological response	0.044	0.007	0.115	6.119	0	
	Cognitive response	0.075	0.018	0.062	4.132	0	

B , xxx; t , yyy; p , probability; SE, standard error.

3.2 Two-valued logistic regression early-warning model and prediction probability of depressive symptoms of college students

We use UPI light business mindfulness ('0': None/'1': Yes) as the dependent variable and depressive symptoms as the covariate to conduct binary logistic regression analysis. The results showed that depressive symptoms significantly affected light business thoughts ($p < 0.01$). The relative risk or rate of light business thoughts for students with depressive symptoms is 1.86 times the odds ratio (OR) of students with non-depressive symptoms. Another group comparison found that the male group's risk rate of depressive symptoms was 1.84 times

the risk rate of non-depressive symptoms. In the female group, the risk rate of depressive symptoms producing light business thoughts was 1.98 times that of non-depressive symptoms [6]. The results are shown in Table 2. At the same time, the predictive classification table generated by the logistic analysis showed that there were 3414 cases with no depressive symptoms and no light business thoughts and 20 cases with depressive symptoms and light business thoughts. The total prediction accuracy rate was 97.0%. The results are shown in Table 3.

Table 2 Binary logistic regression early warning of undergraduates' depressive symptoms

Sample	Covariate	<i>B</i>	SE	Wald χ^2	df	<i>p</i>	OR
Total sample	Depressive symptoms	0.620	0.042	218.629	1	0	1.859
	Constant	-6.196	0.274	511.626	1	0	0.002
Male group	Depressive symptoms	0.613	0.053	135.819	1	0	1.847
	Constant	-6.000	0.326	338.554	1	0	0.002
Women's team	Depressive symptoms	0.681	0.076	80.626	1	0	1.975
	Constant	-6.907	0.548	158.621	1	0	0.001

B, xxx; df, degrees of freedom; OR, odds ratio; *p*, probability; SE, standard error.

Table 3 Classification matrix and probability of undergraduates' depressive symptoms for predicting light business intentions

Observed value	Predictive value		
	Light business will not happen	Light business ideas happen	Prediction accuracy
Light business thoughts do not happen (3425)	3414	11	99.7
Light business ideas happen (117)	97	20	17.1
Percentage	—	—	97

3.3 The stress process in college students induces depressive symptoms and produces light business thoughts

We have planned a path analysis of the stress process (stressor → stress response) of college students that induces depressive symptoms and then produces light business thoughts. The results fit two structural equation models. The significance test found that the goodness of fit of each model was high ($p < 0.01$). The results are shown in Table 4. Model 1 shows that the direct influence coefficient of stressor and stress response on light

business is minimal (0.00, 0.09), so we can ignore it. It also shows that the direct induction coefficient (0.26) of the stressor on depressive symptoms is weaker than the direct induction coefficient (0.32) of the stress response on depressive symptoms [7]. The comparison between Model 1 and Model 2 shows that the influence coefficient of the stressor caused by stress response has increased from 0.80 of Model 1 to 0.83 in Model 2. The impact of the stress response on depressive symptoms increased from 0.32 in Model 1 to 0.56 in Model 2. The impact of depressive symptoms on light business thoughts also increased from 0.26 in Model 1 to 0.31 in Model 2. According to the reality that the stressor must pass the stress response to induce the depressive symptoms and possibly produce the objective path of lightness, we should choose Model 2 as the standard model for this study and Model 1 as the reference model. The model is shown in Figure 1.

Fig. 1 The stress process of college students induces depressive symptoms, which leads to light business thoughts.

Table 4 Structural equation model fitting test of undergraduates' life stressor-induced depressive symptoms and light business thoughts

Model	χ^2	df	p	CMIN/df	GFI	AGFI	RMSEA
Model 1	142.061	21	0	6.765	0.992	0.979	0.041
Model 2	204.93	24	0	8.539	0.988	0.973	0.047

AGFI, adjusted goodness-of-fit index; CMIN/df, minimum discrepancy per degree of freedom; GFI, goodness-of-fit index; RMSEA, root mean square error of approximation.

3.4 Analysis of the influence coefficients of various factors inducing depression symptoms and neglecting business intentions in the stress process of college students

Structural equation Model 2 fits and produces corresponding analysis results of the direct and indirect effects of various factors in the stress process of college students on depressive symptoms and negligence in business [8]. Table 5 shows that the direct influence of the stressor on the stress response is 0.829. The indirect effect of the stress response on depressive symptoms is 0.465. The indirect effect of stress response and depressive symptoms on light business thoughts is 0.145. The direct impact of the stress response on depressive symptoms is 0.562. The indirect effect of depressive symptoms on light business ideology is 0.174. Finally, the effect of the depressive symptoms induced indirectly by the stressor and directly induced by the stress response on the light business idea is 0.311 (Table 5).

