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Relationship between the expectancy value and grit of hand-to-hand combat athletes in Korea: Multiple mediation of challenge and deliberate practice using the phantom model

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Dictionary:

Hand-to-hand combat – is a physical confrontation or sports between individuals at close range without the use of weapons, relying on striking, grappling, or other direct bodily techniques to subdue an opponent [1].

Combat sport – *noun* a sport in which one person fights another, e.g. wrestling, boxing and the martial arts [51].

Technique – *noun* a way of performing an action [51].

Effort – *noun* mental or physical energy that is exerted in order to achieve a purpose [51].

Abstract:

Background and Study Aim: Hand-to-hand combat sports demand a high level of both physical and mental skills, as well as the ability to overcome oneself, requiring long-term effort for success. Psychological traits such as grit are increasingly recognized as key predictors of athletes' success, yet research focusing on hand-to-hand combat athletes remains scarce. Moreover, studies examining antecedent variables that predict grit are limited. The current study aims to validate a structural model that includes expectancy value, challenge, and deliberate practice to predict grit in hand-to-hand combat athletes.

Material and Methods: Data were collected through surveys of 532 athletes participating in hand-to-hand combat as combat sports (i.e., judo, karate, taekwondo, wrestling) in Korea and analysed via structural equation modelling. Additionally, bootstrapping and the phantom model were employed to test the multiple mediating effects of challenge and deliberate practices on the relationship between expectancy value and grit.

Results: The results revealed that all eight direct paths and four indirect paths were statistically significant. Specifically, expectancy of success and task value, as subfactors of expectancy value, positively predicted challenge, deliberate practice, and grit, whereas challenge and deliberate practice were also positively related to the promotion of athletes' grit. Furthermore, the expectancy of success and task value indirectly influenced grit by mediating challenge and deliberate practices.

Conclusions: These findings suggest that practitioners of hand-to-hand combat (combat sports athletes) who interpret the value of tasks and expectations of success positively are more likely to adopt a challenging and proactive training attitude, ultimately leading to persistent effort toward long-term goals.

Keywords: bootstrapping, consistency of interests, expectancy beliefs for success, long-term goal, perseverance of effort, task value

1. Introduction

In the past, hand-to-hand combat was systematically established as techniques primarily rooted in Eastern cultures for self-defence or offensive combat. However, they have since evolved into 'combat sports' and have been disseminated globally [1]. Furthermore, with the inclusion of various hand-to-hand combat and combat sports disciplines (e.g., judo, taekwondo) as official Olympic events, the number of coaches and athletes around the world has significantly increased. Unlike other sports disciplines (e.g., basketball, soccer, table tennis, volleyball, etc.), hand-to-hand combat and combat sports are mostly individual events characterized by using one's own body for techniques (i.e., unarmed techniques) [2]. As a result, success in hand-to-hand combat and combat sports relies less on mastering equipment (e.g., a golf club or a table tennis racket) or fostering teamwork (e.g., basketball or soccer) and more on overcoming long and arduous personal challenges. Given these unique characteristics of hand-to-hand combat and combat sports, the psychological variable that demands attention when predicting athletes' success is grit.

Grit, rooted in positive psychology, has evolved into a widely discussed variable across various fields, such as music, art, and sports [3-5]. It refers to an athlete's ability to maintain long-term passion and perseverance toward achieving a goal and encompasses three main dimensions: harmonious passion, perseverance of effort, and consistency of interest [4, 6]. Harmonious passion refers to the voluntary desire to integrate one's pursuits with other activities that generate positive experiences [6], whereas perseverance of effort reflects a tendency to continually strive for achievement despite adversity [4]. Consistency of interest indicates a propensity to consistently pursue a set goal without deviation [4]. In various academic disciplines, grit has been shown to positively predict well-being, achievement, happiness, and motivation in areas such as academics, daily life, and career development [7-9]. In the field of sports science, grit has also been reported to explain sports performance, self-compassion, mindfulness, motivation, resilience, and mental toughness [10-12]. Therefore, as an emotional capacity that strengthens positive psychological variables, athletes with higher levels of grit are more likely to exhibit superior performance and maintain a positive attitude toward their goals.

Several studies in the field of hand-to-hand sports have demonstrated that grit is related to athletes' successful performance. For example, a study conducted with taekwondo practitioners and their parents reported that grit is associated with performance outcomes related to taekwondo practices [13]. Another study on taekwondo athletes also revealed that athletes' self-leadership, grit, and performance are structurally related [14]. However, despite the growing interest in grit among researchers, these findings remain limited and quantitatively insufficient. In particular, there is a lack of research on the variables that predict grit. While many researchers have proposed factors such as personal beliefs, life purpose, conscientiousness, self-regulation, and self-control as predictors of grit [15, 7, 16], there is a scarcity of evidence connecting these traits to characteristics emerging in sports contexts, especially among practitioners of hand-to-hand combat. Therefore, more research is needed to identify the variables that predict grit in practitioners of hand-to-hand combat and combat sports athletes.

