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Exploring the Association Between English Language Learners' Psychological Motivation and Learning Outcomes with the Help of Big Data Analysis Techniques

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SUMMARY: *This study constructs a multifaceted theoretical framework centered on self-determination theory, achievement motivation theory and attribution theory, and combines them with empirical data mining techniques to systematically reveal the differentiated effects of four key dimensions on English learning outcomes, namely, intrinsic motivation, extrinsic motivation, ideal bilingual self and ought to bilingual self, The four key dimensions of "intrinsic motivation", "extrinsic motivation", "ideal bilingual self" and "supposed bilingual self" were systematically revealed to have differentiated effects on English learning outcomes. The results showed that intrinsic motivation was the strongest positive predictor of learning outcomes ($\beta = 0.542$, $p < 0.001$), followed by positive bilingual self ($\beta = 0.367$, $p < 0.001$), and a weaker role for extrinsic motivation ($\beta = 0.298$, $p = 0.001$) and should bilingual self ($\beta = 0.156$, $p = 0.064$). The regression prediction equation developed in this study had a contribution value of 67.3% to the total number of variances in the dependent variable learning effectiveness; while the results of the cluster statistics using motivation type as a basis for categorization verified that students dominated by internal motivation had better language learning performance than students dominated by external motivation.*

KEYWORDS: *big data analysis; psychological motivation; self-determination theory; English language learning; learning outcomes*

1 Introduction

With the continuous progress of globalization, the status of English as an international common language is becoming more and more prominent [1]. The level of English proficiency is not only related to the future development of an individual, but also affects the competitiveness of a country in the international arena [2]. However, the relationship between learners' psychological motivation and learning outcomes has not been fully explored in current English learning. In the era of big data, it is of great significance to understand the association between learners' psychological motivation and learning outcomes by utilizing advanced technology, especially big data analysis technology, in order to improve the quality of English teaching.

The psychological motivation of learners is the positivity and initiative shown by learners in learning activities [3]. Psychological motivation in English learning mainly contains three dimensions: desire to learn, attitude towards learning and strength of motivation, which is the positive emotions and attitudes brought about by the internal satisfaction and external sense of

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achievement that learners can obtain through learning English, as well as their interest in and desire for English learning, and has an important influence on the participation, effort, duration and learning outcomes of the learning process [4-7]. However, due to the complexity and variability of learners' psychological motivation, it is difficult for teachers to realize the analysis of the relationship between motivation and learning outcomes, while the application of big data analysis technology is able to intuitively demonstrate the correlation between the two and provide reference for the adjustment of teaching strategies [8-11]. The most important feature of big data analysis technology is that it can deal with the dazzling information network and extract the potential value through technical means, replacing the past mode of relying solely on manual perceptual judgment [12, 13]. It is able to analyze learners' behavioral data such as learning time, class participation, practice completion rate, academic performance, etc. By understanding the current status of learning such as learners' preference and interest in English learning, knowledge mastery, etc., it is possible to grasp the correlation between the learners' psychological motivation and learning outcomes, and to appropriately adjust the teaching strategies and personalized teaching for the deficiencies existing in the learners [14, 15].

For English language learning, the correlation between learners' psychological motivation and learning outcomes is close, and academics have carried out extensive research in this regard. Literature [16] examined the correlation between university English learners' psychological motivation, interest and learning outcomes, and analyzed the data to point out that the two did not have a positive impact on learning outcomes or even negatively correlate with each other, revealing that motivation and interest are not the determinants of success in English language courses. Literature [17] explored the association between motivation and learning outcomes of Chinese English learners in blended learning, and analyzed the data from questionnaires and interviews to point out that both intrinsic and extrinsic motivation were positively related to learning outcomes, and emphasized the key role of intrinsic motivation such as intrinsic interest and cultural understanding in enhancing language proficiency and promoting psychological development. Literature [18] examined the association between students' self-efficacy, motivation and English learning outcomes, and through regression analysis, it was pointed out that both of them had a significant positive effect on achievement, and emphasized that self-efficacy contributed much more than motivation, which revealed the importance of fostering self-control and intrinsic motivation in enhancing English learning outcomes. Literature [19] analyzed the co-existence of integrative and instrumental motivation of English learners through online interviews and achievement comparisons, examined their effects on learning outcomes, pointed out that teachers should design instructional materials combining the two types of motivation in order to stimulate learning, and emphasized the importance of motivation in promoting students' English learning. Literature [20] comprehensively analyzed the association between psychological motivation and English learning outcomes of second language learners, pointed out that both intrinsic and extrinsic motivation are key influencing factors, and emphasized that extrinsic motivation is a stronger predictor of academic achievement, and examined the practical value of its teaching model to optimize the teaching strategies and learning environment. Literature [21] explored the association between ELLs' course motivation and achievement through mixed methods, pointed out that there was a low positive but insignificant correlation between the two, analyzed the deeper reasons such as unsuitable teaching methods, grammatical difficulties, teacher-student interactions and lack of student autonomy, and emphasized the necessity of improving the relevance of teaching and stimulating students' intrinsic motivation to learn.