4 Discussion

The life stressors that indirectly induce depressive symptoms in college students come from frustration, pressure, change and self-imposition. According to the factor items of the SLSI scale designed by Gadzella, students' 'frustration' factors come from seven aspects, such as delay in reaching, being often disturbed and hence not reaching the goal, frustration due to lack of financial resources, failure to achieve the goal, rejection by society or others, rejection of heterosexual friendship and rejection of opportunities for qualified ability. The student 'stress' factor comes from four aspects: professional competition pressure, academic burden pressure, friend competition pressure and family expectation pressure. The student 'change' factor comes from three aspects: sudden unpleasant changes, facing too many life changes simultaneously and changes that affect the life or hinder achievement of goals. Students' 'self-imposition' factors come from six aspects, such as excessive self-expectations, desire to be loved by everyone, excessive worry about anyone and everything, anxiety for the pursuit of high test scores and the need to solve the problems facing them perfectly [9]. These four factors are all significant triggers of depressive symptoms. However, the students' inner 'conflict' factor did not have a significant effect on the depression symptoms. The above analysis shows that the stressor of depression symptoms in college students mainly comes from environmental or exogenous factors. Even though endogenous factors – as the significant inducers of depression symptoms – are self-imposed, they are expressed through the described external objects. As for the endogenous conflict factors, the brain is often in a state of active excitement due to motivational struggles and unresolved conflicts, so it does not form a state of depression. This empirical analysis shows that the external environmental stimulus of the behavioural response has a more significant impact on depressive symptoms. In comparison, the inner conflict of psychoanalysis has a lesser impact on depressive symptoms.

The stress response that directly induces depression symptoms in college students comes from the following: emotional response, physiological response and behavioural response. This is mainly because depressive symptoms comprise a mood disorder [10]. Frustration, stress, changes and self-imposition life stressors can all cause abnormal emotional reactions. Emotional abnormal reactions will affect autonomic nervous and visceral activities and cause endocrine changes through the emotional centre, namely the hypothalamus. The onset of depressive symptoms is directly related to the direct induction of these comprehensive stress responses.

The stress process in college students (stressor–stress response) indirectly induces light business thoughts through depressive symptoms. This study shows that life stressors have a minimal direct impact on the idea of light business [11]. As a source of frustration, pressure, change and self-imposed stress, stress does not directly induce depressive thoughts but induces depressive symptoms through the induced stress response and indirectly triggers depressive thoughts. This path model reveals that light business thoughts and even suicidal behaviours often arise in depressed people under high stress in real life. Depressive symptoms are intermediaries through which stress triggers light business thoughts and even suicidal behaviour. The reason is that patients with depressive symptoms are easily susceptible to suicide.

Table 5 The direct and indirect influence coefficients of various factors inducing depressive symptoms and negligence in business in the stress process of college students

Factors			
	Stressor	Stress response	Depressive symptoms
	Standard direct influence coefficient		
Pressure	0.711	0	0
Frustration	0.811	0	0
Variety	0.617	0	0
Self-imposition	0.494	0	0
Physiological response	0	0.699	0
Emotional response	0	0.811	0
Behavioural response	0	0.7	0
Cognitive response	0	0.034	0
Stress response	0.829	0	0
Depressive symptoms	0	0.562	0
Concept of suicide	0	0	0.311
	Standard indirect influence coefficient		
Pressure	0	0	0
Frustration	0	0	0
Variety	0	0	0
Self-imposition	0	0	0
Physiological response	0.579	0	0
Emotional response	0.672	0	0
Behavioural response	0.58	0	0
Cognitive response	0.028	0	0
Stress response	0	0	0
Depressive symptoms	0.465	0	0
Concept of suicide	0.145	0.174	0

5 Conclusion

Crisis psychology, such as light business thoughts, can be detected and intervention can be provided fruitfully. Some scholars have found that young people's suicide is not an act of thinking and impulsiveness. It usually occurs in the final stage of internal chaos and external pain. Most young suicide victims talked about or wrote about suicidal intentions before committing suicide. This shows that suicide can be analysed and predicted through observation and psychological tests. Among these indicators, the light business intention is an early warning signal. To warn college students of their weak business minds, we need to detect the life stressor or psychological load they bear and diagnose whether they suffer from depressive symptoms, so that we can provide timely psychological diagnosis and early warning, effective psychological counselling and treatment

and active social support and assistance, along with the application of psychotropic medication. These are all means to implement crisis interventions for light business ideas induced by depressive symptoms.

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