Considering the unique characteristics of combat sports, this study focuses on 'challenge' and 'deliberate practice' as key predictors of athletes' grit. First, challenge, as proposed by flow theory, refers to a challenging disposition toward task

performance and is a crucial variable that promotes positive psychological traits related to personal achievement and success [17, 18], making it highly associated with grit. In particular, a sense of challenge is deeply intertwined with the varying levels of task difficulty encountered during exercise or training, influencing motivation and emotions depending on how individuals perceive and accept the difficulty of the tasks [17]. Combat sports consist of a continuous series of challenging tasks aimed at pushing athletes beyond their physical and mental limits, and only those who can overcome these challenges over the long term can achieve their goals. Therefore, it can be assumed that a sense of challenge is closely related to emotional capacities such as grit and motivational attitudes [19, 20].

Additionally, deliberate practice is an essential prerequisite for improving performance and achieving positive outcomes [21, 22]. It refers to the motivation to engage in systematic, structured practice behaviours (i.e., training) aimed at achieving peak performance [23, 21]. High levels of deliberate practice indicate that an individual is consistently making efforts to achieve set or given goals [21], has the ability to overcome challenges or adversity [24], and possesses strong intrinsic motivation to address and improve issues that arise in the current situation voluntarily [25, 26]. Existing studies consistently report that deliberate practice distinguishes individual differences among athletes [27]. Elite athletes with high levels of deliberate practice exhibit proactive training attitudes [25, 21, 22], and a stronger propensity for deliberate practice is associated with higher levels of actual performance [28, 29] and positive psychological traits [24, 23]. These characteristics of deliberate practice are considered explanatory factors for grit [29].

For practitioners of hand-to-hand combat to adopt a challenging attitude or engage proactively in training, they must first have hopeful expectations of success and perceive the value of success-related tasks. The expectancy-value model of achievement motivation posits that an individual's expectations of success and the perceived value of tasks influence motivation and task choice [30, 31]. In other words, the stronger the individual's confidence in his or her ability and the greater his or her expectations of success, as well as the greater his or her perception of the value of training or challenging tasks as important, the greater his or her achievement motivation is strengthened, leading to goal-directed behaviour [32]. A unique feature of the expectancy-value model is that perceptions of expectancy and value do not arise at a single moment but accumulate over time, shaped by cultural environments, the beliefs and actions of socialization agents, and individual goals and self-schema [30]. In this sense, past experiences are reflected in the values and beliefs attached to current tasks, driving achievement-oriented behaviour [33]. Therefore, individual differences in expectancy and value can be seen as the result of an athlete's accumulated past experiences, making them appropriate antecedents for predicting motivation related to performance [34, 35].

Furthermore, a wide body of empirical evidence indicates that expectancy value precedes and explains challenges [36, 37], deliberate practices [34, 35], and grit [38], suggesting a likely structural relationship among these four variables [39]. However, research specifically targeting athletes in hand-to-hand combat and combat sports remains scarce, highlighting the need for empirical validation in this context. It is also necessary to examine how the components of expectancy value, namely, the expectancy of success and task value, influence grit through challenge and deliberate practice. Understanding these pathways can help stakeholders identify key variables

to focus on when supporting practitioners of hand-to-hand combat and combat sports athletes in fostering the grit needed to achieve long-term goals.

The current study aims to validate a structural model that includes expectancy value, challenge, and deliberate practice to predict grit in hand-to-hand combat athletes.

The research hypotheses and model are presented in Figure 1.