Literature [22] explored the association between motivation and English achievement of high school students, pointed out that there was a moderate significant positive correlation between the two through correlation analysis, and emphasized that teachers can enhance

students' motivation and learning outcomes through effective teaching strategies. Literature [23] analyzed the association between motivation and language learning strategies of engineering students, and through questionnaire and correlation analyses pointed out that there is a positive correlation between the two, and emphasized the important role of teachers' provision of appropriate teaching materials and strategies to enhance students' motivation in foreign language learning. Literature [24] analyzed the association between eighth grade students' motivation to learn English and their grammar performance, and the questionnaire data yielded a correlation coefficient of 0.723, which pointed out that there was a strong positive correlation between the two and emphasized the importance of motivation on academic performance. Literature [25] explored the association between psychological motivation, personality traits and academic performance of Chinese English majors through an online survey, analyzed the significant effects of motivation and openness on performance, and pointed out that affinity plays a moderating role, emphasizing the need for teachers to pay attention to learners' personality differences in order to develop more effective teaching strategies. Literature [26] examined the association between students' motivation and English achievement in the e-schoolbag environment, pointed out that high motivation groups had better learning outcomes through cluster analysis and assessment over time, and emphasized the positive predictive effect of achievement value on achievement, while analyzing the finding that prior knowledge, gender and motivation were not significantly related. Literature [27] analyzed the association between internal and external motivation and English learning outcomes of students in local universities, and through questionnaire and statistical analyses, pointed out that there was no significant correlation between the two, and examined that gender differences also did not present a significant effect, emphasizing that motivation level is not a key factor in determining academic achievement.

Based on self-determination theory, goal orientation theory and success or failure attribution theory, this paper conducts an empirical study on 500 foreign language learners with the support of big data, explores the mechanism of the influence of four types of variables, namely, endogenous motivation, extrinsic drive, ideal L2 self, and supposed L2 self, on foreign language achievement, and with the help of the established multiple regression prediction model, elaborates the psychological motivation of English learners and its The relationship between

2 Theoretical foundations

2.1 Psychological motivation theory

Rational motivation is the basic reason for people to carry out learning activities, and the process of research on rational motivation evolving from a single-factor model to a multi-factor model is precisely based on the self-determination theory.The self-determination theory put forward in the 1970s divides human motivation into two categories of internal motivation and external motivation, and points out the mechanism of the relationship between the fulfillment of the psychological needs of the learner and the commitment to learning. Endogenous motivation means that students learn because they like to learn, and when learners have the three basic psychological needs of autonomy, competence and connection they will produce stronger willingness to learn and persistence; extrinsic drive is based on external rewards or punishments, and is reflected in the four progressive relationships of extrinsic regulation, intrinsic regulation, assimilative regulation and integrative regulation, and the process of change in the learner's from extrinsic regulation to integrative regulation In fact, it reflects the continuous improvement of learners' subjectivity and the gradual improvement of learning

effectiveness. Based on this theoretical framework, we can characterize the integrated mechanism of motivation through the following mathematical model:

$$M = \alpha \cdot IM + \beta \cdot ER + \gamma \cdot IR + \delta \cdot IDR + \varepsilon \cdot ITR \tag{1}$$

where, M represents the overall motivation level, IM represents intrinsic motivation, ER, IR, IDR, and ITR represent external regulation, introspective regulation, identity regulation, and integrative regulation, respectively, and α, β, γ, δ, and ε are the weighting coefficients for each motivation type.

