# Cognitive ability and self-control in relation to healthy habits in fitness crowd

Erasmus School of Economics

Behavior Economics

Rotterdam, August 10th, 2017

Name: Yuhan Huang

Student Number: 427740

Supervisor: Chen Li

Second Assessor: Prof. Dr. Peter. P. Wakker

## Abstract

The positive relationship between individuals' health and cognitive ability is well documented. However, the reason why this relationship exists remains largely unexplored. This paper uses a survey to collect the data from a Chinese gym to examine the relationship between health-related behaviors and cognitive ability by considering self-control as a mediator. The results show that there is a positive correlation between cognitive ability and health-related behaviors, while self-control does not seem to mediate the relationship. Moreover, the data shows that individuals' cognitive ability, self-control and age are three independent predictors of health-related behaviors. Further research is suggested to look into this link by employing different methodology and subjects and measuring health status at the same time.

## Contents

# 1. Introduction

Extensive empirical findings have revealed the existence of a positive correlation between individuals' cognitive ability and health. Nevertheless, how to explain this link still remains inconclusive. Batty and Deary (2004) have proposed an authentic explanation, which is based on the premise that people's cognitive ability would affect their health-related behaviors. Generally speaking, individuals with a higher cognitive ability exhibit more health behaviors, for example, they smoke less and suffer less from alcoholism. All these health behaviors facilitate a healthier lifestyle, which further contributes to better health conditions. Moreover, intelligent people seem to perform more effectively in their thinking skills, which also assist them in protecting themselves in more complex situations (Gottfredson & Deary, 2004).

In addition, a similar correlation could be determined between people's health and another important indicator, namely, self-control. Self-control constitutes one of the most important determinants in one's behavior, as it could explain a wide range of desirable and undesirable behaviors (Logue, 1996). For instance, Tangney and his colleagues (2004) have reported that, in general, adolescents who exhibit more self-control live healthier lives than those with less self-control. As an important personality characteristic that could explain one's behavior, self-control might also be a significant predictor of health behaviors. According to Jones (1968), people who exhibit less self-control are more likely to engage in alcoholism, which means self-control also contributes to the acquisition of healthy habits. In addition, another related study, conducted by Borghans et al. (2008), investigated the effect of noncognitive skills on individuals' cognitive performance. The results pointed toward the fact that personality characteristics could have a significant effect on one's performance in a cognitive test, which supports the argument that self-control might have an effect on individuals' overall cognitive performance. Consequently, it can be argued that individuals' self-control ability might also mediate the relationship between healthy habits and cognitive

ability.

In the present study, the focus will be on investigating the correlation among individuals' health-related behaviors, cognitive ability, and self-control within a fitness crowd, which is defined as a group of individuals who have a habit of going to the gym to exercise. This paper will provide new insights into the applicability of empirical findings concerning the positive relationship among health-related behaviors, cognitive ability and self-control among people who exercise, while also considering self-control as a mediator between healthy habits and cognitive ability.

Subjects were recruited at a Chinese gym, FYD. They filled in an online survey, consisting of three parts, which measured their healthy habits, cognitive ability and self-control, respectively. Health-related questions were extracted from a related study of a Dutch institute of mental health and addiction (Van et al., 2003). A three-item Cognitive Reflection Test (Frederick, 2005) and Self-Control Scale from Tangney et al. (2004) were also utilized in the survey to measure their cognitive ability and self-control respectively. First, I found a positive and significant correlation between people's health behaviors and cognitive ability amongst exercising people. This link can provide a possible explanation of the positive correlation between health and cognitive ability. Second, a positive and significant effect of the individuals' self-control on acquisition of healthy habits was also determined. However, self-control cannot mediate the relationship between healthy habits and cognitive ability in the present case.

The structure of the paper is as follows. First, the relevant literature will be discussed the relationship among individuals' health, cognitive ability, self-control, and the hypotheses of this paper. In Section 3, an experimental design will be explained. Subsequently, the collected data and methodology used for the analysis will be addressed in Sections 4 and 5. Finally, the results will be presented in Section 6, followed by a discussion and conclusion in Sections 7 and 8, respectively.

## 2. Literature review

The following section will discuss the relevant concepts and literatures that are used in this paper more extensively. Subsection 2.1 addresses the empirical findings of relationship people's cognitive ability and health, with emphasis on possible reason why these relationships exist. Subsection 2.2 explains the importance of self-control and presents the first hypothesis, while literature on relationship among people's cognitive ability, self-control and health behaviors is discussed in Subsection 2.3, alongside the second hypothesis.