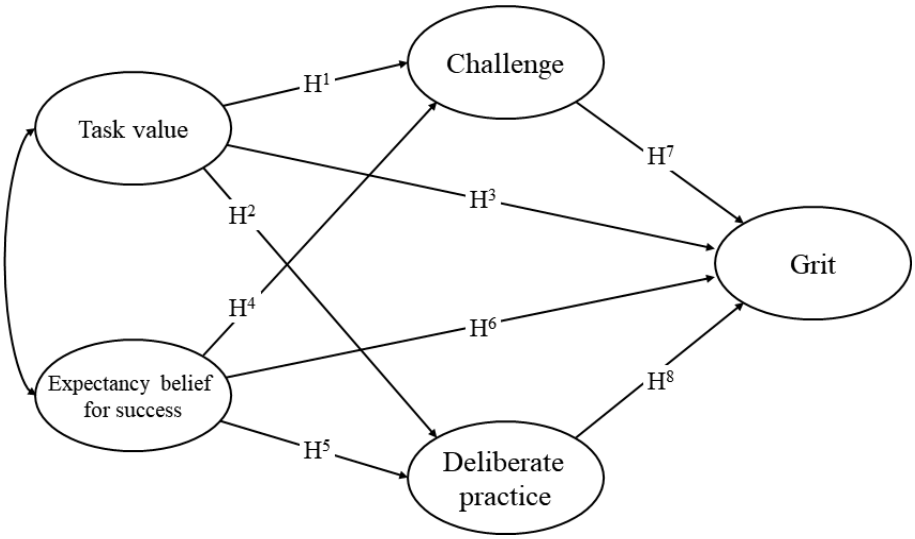

Figure 1. Hypothesized model.

2. Materials and Methods

Participants

This study employed a nonprobability sampling method, specifically convenience sampling, to select research participants. The participants consisted of 532 combat sports student-athletes registered with the Korea Olympic Committee in 2024. Among them, 384 were male (72.2%) and 148 were female (27.8%), with 289 being middle school students (54.3%) and 243 being high school students (45.7%). The ages of the participants ranged from a minimum of 13 years to a maximum of 18 years, with a mean age of 15.20 years (*SD*=1.67). Their athletic experience varied from a minimum of 1 year to a maximum of 9 years, with an average of 3.75 years (*SD*=1.67). The sports represented included taekwondo with 203 participants (38.2%), judo with 178 participants (33.5%), karate with 90 participants (16.9%), and wrestling with 61 participants (11.5%). Additionally, 184 participants (34.6%) reported having won awards at national-level competitions in Korea.

Measures

To ensure the relevance of the measurement tools used in this study to the level of adolescent hand-to-hand combat athletes, a content validity review was first conducted with a panel of experts, including one professor specializing in hand-to-hand combat, one professor specializing in measurement and evaluation, and one high school taekwondo coach. To provide evidence of construct validity and internal consistency reliability for the survey instruments (expectancy value, deliberate practice, challenge, and grit), confirmatory factor analysis (CFA) was subsequently conducted via the maximum likelihood (ML) estimation method, along

with reliability analysis via Cronbach's alpha coefficients. The fit of the CFA model was assessed via x^2/df <3, TLI >0.90, CFI >0.90, RMSEA <0.08, and SRMR <0.08 [40]. Internal consistency was considered adequate if the Cronbach's alpha coefficient was above 0.6 [41].

Expectancy value

The expectancy-value measurement used in this study was based on the *Self and Task-Perception Questionnaire* developed by Eccles & Wigfield [42] and adapted for Korean athletes [43]. This questionnaire includes the theoretical concepts of task value (comprising intrinsic value, attainment value, and utility value) and expectancy beliefs for success. Consequently, the Korean athlete version consists of two factors with a total of eight items: four items for task value (e.g., 'How much do you enjoy the sport you are currently practising?') and four items for expectancy beliefs for success (e.g., 'How good do you think you are at this sport?'). Responses are provided on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). In this study, the reliability of the questionnaire was confirmed, with Cronbach's alpha of 0.872 for subjective value perception and 0.887 for expectancy beliefs for success. The confirmatory factor analysis results for the expectancy-value model showed a good fit, with x^2 = 57.80, df = 19, TLI = 0.976, CFI = 0.984, RMSEA= 0.061, and SRMR= 0.044.

Challenge

Challenge was measured via the instrument developed by Sim & Seo [44], which is based on Gentry & Owen's [45] *Secondary Student Perceptions of Classroom Quality* (SPOCQ) and has been translated and validated for Korean student athletes. This questionnaire assesses how much athletes perceive challenges in various tasks during training situations. It consists of five items on a single factor (e.g., 'This training/exercise is an appropriate challenge for me'), with responses provided on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). In this study, the reliability of the questionnaire was confirmed, with Cronbach's alpha of 0.901. The confirmatory factor analysis results for the challenge model indicated a good fit, with x^2 = 7.90, df = 5, TLI = 0.996, CFI = 0.998, RMSEA = 0.033, and SRMR = 0.010.

Deliberate practice

Deliberate practice was measured via an instrument based on the deliberate practice scale developed by Vallerand et al. [27], which has been adapted and validated for Korean athletes [46]. This questionnaire assesses how consciously athletes exert effort for their development during times outside of training. It consists of a single factor with a total of five items (e.g., 'I practice the movements I have been pointed out as needing improvement repeatedly'). Responses are provided on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). In this study, the reliability of the questionnaire was confirmed, with a Cronbach's alpha of .875. The confirmatory factor analysis results for the deliberate practice model indicated a good fit, with x^2=9.41, df = 5, TLI = 0.992, CFI = 0.996, RMSEA = 0.040, and SRMR = 0.013.