Achievement motivation theory further emphasizes the dynamic equilibrium between the individual's desire for success and failure avoidance. Highly motivated learners tend to choose moderately difficult tasks that are both challenging and have a reasonable probability of success, and such a tendency to choose is manifested in English language learning situations by the learner's clear expectations of the degree of language mastery and his or her persistent pursuit of learning goals.

2.2 Big data analysis techniques

In the context of big data, the fusion of data analytics technology and educational research has created a new research paradigm, in which technologies such as data mining, machine learning, and natural language processing have begun to influence the way people understand learning. Data mining uses among others association rule mining algorithms to discover underlying patterns, for example, Apriori and FP-Growth found relationships between a large amount of behavioral data in LMS. Clustering methods, on the other hand, use K-means and so on to cluster learners' having the same or similar behaviors to support the development of personalized teaching and learning activities. With the help of predictive modeling function of machine learning, supervised learning methods such as SVM, Random Forest, etc. are used to predict academic performance using historical records, CNN and RNN have better applications in unstructured data and time series data analysis, and their performance is generally measured in terms of accuracy:

$$\text{Accuracy rate} = \frac{TP + TN}{TP + TN + FP + FN} \tag{2}$$

where TP denotes a true example, TN denotes a true negative example, FP denotes a false positive example, and FN denotes a false negative example.

Using NLP technology for sentiment analysis and text mining to understand the students' state of mind, it can automatically analyze the students' composition level and grammatical correctness during the English learning assessment process; based on collaborative filtering technology and content filtering-based technology for personalized teaching system recommendation. Combined with adaptive learning, it can provide truly customized teaching.

3 Research methodology

3.1 Study design

On the basis of the above mixed-design study, in order to gain a deeper understanding of learners' intrinsic motivation and its impact on academic performance, the author used a combination of qualitative and quantitative methods to carry out the survey, and selected some

English majors and non-English majors as the samples for the questionnaires and interviews research in a university in East China. A sample of 500 undergraduate students (40% English majors, 60% non-English majors, the ratio of male to female is about 1:1.2) were selected for the survey, and all of them were in the age group of 18 to 22 years old. In the sampling process, taking into account the possible different effects of students with different English proficiency, the subjects were divided into three groups of low, middle and high according to their scores on the College English Level 4 and 6 Exams and the Professional English Level Exams in order to ensure the universality of the findings of the study; in addition, in order to eliminate the influence of other factors on the experiment, some limitations such as the learning experience, the family atmosphere, and the time of starting to learn English were set, and the covariance was used to eliminate the influence of other factors on the experiment. In addition, in order to eliminate the influence of other factors on the experiment, some restrictions such as learning experience, family atmosphere and the time of starting to learn English were set, and the covariance method was used to eliminate their influence.

The research tools used in this study are the Psychological Motivation Questionnaire and the Learner Satisfaction Questionnaire, which were constructed on the basis of previous research results. Psychological motivation is divided into four parts: intrinsic motivation, extrinsic motivation, ideal bilingual self and supposed bilingual self, totaling 32 questions, and is presented in the form of a five-point Likert scale. After exploratory and confirmatory factor analyses, it was found to have high structural reliability, while the Cronbach's alpha values were all above 0.85, indicating that the scale has good intrinsic reliability. The learning test system, including three modules: generalized English assessment test, course learning results and information on students' learning process. The generalized test consists of TOEFL simulation questions involving four aspects of listening, speaking, reading and writing. The process evaluation data includes the automatically generated mid-term and final grades of each English course in the learning system of each English course; the data for summative evaluation comes from the number of times students logged in, the time of use, and the type of materials used on the online learning platform, which is mainly derived from the log statistics in the online independent learning platform, and some of the information needs to be counted offline.

The psychological motivation questionnaire was released and recovered using Questionnaire Star, and the retrieval rate of the survey that lasted two weeks was as high as 94.2%. The data of the learning results were mainly exported from the teaching system as well as the Smart Teaching System in order to ensure their completeness and reliability, and in order to effectively reflect the trend of the change of students' psychological motivation, the relevant data were collected three times in a semester at the beginning of the period, the middle of the period and the end of the period respectively, and arranged into column vectors according to the time period. The data collection in this paper fully complied with the principles of research ethics, and all subjects signed an informed consent form and kept their personal information confidential, which ensured the safety of the data and the legitimate rights and interests of the participants.

