THE RELATIONS OF GRIT, BELIEFS ABOUT INTELLIGENCE AND OPTIMISTIC SELF-TALK IN INVENTION EDUCATION

[1]DAIN KIM, [2]DOEHEE AHN

Chung-Ang University
E-mail: [1]fidcsm123@hanmail.net, [2]dahn@cau.ac.kr

Abstract - This study was to examine the correlations of invention and patent characterization high school students' grit, beliefs about intelligence (i.e. incremental, and entity), and optimistic self-talk, and to explore the mediating role of students' optimistic self-talk in the links between beliefs about intelligence and grit. Of the 340 high school students specialized in invention and patent education in Seoul, Korea, 308 completed and returned the questionnaires. The results showed that correlations between the two sub-factors of grit(i.e. consistency of interest, and perseverance of effort) was not statistically significant.Incremental belief about intelligence was positively correlated with grit, whereas entity belief about intelligence wasnegativelycorrelated withgrit. Optimistic self-talk was positively correlated with grit and incremental belief about intelligence. In the results of path analysis, incremental belief about intelligence had direct effects on optimistic self-talk and grit, and the effect of incremental belief about intelligence on grit was partially mediated by optimistic self-talk. This study will be helpful understanding how to develop grit of high school students specialized in invention and patent education.

Index Terms - Invention, high school student, grit, beliefs about intelligence, self-talk.

I. INTRODUCTION

As we get into the era of the Fourth Industrial Revolution, the required ability is changing. We needed the labor force in the previous era, whereas, we need the ability to search, collect, judge, and synthesize information to make new outcomes and the ability to create innovative ideas at the present([8], [10]). Therefore, many countries around the world are trying to foster inventors in order to cultivate knowledge industry([7]).

In Korea, we are conducting invention education as part of cultivating creative inventors. There is grit, which has recently attractedconcept of predicting success in a variety of areas. Gritis defined as perseverance and passion for long-term goals([3], [4]). Grit means maintaining interest and trying hard work for years, despite the adversity. Grit consists of twosub-factors, 'consistency of interest' which keeps passion even though time passes, and 'perseverance of effort' which is constantly striving for goal([3], [4]). One of the important roles in the efforts is the beliefs about intelligence. Dweck argues that beliefs about intelligence are determined whether intelligence is improved or not by efforts([6]). The belief that intelligence can be improved through effort is called 'incremental' and the belief that intelligence is fixed is called 'entity'.

In addition, Duckworthpresents optimistic self-talk in the way to improve grit([3]). She stated that incremental belief leads to optimistic interpretations about adversity, and it can lead to persistent effort about new challenges. Optimistic self-talk reveals the self-view that evaluates the external situation as a decisive factor in determining the individual's optimism([9]).

II. METHOD

A. Participants and Procedures

Of the 340 high school students attending a high school specialized in invention and patent education in Seoul, Korea, 308 completed and returned the questionnaires(N_{male}=227; N_{female}=79). The questionnaires were distributed by teachers in each classroom, and conducted as a group.

B. Measures

Short Grit Scale(Grit-S)We used the 8-item grit scale developed by [5] andtranslated into Korean. The grit scale consists of two sub-factors, consistency of interest and perseverance of effort, and each with four items. Items were rated on a 5-point Likert-type ranging from 1(not at all like me) to 5(very much like me), and consistency of interest items were scored in reverse. The confirmatory factor analysis was conducted to examine the validity of the scale. As a result, we used 7 items except for one item of consistency of interest with factor loads less than 0.40. The Cronbach's alphas of the consistency of interest, perseverance of effort, and overall grit were 0.77, 0.87, and 0.69, respectively. Beliefs about Intelligence ScaleWe used the scale developed by [1], and we modified it to fit the invention domain. The scale consists of two sub-factors, incremental belief and entity belief, and each with five items. Items were rated on a 5-point Likert-typeranging from 1(not at all like me) to 5(very much like me). The Cronbach's alphas of incremental belief and entity belief were 0.89 and 0.88, respectively. The Positive Self-Talk ScaleWe used the positive orientation factor of the scale developedby [2]. The items were imagined a presented hypothetical situation, were asked the degree of likelihood that they can think. The items were rated on a 4-point Likert-type ranging from 1(not very probable) to 4(very probable). The confirmatory

factor analysis was conducted to examine the validity of the scale. The factor loads of all items were found more than 0.40. The Cronbach's alpha was 0.91.