Grit

Grit was measured via the *Triarchic Grit Scale* [47], which was adapted and validated for athletes from an original scale developed for the academic environment in Korea. This questionnaire assesses how much athletes persist in their long-term efforts to achieve their goals. It consists of three factors with a total of 15 items: harmonious passion (5 items, e.g., 'I am a person with strong passion'), consistency of

interests (5 items, e.g., 'I often engage in training that maintains my interest for a long time'), and perseverance of effort (5 items, e.g., 'I do not stop challenging myself, even after failure'). Responses are provided on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). In this study, the reliability of the questionnaire was confirmed, with Cronbach's alpha coefficients of 0.903 for harmonious passion, 0.900 for consistency of interest, and 0.915 for perseverance of effort. The confirmatory factor analysis results for the grit model indicated a good fit, with $x^2 = 189.64$, $df = 62$, TLI = 0.969, CFI = 0.975, RMSEA = 0.062, and SRMR = 0.030.

Procedure

To collect research data, the researchers first sought cooperation from the coaches of middle and high school athletic teams that included combat sports. Considering that the participants were minors, parental consent for participation was mandatory. The data collection schedule was adjusted according to the training and competition schedules of each team, and the researchers personally visited the training venues. During these visits, the researchers provided detailed explanations to the student-athletes regarding the purpose of the study, the type of data to be collected, and how to complete the questionnaires. It was emphasized that participation in the study should not be coerced by coaches or parents, and only those athletes who expressed a willingness to participate received consent forms and questionnaires. After signing the consent form, the athletes completed the questionnaires via a self-reported method. The completed questionnaires were immediately collected by the researchers. The collected data were then initially verified by the research team before being coded for statistical analysis.

Statistical analysis

The data collected in this study were processed via jamovi 2.0 and AMOS 23.0, with the significance level set at $\alpha = 0.05$. Initially, to examine the trends in the collected data and assess normality, means, standard deviations, skewness, and kurtosis were calculated. The critical thresholds for skewness and kurtosis to assess the normality assumption were set at ±3 for skewness and ±7 for kurtosis [40]. To evaluate the convergent validity among the main variables, a correlation analysis was subsequently conducted. Structural equation modelling (SEM) was then used to investigate the relationships between expectancy value, challenge, deliberate practice, and grit. Following the two-step approach recommended by Anderson & Gerbing [48], confirmatory factor analysis (CFA) was first conducted to validate the model, followed by structural model analysis to derive the results. Model fit indices included x^2/df, TLI (Tucker–Lewis index), CFI (Comparative Fit Index), RMSEA (Root Mean Square Error of Approximation), and SRMR (Standardized Root Mean Square Residual). The criteria for evaluating the adequacy of the fit indices were as follows: x^2/df should be less than 3, CFI and TLI should be greater than 0.90, and RMSEA and SRMR should be less than 0.08 [40].

Finally, to test the statistical significance of the indirect effects (mediating effects) of challenge and deliberate practice in the relationship between expectancy value (success expectancy and subjective value) and grit, the bootstrapping method was utilized, with 2,000 iterations and statistical significance assessed via bias-corrected confidence intervals at the 95% confidence level [49]. Furthermore, since the structural model of this study included two mediating variables, a phantom variable was created to validate the indirect pathways [50]. The phantom model approach involves introducing a phantom variable into the path model to estimate the indirect

effects while fixing the estimated coefficients to be the same as those in the original model, thus allowing the total effect to be estimated as the indirect effect of the original model. Importantly, the fit indices of the model with the added phantom model are reported as being equivalent to those of the original model [50].

3. Results

Descriptive statistics and correlations

Table 1 presents the mean, standard deviation, skewness, kurtosis, and correlation coefficients for the collected data. The means of the factors ranged from a minimum of 3.406 to a maximum of 4.020, whereas the standard deviations ranged from 0.664 to 0.781. The skewness and kurtosis values calculated to assess the normality of the data all met the criteria [40]. Specifically, the skewness ranged from −0.487 to −0.064, and the kurtosis ranged from −0.021 to −0.329. Moreover, the correlation analysis indicated that all seven factors were positively correlated (p<0.01). Notably, the relationship between deliberate practice and perseverance of effort showed the highest correlation at r = 0.738 (p<0.01). In contrast, the correlation between task value and consistency of interest exhibited the lowest correlation at r = 0.374 (p<0.01).

Table 1. Descriptive statistics and correlations of all sub-factors.