3.2 Data analysis methods

The key to the data analysis process is data cleansing, so in this paper, multiple interpolation technique is utilized to fill in the missing data and box-and-line plot technique and Z-score criterion technique are used to eliminate outlier data. In addition, in order to reduce the effects due to the unit differences of each feature parameter, the data were normalized in the interval [0, 1] using the Min-Max normalization technique. First, measures of centralized as well as dispersed trends were computed in the descriptive analysis: centralized trends consisted of mean, median, and plurality, and dispersed trends consisted of standard deviation, variance, and

interquartile spacing to reflect the overall situation of each factor of psychological motivation and each variable of academic performance; skewness coefficients and kurtosis coefficients were used to test for obeying a normal distribution. Preparation was made for the selection of methods for parametric statistics below. In this study, Pearson and Spearman were utilized for correlation analysis respectively; Pearson correlation is applicable to the correlation analysis of linear relationship between quantitative variables, while Spearman correlation is applicable to the correlation analysis between qualitative variables and quantitative variables, and the correlation coefficients between them are expressed as follows:

$$r_{xy} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^{n}(x_i - \bar{x})^2 \sum_{i=1}^{n}(y_i - \bar{y})^2}} \tag{3}$$

where r_{xy} denotes the Pearson correlation coefficient between variables x and y, $\bar{x}$ and $\bar{y}$ are the means of the two variables, respectively, and n is the sample size.

The regression analysis is based on a multilevel modeling framework that extends from simple linear regression to multiple regression and structural equation modeling. The basic form of the multiple linear regression model is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_k X_k + \varepsilon \tag{4}$$

Model fit goodness of fit was assessed by adjusting the coefficient of determination R^2_{adj}. The significance of the regression coefficients was verified using the t-test, and the overall model significance was verified by applying the F-test.

In order to better explore the nonlinear relationship between the influence of psychological motivation factors on academic performance, the paper uses Random Forest, SVM and BP neural network for the analysis, and applies the cross-validation method to test the generalization ability of the models and to avoid the over-adaptation of the models to the training set. Meanwhile, in order to compare the advantages and disadvantages of different models, RMSE and MAE are used to evaluate their accuracy. In addition, K-means clustering is used to classify the groups of learners with similar motivational characteristics, and the tree diagram obtained from hierarchical clustering is used to visualize the hierarchical relationship between various types of motivations. The classification function derived from discriminant analysis predicts learners' motivation by category, and the combination of the results of various types of discriminant analysis can reflect the influence of psychological factors on academic performance more comprehensively and provide a basis for the subsequent proposal of effective measures to solve the problem.

4 Analysis of the results of the study

4.1 Descriptive statistics

Descriptive analysis based on the above data of 500 subjects' psychological motivation for learning English and their academic performance can reflect the overall situation of the sample individuals' psychological motivation for learning and their learning effects.In this survey, the distribution of the types of learners' psychological motivation for learning English is shown in Table 1.In terms of the average number of each psychological motivation, it is the strongest intrinsic motivation (M=4.23, SD=0.67), which indicates that the subjects are interested in and

maintain a positive attitude towards the English learning activity itself, confirming the important premise hypothesis that intrinsic motivation influences continuous learning - the intrinsic motivation hypothesis in self-determination theory. This is followed by ideal bilingual self (M=4.05, SD=0.74), which indicates that positive future prediction of one's English proficiency is an important part of the whole motivation system; extrinsic motivation (M=3.67, SD=0.82) and ought bilingual self (M=3.42, SD=0.91) have lower mean values but higher variance, which suggests that there is a large degree of dispersion in these two variables.

Table 1: Distribution of Psychological Motivation Types

Motivation type	N	%	Mean	SD	95% confidence interval
Intrinsic motivation-driven type	156	31.2	4.23	0.67	[4.12, 4.34]
Extrinsic motivation-driven type	89	17.8	3.67	0.82	[3.50, 3.84]
Ideal self-oriented type	143	28.6	4.05	0.74	[3.93, 4.17]
One should be self-oriented	67	13.4	3.42	0.91	[3.20, 3.64]
Hybrid type	45	9.0	3.89	0.58	[3.72, 4.06]
Total	500	100.0	3.85	0.74	[3.79, 3.91]

The results of the overall analysis of the learning outcomes are shown in Table 2, which shows that the average score on the standardized English proficiency test is 78.6 out of 100, with listening comprehension (M=81.2, SD=12.4) and reading comprehension (M=82.1, SD=11.8) significantly outperforming oral expression (M=74.3, SD=15.2) and writing (M=76.8, SD=13.6), and this pattern of skill distribution is highly consistent with the typical characteristic of Chinese English learners that “input skills are superior to output skills”. This pattern of skill distribution is highly consistent with the typical characteristic of Chinese English learners that “input skills are superior to output skills”.