III. RESULT

A. Correlations between variables

The results of correlations between variables are given in Table 1. The correlations between the two sub-factors of grit(i.e. consistency of interest, and perseverance of effort) were not statistically significant. Incremental belief was positively associated with grit(r=0.38, p<0.01), whereas entity belief was negatively associated with grit(r=-0.23, p<0.01). Optimistic self-talk was also positively associated with grit(r=0.42, p<0.01), and incremental belief(r=0.56, p<0.01).

Table 1: correlations between variables

	variables	1	2	3	4	5	6
Grit	1. Consistency of interest	-					
	2. Perseverance of effort	-0.02	-				
	3. total of grit	0.59**	0.79**	-			
Beliefs of intelligence	4. Entity belief	-0.42**	0.38	-0.23**	-		
	5. Incremental belief	-0.12*	0.56**	0.38**	-0.06	-	
	6. Optimistic self-talk	-0.06	0.57**	0.42**	0.02	0.56**	-

*p<.05, **p<.01

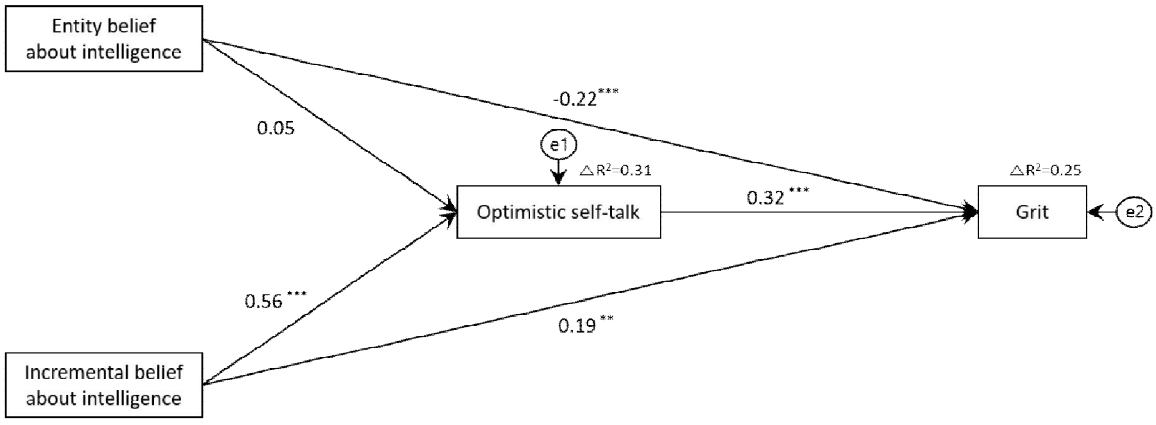
B. Path analysis

The fit of the measurement model was acceptable(see Table 2).CFI, NFI, and TLI values were greater than 0.90, RMSEA was less than 0.05, and SRMR wasless than 0.05.

	x^2	*df*	*p-value*	CFI	NFI	TLI	RMSEA	AIC	SRMR
Model fit	1.044	1	0.307	1.000	0.995	0.999	0.012	19.044	0.022

Table 2: model fit

In the results of path analysis(see Fig 1, Table 3), incremental belief positively predicted optimistic self-talk (β=0.56, p<.001) and grit (β=0.19, p<.01), whereas entity belief negatively predicted grit (β=-.22, p<.001). Uponexamination of the mediating effect of optimistic self-talkbetween beliefs about intelligence and grit, incremental belief on grit was partially mediated by optimistic self-talk. Whereas optimistic self-talk was not mediated between entity belief and grit, entity belief only had direct effect on grit.



**p<.01, ***p<.001

Fig 1. Results of the structural model.

Table 3

			B	S.E.	β	C.R.
Grit	←	Entity belief	-0.14	0.03	-0.22***	-4.41
Optimistic self-talk	←	Entity belief	0.04	0.04	0.05	1.00
Grit	←	Incremental belief	0.14	0.04	0.19**	3.25
Optimistic self-talk	←	Incremental belief	0.46	0.04	0.56***	0.04
Grit	←	Optimistic self-talk	0.27	0.05	0.32***	0.05

**p<.01,
***p<.001

DISCUSSION

This study indicated thatthere were statistically significant correlations among grit, beliefs about Intelligence and optimistic self-talk.However, it was observed that correlation between the two sub-factors of grit(i.e. consistency of interest, and perseverance of effort) was not statistically significant. In addition, consistency of interest which was one of the sub-factors of grit was negatively correlated with incremental belief and entity belief. These resultsshowedthat we need to examine the concept of grit and the factor structure. Also, incremental belief and optimistic self-talkpositively predicted grit. Therefore, it is suggested that that incremental belief and optimistic self-talk can be one way to develop grit.

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