Factors	1	2	3	4	5	6	7
1. Task value	-						
2. Expectancy beliefs for success	0.366**	-					
3. Deliberate practice	0.419**	0.696**	-				
4. Challenge	0.383**	0.576**	0.633**	-			
5. Harmonious passion	0.553**	0.644**	0.701**	0.665**	-		
6. Consistency of interests	0.374**	0.664**	0.669**	0.614**	0.738**	-	
7. Perseverance of effort	0.533**	0.626**	0.738**	0.648**	0.798**	0.717**	-
Mean	4.020	3.406	3.788	3.821	3.844	3.991	3.786
Standard deviation	0.778	0.781	0.664	0.750	0.751	0.771	0.745
Skewness	−0.637	−0.065	−0.064	−0.285	−0.321	−0.487	−0.189
Kurtosis	0.329	0.287	0.225	0.129	0.269	0.005	−0.021

**p<0.01

Direct path model

Before verifying the structural equation model, a confirmatory factor analysis (CFA) was conducted to assess the model fit, and the results are presented in Table 2. The model fit indices were x^2/df = 2.382 (x^2 = 426.346, df = 179), TLI = 0.962, CFI = 0.968, RMSEA = 0.051 (90% CI = 0.045, 0.057), and SRMR = 0.047, confirming that the research model was a good fit.

Table 3 provides the results of the structural equation modelling analysis. All eight direct paths were statistically significant at p<0.001. Specifically, task value had a positive and significant effect on challenge (β = 0.698), deliberate practice (β = 0.541), and grit (β = 0.169). Similarly, expectancy beliefs for success positively and significantly influenced challenge (β = 0.171), deliberate practice (β = 0.236), and grit (β = 0.212). This finding indicates that as the expectancy value increases, challenge, deliberate practice, and grit also increase linearly. Moreover, challenge had a

significant positive effect on grit (β = 0.403, p<0.001), and deliberate practice also significantly influenced grit (β = 0.306, p<0.001). Thus, both challenge and deliberate practices emerged as significant predictors of grit. On the basis of these results, it can be concluded that the two factors of expectancy value positively predict challenge, deliberate practice, and grit, whereas challenge and deliberate practice directly predict grit. The direct paths of the research model are illustrated in Figure 2.

Table 2. Confirmatory factor analysis of research model.

Latent variables	Observed variables	B	β	S.E.	t
Expectancy-value					
Task value	TV1	1.000	0.789	-	-
	TV2	0.898	0.722	0.052	17.129***
	TV3	0.998	0.850	0.048	20.618***
	TV4	1.033	0.830	0.051	20.135***
Expectancy beliefs for success	EBS1	1.000	0.717	-	-
	EBS2	1.085	0.834	0.059	18.444***
	EBS3	1.118	0.856	0.059	18.900***
	EBS4	1.115	0.873	0.058	19.251***
Challenge	Challenge1	1.000	0.804	-	-
	Challenge2	0.977	0.793	0.050	19.500***
	Challenge3	0.805	0.662	0.051	15.676***
	Challenge4	0.875	0.752	0.048	18.285***
	Challenge5	0.874	0.663	0.056	15.705***
Deliberate practice	DP1	1.000	0.702	-	-
	DP2	1.275	0.861	0.068	18.688***
	DP3	1.165	0.827	0.065	18.001***
	DP4	1.225	0.862	0.065	18.707***
	DP5	1.154	0.774	0.068	16.895***
Grit					
Harmonious passion	HP	1.000	0.897	-	-
Consistency of interests	CI	0.932	0.814	0.037	25.079***
Perseverance of effort	PE	0.985	0.891	0.033	30.076***

***p<0.001

Model fit indices: x^2/df = 2.382 (x^2 = 426.346, df = 179), TLI = 0.962, CFI = 0.968, RMSEA = 0.051 (90%CI = 0.045, 0.057), SRMR = 0.047.

Table 3. Estimates and standardized estimates of direct paths.

	Direct paths			B	*β*	S.E	*t*	Result
H1	TV	→	Challenge	0.628	0.698	0.051	12.343***	supported
H2	TV	→	DP	0.457	0.541	0.046	9.979***	supported
H3	TV	→	Grit	0.167	0.169	0.044	3.756***	supported
H4	EBS	→	Challenge	0.140	0.171	0.032	4.390***	supported
H5	EBS	→	DP	0.182	0.236	0.036	5.103***	supported
H6	EBS	→	Grit	0.192	0.212	0.028	6.900***	supported
H7	Challenge	→	Grit	0.443	0.403	0.061	7.310***	supported
H8	DP	→	Grit	0.358	0.306	0.053	6.756***	supported

***$p < 0.001$

Note. TV refers Task Value, EBS refers Expectancy Beliefs for Success, DP refers Deliberate Practice.