Table 2: The overall analysis results of learning outcomes

English Proficiency Test	N	Mean	SD	95% confidence interval
Listening comprehension	500	81.2	12.4	[54.3, 95.1]
Reading Comprehension	500	82.1	11.8	[65.7, 98.8]
Oral expression	500	74.3	15.2	[52.9, 89.2]
Writing ability	500	76.8	13.6	[74.0, 93.4]
Average score	500	78.6	15.4	[63.8, 89.6]

In addition, clustering of motivation for learning also revealed differences among students; students with internal motivational orientation not only had the highest percentage (31.2%), they also had the highest standardized test scores (84.7), which indicated that these students had higher levels of initiative and were willing to spend more time on learning. Students with positive ideal orientation took the second place (28.6%) and they also scored higher on the standardized test (82.3), they generally have clear career goals and are able to combine English learning with personal development, while the relatively low score (mean 71.8) of the should be self-directed learners may be attributed to the fact that this group of students are more influenced by external factors and are not motivated to learn on their own. The proportion of students with low, medium and high types of motivation is not equal, but the most balanced combination of motivation types is mixed motivation, with the lowest proportion of students in this category (9.0%), and their academic performance is in the middle of the range (78.1 points), which indicates that this category of students can make good use of various types of motivation to meet their current learning needs in the learning process, and has certain significance in the

development of teaching methods tailored to the individual by educators. It has some significance for educators to develop tailored teaching methods.

4.2 Correlation analysis between psychological motivation and learning outcomes

The degree of influence of each element of psychological motivation on learning effectiveness is different, and after the Pearson correlation test, it is found that their correlations are also different and show obvious strengths and weaknesses, which suggests that the effect of these motivational factors on different stages of second language acquisition is also different. The correlation coefficients between psychological motivation and learning effectiveness are shown in Table 3 and visualized as shown in Figure 1. Intrinsic motivation has the highest correlation coefficient with it ($r = 0.672$, $p < 0.001$), which directly validates the idea that the internal drive is stronger in the self-determination theory: students' learning is most engaged and most effective when they are motivated by the desire to learn, curiosity, and the pleasure derived from the acquisition of competence. This results in better performance in terms of objective achievement. Positive second language self-representation also showed a significant positive relationship ($r=0.589$, $p<0.001$), and this correlation coefficient shows that students' desired future English proficiency not only enhances their motivation to learn English in the present, but also implements their expectations for the future into real-life learning outcomes by means of behavioral regulation; external motivation, on the other hand, showed a moderate positive correlation ($r=0.398$, $p< 0.01$), although the decreasing degree suggests that exogenous motivation and punishment are of limited help in improving sustained learning outcomes. The correlation between bilingual self and its learning performance should be the smallest ($r=0.267$, $p<0.05$), which also confirms that the motivation categories mainly characterized by responsibility and others' expectations are difficult to effectively promote the development of realistic learning performance.

Table 3: Correlation Coefficient between Psychological Motivation and Learning Outcomes

Variable	(1)	(2)	(3)	(4)	(5)
Intrinsic motivation (1)	1.000	0.234**	0.567***	0.189*	0.672***
Extrinsic motivation (2)	0.234**	1.000	0.312**	0.445***	0.398**
Ideal Self (3)	0.567***	0.312**	1.000	0.278**	0.589*
One should be self-centered (4)	0.189*	0.445***	0.278**	1.000	0.267*
Learning outcomes (5)	0.672***	0.398**	0.589***	0.267*	1.000

Note: *p<0.05, **p<0.01, ***p<0.001.