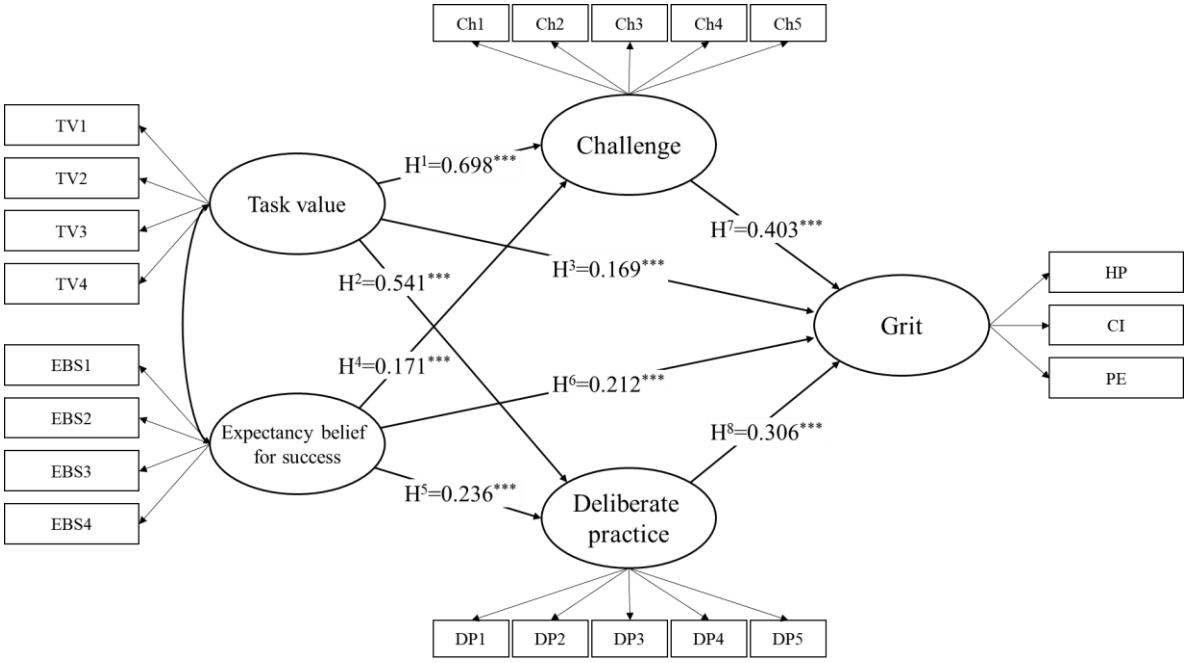

Figure 1. Tested research model (***p<0.001).

Indirect path model

To examine the mediating effects of challenge and deliberate practices on the relationship between the expectancy value and grit, bootstrapping was utilized. Additionally, since there are two mediating variables in the research model, phantom variables were created to analyse the indirect paths. The results, as shown in Table 4, indicated that all the indirect paths were statistically significant. Specifically, the total indirect effect of task value on grit was 0.502 (p<0.001), whereas the total indirect effect of expectancy beliefs for success on grit was 0.136 (p<0.01). In terms of the relationship between task value and grit, the indirect effect of challenge was 0.027 (p<0.01), and the indirect effect of deliberate practice was 0.163 (p<0.001). Furthermore, in the relationship between expectancy beliefs for success and grit, the

indirect effect of challenge was 0.062 (p<0.001), and the indirect effect of deliberate practice was 0.065 (p<0.001). Thus, both task value and expectancy beliefs for success not only have direct effects on grit but also explain grit through the mediating roles of challenge and deliberate practice.

Table 4. Estimates of indirect paths.

Indirect paths	Total indirect effect	Indirect effect	S.E.	*p*	95% CI	
					Lower	Upper
Task value	0.502	-	0.066	0.001	0.370	0.628
TV → Challenge → Grit	-	0.027	0.052	0.002	0.542	0.757
TV → DP → Grit	-	0.163	0.052	0.000	0.372	0.579
Expectancy belief for success	0.136	-	0.032	0.002	0.067	0.202
EBS → Challenge → Grit	-	0.062	0.041	0.001	0.069	0.231
EBS → DP → Grit	-	0.065	0.041	0.001	0.069	0.235

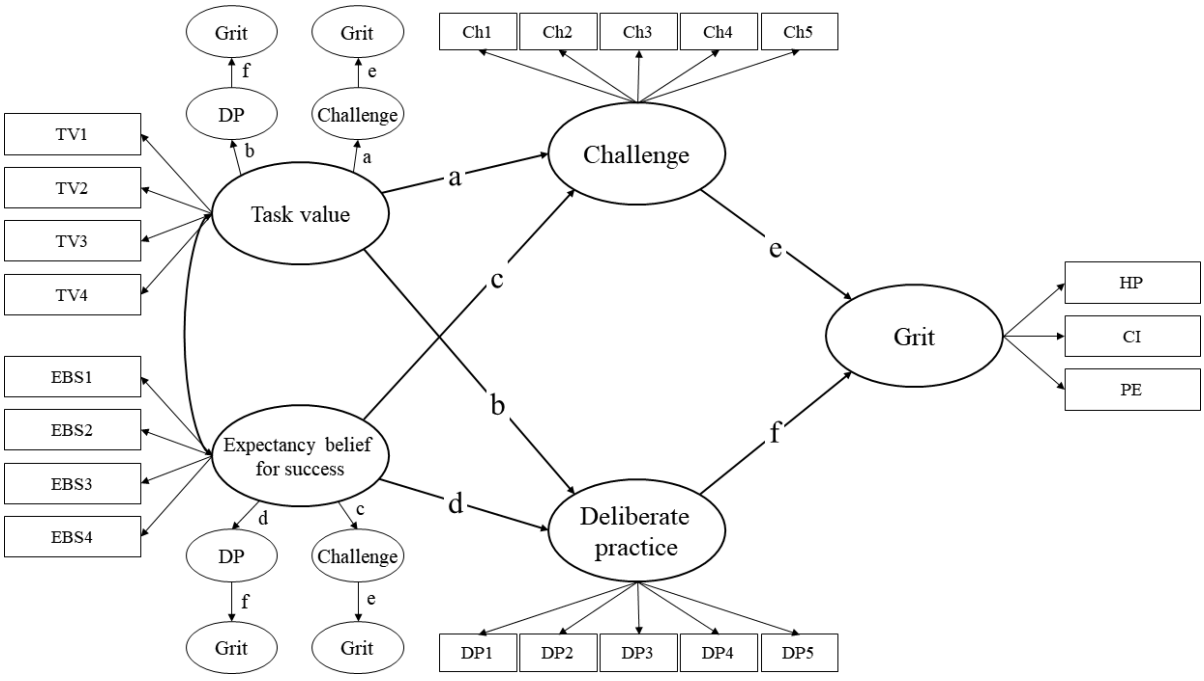

Figure 2. Indirect path model with phantom variables

4. Discussion

This study posited that grit, reflecting passion, perseverance, effort, interest, and persistence, is an essential positive psychological capacity for combat sports athletes [27, 4]. The validation of the research model yielded statistically significant results.

First, the two characteristics of the expectancy-value model (expectancy for success and subjective value) were found to positively explain challenge, deliberate practice, and grit. Specifically, higher confidence in one's abilities and elevated expectations for success, along with a greater perceived value of exercise or training, led to an

increased tendency to embrace challenges (challenge), sustained efforts to achieve set goals and overcome adversity (deliberate practice), and the passion and perseverance required to achieve these goals (grit). These findings align with previous research indicating that expectancy for success and subjective value explain challenges [36, 37], deliberate practices [34, 35], and grit [38]. Furthermore, the results support existing theories suggesting that the expectancy-value model is closely linked to motivation related to task selection, performance, and achievement needs [31, 33, 34].

The finding that the expectancy-value model explains positive psychological variables such as challenge, deliberate practice, and grit in adolescent elite athletes has several implications. The two dimensions presented in the expectancy-value model reflect how athletes perceive the importance of the value and beliefs associated with sports on the basis of their past experiences and current circumstances [31, 32]. For example, greater enjoyment, interest, and perceived importance of training, as well as a high recognition of the significance of skills and tactics, enhance athletes' perceptions of expectancy and value. Additionally, a strong perception of relative competence—compared with peers and considering their current level and future potential—also contributes to this increase in personal attributes related to expectancy and value [31, 34, 35]. Importantly, athletes' perceptions of expectancy and value are significantly influenced by their past experiences [30]. Specifically, the interpretation of past tasks or events greatly affects individual differences in expectancy and value. Thus, experiences of success in tasks are crucial factors in determining expectations for success and subjective value rather than experiences of failure [30].