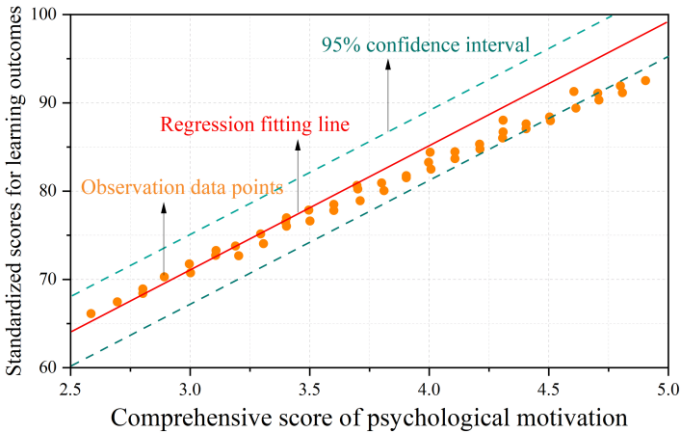

Figure 1: Scatter plot of relevant analysis

The interaction between motivational factors reflects the intricate connections within people's psychological world. The highly significant correlation between intrinsic motivation and ideal second language self ($r=0.567$, $p<0.001$) suggests that the two types of motivation are closely cognitively related, and that people with greater intrinsic motivation for learning usually also possess a clearer and more inspiring ideal second language ability. The two work together in the long process of second language acquisition, producing a synergistic and synergistic virtuous feedback system. Whereas the relationship between intrinsic motivation and the should-be-second language self ($r=0.445$, $p<0.001$), indicating a positive predictive effect of external motivation on the should-be-second language self, suggests that the external environment facilitates the emergence of a sense of responsibility and obligation in learners. Social, familial, and academic pressures tend to motivate the “should” rather than the “want” to learn.

Although this type of reason can play a role in behavior for a short period of time, the role it plays in the final learning outcome is weak. Further, after the partial correlation analysis, the significant correlations between most of the variables did not change and were not affected by the learning background factors, indicating that the influence of these factors on learning outcomes is relatively stable and significant, which is conducive to the establishment of an accurate prediction model of learning outcomes; at the same time, it is possible to cultivate the motivation of different students in a targeted manner according to their characteristics.

4.3 Regression analysis of psychological motivation on learning outcomes

The multiple linear regression model developed in this paper introduces intrinsic motivation, extrinsic motivation, ideal second language self, should second language self and study duration as independent variables into the predictive equation, which to some extent reflects the differences in the effects of different aspects of psychological motivation on English learning outcomes. The multiple linear regression analysis is shown in Table 4, and its residuals are shown in Fig. 2. The model, with R^2 adjusted = 0.673 and $F(5494) = -201.45$, $p<0.001$, explains 67.3% of the total variance in learning effectiveness, which is a result that deserves the attention of the educational psychology community. First, among the factors affecting students' learning effectiveness, intrinsic motivation has the greatest impact on learning effectiveness ($\beta=0.542$, $p<0.001$), i.e., when an individual's intrinsic motivation increases by one standard deviation, his or her learning effectiveness increases by 0.542 standard deviations, indicating that intrinsic motivation has a significant positive predictive effect on learning effectiveness, which mainly comes from an individual's own internal drive for deep-level learning; secondly, ideal bilingual self also has a significant positive predictive effect on learning effect ($\beta=0.367$, $p<0.001$), indicating that clear future goals can be better translated into present enthusiasm for learning and reflected in the objective growth of performance, while external motivation is still statistically significant gender ($\beta=0.298$, $p=0.001$) but its influence is much lower than the above two, which reflects the innate weakness of external rewards as a constraint on learning persistence, and the coefficient of the bilingual self dimension is positive ($\beta=0.156$) yet insignificant ($p=0.064$), suggesting that motivation for learning oriented toward accountability and social norms contributes little to the learning outcome itself.

Table 4: Regression Analysis Results

Variable	Regression coefficient	Standard error	t value	p value	95% confidence interval
Intrinsic motivation (1)	0.542	0.087	6.23	< 0.001	[0.371, 0.713]
Extrinsic motivation (2)	0.298	0.092	3.24	0.001	[0.117, 0.479]
Ideal Self (3)	0.367	0.079	4.65	< 0.001	[0.212, 0.522]
One should be self-centered (4)	0.156	0.084	1.86	0.064	[-0.009, 0.321]
Learning length	0.234	0.065	3.60	< 0.001	[0.106, 0.362]
Constant term	1.247	0.198	6.30	< 0.001	[0.858, 1.636]