Considering the concepts of the expectancy-value model, several strategies exist to enhance the performance and positive psychological attitudes of adolescent elite athletes. First, since the expectancy-value model reflects an individual's perceived likelihood of success in the present and future, psychological coaching aimed at enhancing this perception is essential. Such coaching should focus on increasing enjoyment in task performance, building confidence that current tasks will aid future success, emphasizing the importance of executing tasks accurately, and enhancing the effort put into task completion [31]. Second, while psychological coaching can be effectively delivered by professional counselling psychologists, it is also important for key figures close to the athlete – such as coaches and parents – to actively engage in this process. Given that the expectancy-value model assumes a significant influence of past experiences on current performance [30, 33], negative coaching experiences or parental attitudes may have detrimental effects on athletes' psychological motivation. Third, when training programs are designed, systematic consideration of task difficulty is crucial. The expectancy-value model posits that an athlete's competence level (i.e., ability) influences the persistence of achievement behaviour [34]. Therefore, providing tailored training programs that consider individual abilities is vital. The findings of this study indicate that both success expectancy and subjective value positively influence challenge perception; thus, experiencing appropriate task difficulty can enhance an athlete's propensity to tackle new challenges. The implementation of these strategies could help minimize experiences of psychological distress among adolescent elite athletes, ultimately enhancing their grit and overall well-being.

In this study, the mediating factors of challenge perception and deliberate practice were found to positively predict grit while being controlled by the two dimensions of

the expectancy-value model. Specifically, a stronger acceptance of task difficulty and a greater desire to achieve set goals, as well as a commitment to overcoming challenges and adversities, were associated with increased levels of grit. These results support existing research indicating that athletes' challenge perceptions predict grit [17, 19, 20], as well as studies highlighting the close relationship between deliberate practice and grit [28, 23, 29]. Furthermore, this aligns with research suggesting that both challenge perception and deliberate practice contribute to the formation of positive psychological attitudes and the improvement of actual performance in athletes [24, 22]. These findings underscore the importance of fostering a challenging training environment and encouraging athletes to engage in deliberate practice as key components for developing grit and enhancing performance outcomes.

The common traits of elite athletes with high levels of challenge perception and deliberate practice lie in their positive acceptance of task difficulty and strong ability to overcome adversities in pursuit of their goals [22, 18, 20]. These athletes are characterized by their ability to set planned and systematic training goals, demonstrating proactive rather than passive attitudes [25, 21]. Such tendencies are crucial attributes that predict grit, suggesting that coaches should prioritize creating environments that foster these qualities. For example, establishing a positive mind-set through conversations with athletes, setting aligned goals among peers, and encouraging supportive relationships with figures such as parents are important aspects of this environment. Another noteworthy point is that challenge perception and deliberate practice serve as statistically significant mediators in the relationships among expectancy value, subjective value, and grit. This finding indicates that while grit can be explained through the expectancy-value model, the roles of challenge perception and deliberate practice are also essential in elucidating grit [24, 23]. These characteristics highlight the importance of the elements of grit – passion, perseverance, and effort – in tackling challenging tasks and exhibiting a voluntary will to resolve issues. These findings provide empirical evidence for conceptualizing grit within sport contexts, emphasizing the importance of these traits in understanding and developing athletes' psychological resilience.

Future Direction

The current study provides an integrated understanding of expectancy value, challenge perception, deliberate practice, and grit among combat sports athletes. However, it also has limitations, suggesting several recommendations for future research. First, the study did not consider the impact of actual performance levels when validating the research model. While challenge perception and deliberate practice are recognized traits of elite athletes [25, 22, 19], this research did not statistically control for these factors. Additionally, it failed to account for variables reflecting adolescent characteristics (e.g., career aspirations, psychological distress). Therefore, subsequent research should develop a model that includes performance and adolescent-specific characteristics as variables, offering new interpretations of their roles. Second, although this study targeted professional student athletes, it lacked the diversity of sports characteristics and athlete attributes (e.g., gender, experience, coaching environment). Many studies assume that psychological traits vary by sport and athlete characteristics; however, this research was limited to combat sports. Future studies should incorporate moderating variables such as individual versus team sports, male versus female athletes, and the influence of

coaching environments on athletes. Finally, alongside quantitative research, qualitative studies should also be conducted. Understanding the strategies coaches and parents can use to increase grit in combat sports athletes could be effectively explored through qualitative approaches.

5. Conclusion

The analysis revealed that all eight direct paths and four indirect paths were statistically significant. Specifically, the subfactors of expectancy value – namely, success expectation and task value – were identified as positive predictors of challenge perception, deliberate practice, and grit. Additionally, both challenge perceptions and deliberate practices were positively related to enhancing athletes' grit. Furthermore, it was confirmed that success expectations and task value indirectly influence grit through the mediation of challenge perceptions and deliberate practices. These findings suggest that hopeful expectations of success and positive perceptions of task value among combat sports athletes in Korea serve as motivational drivers that foster challenge-seeking behaviours and proactive training attitudes, ultimately leading to sustained efforts toward long-term goals.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy issues.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board (or Ethics Committee) of Woosuk University (IRB No. WS-2023-15).

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