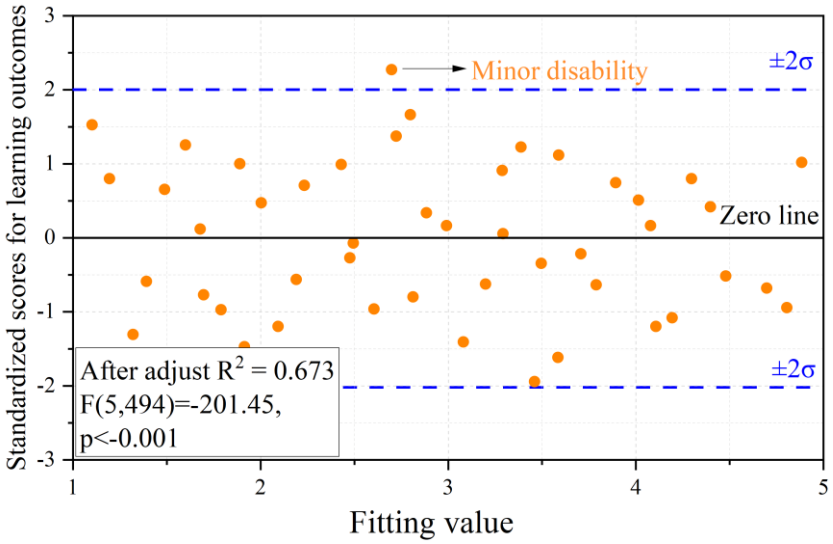

Figure 2: Regression analysis residual plot

Further residual diagnostics were performed to verify that the assumptions made by the regression model were met: random scatter plots of standardized residuals under the fitted values showed that the residuals basically obeyed a uniform distribution and that most of the sample points fell within the ±2σ level bands, suggesting that the model did not suffer from heteroskedasticity. The residual normality test showed Shapiro-Wilk test, W = 0.987, p = 0.142), satisfying normality. And some suspected outliers checked by Cook's distance were found to be extreme values that actually existed and were not input errors, so retaining these values could improve model stability and applicability. From the regression results, the multicollinearity is not out of range, and the variance inflation factors among the predictor variables are all within the safe range (VIF < 3.0), which indicates that their regression coefficients are stable and have practical significance, which suggests that we should pay more attention to the students' own interest in learning as well as establishment of goals for their future English proficiency in the future teaching. The purely external rewards and punishments or the learning as a responsibility approach need to be transformed from the new theory to improve the students' learning efficiency under reasonable incentives to achieve the purpose of English learning.

5 Conclusion

This paper utilizes the method of big data research to collect data information from 500 subjects, and empirically explores how psycho-motivational elements and their combinatorial patterns

affect second language proficiency, and draws the appropriate conclusions:

(1) Endogenous motivational factors have the largest influence coefficient on foreign language achievement (β=0.542, $p<0.001$), supporting the assertion in the SDT that endogenous motivation has a higher influence. When students were motivated by their interest in language knowledge and their sense of accomplishment in completing tasks, they had the best quality and stability of learning and achieved better results on the actual exams. Ideal second language self was a significant positive predictor ($\beta = 0.367$, $p < 0.001$), suggesting that future expectations are important for second language acquisition, and that students with clear expectations of English learning outcomes are able to transform learning outcome expectations into actual learning outcomes based on a goal-oriented behavioral regulation system. Extrinsic motivation $\beta = 0.298$, $p = 0.001$ (not significant), suggesting that extrinsic motivation has less influence on deep learning, and extrinsic motivation has some structural deficiencies for promoting deep learning.

(2) Should bilingual self $\beta = 0.156$, $p = 0.064$ (not significant), suggesting that should-type motives such as sense of responsibility and social expectations do not directly affect learning outcomes. Descriptive statistics of the clustering results of motivation types show that the number of subjects with internal motivation is the largest (31.2% of the sample size), and their standardized test scores have the highest mean (84.7), and the students with should-type self as the dominant student have the lowest mean standardized test score (71.8), and there are statistically significant differences in the academic performance of different types of students;

(3) The overall multiple linear regression equations can effectively explain 67.3% of the total sum of squares of students' academic achievement, which provides basic data support for the establishment of an academic achievement prediction system based on individual psychologically motivated characteristics, in addition to providing theoretical support for tailoring actions to students' needs in educational practice.

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