### 2.1 Relationship between cognitive ability and health

The positive relationship between people's cognitive ability and health has long been recognized. A recent study conducted by Batty et al. (2007) has found that people with a higher IQ score have a lower mortality risk in their later life. The explanation of this association is confounded by factors such as reverse causality. Nevertheless, the cohort studies of Batty and his colleagues (2007) have all demonstrated the existence of this negative relationship between IQ score and mortality rate. Based on the results of these studies, socioeconomic status can partly interpret this positive relationship. The United States' National Center for Education Statistics (NCES) has proposed a definition of socioeconomic status (SES). They define SES as a measurement of the social and economic positions of individuals or families based on three main factors, namely educational level, income and occupation. SES is more commonly used to determine the differences in those three main factors among individuals. In fact, individuals' cognitive ability, SES and health are highly correlated. Consequently, people's health has been found to correlate with their socioeconomic status and cognitive ability. Joseph and Kramer (1996) suggested that people's socioeconomic status in childhood substantially determines their health condition in later life. Meanwhile, both educational level and occupational life can predict their mental ability. However, the findings about the link between individuals' cognitive ability and health are still lacking.

Gottfredson and Deary (2004) has tried to fill in this gap by arguing that cognitive ability would promote health behaviors like self-care and self-protection, since cognitive ability represents useful knowledge and skills in preventing injury and diseases.

Besides, a follow-up study of Scottish Mental Survey which measured a valid mental ability of 1932 children born in 1921, has also attributed the difference among people's health conditions to the difference of their general intelligence (Deary et al., 2003). Higher IQ scores in childhood are associated with a low risk of suffering from a variety of illnesses. These findings not only indicate the existence of a positive relation between people's cognitive ability and health, but also reveal the possible reasons why this relationship exists: cognitive ability influences health-related behaviors, which in turn affects individual's health status.

On top of this, several studies have tried to explain this link between cognitive ability and health. The explanation of Whalley and Deary (2001) is based on the idea that a higher cognitive ability will stimulate people to behave healthily. The study results suggest that intelligent people smoke less and suffer less from alcoholism. Taylor et al. (2003) have also found that the children with higher IQ scores are more likely to quit smoking in adult life than those with lower IQ scores. In addition to this, previous research has manifested that cognitive ability plays an important role in thinking process. Specifically, intelligent people seem to show more effective performance in logic thinking and problem solving, especially in a complex situation where cognitive ability is the most valuable. Cognitive ability is also a key component of self-care and self-protection. For instance, Gottfredson and Deary (2004) found that people with lower cognitive abilities are more inclined to misunderstand the instructions of drugs and are hence unable to use them correctly.

All in all, it seems that there is a positive relationship between people's cognitive ability

and health and health behaviors might be a possible explanation. This paper will try to confirm this possible relationship between health behaviors and cognitive ability among exercising people, and complement the findings of previous researches.

## 2.2 Relationship between self-control and health

To figure out why intelligent people live healthier than average people do, some other related studies have investigated the effect of self-control. According to the definition of Tangney et al. (2004), self-control is a pivotal mental resource that can help people avoid undesirable behaviors by changing their inner responses. Higher self-control will produce a variety of positive outcomes systematically in life. For example, Tangney and his colleagues (2004) found that students with higher ability of self-control have better academic performance, healthier lifestyle and higher self-esteem compared with average students. Meanwhile, lower ability of self-control, which is considered to be a fundamental inducement of personnel problem, is always associated with undesirable behaviors. Besides, Jones (1968) found that people's self-control ability is a significant predictor of alcohol consumption, which means that people with a lower self-control ability are more likely to engage themselves in alcoholism. In addition, self-control plays a crucial role in explaining dietary habit among college students.

Moreover, Storey (1999) found that people's impulsive behavior may be driven by a low ability of self-control, which would cause them to get addicted to heroin. As argued by Baumeister et al. (1994), self-control is the key personality characteristic that can explain people's health-related behaviors. It has been found that the adolescents with a greater ability of self-control may have healthier habits than those with a lower self-control ability.

All these findings described previously lead to the first hypothesis of this paper. Higher cognitive and self-control abilities are expected to result in a healthier lifestyle, which means more healthy habits. Hence, the first hypothesis is as follows:

*Hypothesis 1: Individuals with higher cognitive ability and self-control ability will be more inclined to develop a healthy habit, compared with the individuals with lower cognitive ability and self-control ability.*

## 2.3 Relationship among cognitive ability, self-control and health

Based on previous findings, it can be expected that there is also a positive relationship between self-control and health behaviors. Therefore, it can be argued that self-control may mediate the relationship between people's cognitive ability and health behaviors. In turn, cognitive ability might help to acquire self-control, because both self-control and cognitive ability are manifested in thinking skills such as logic thinking and problem solving. It is possible that cognitive ability contributes to the acquisition of self-control and eventually leads to healthy habits. A recent study in the USA has found that a lower delay discounting is associated with a higher cognitive ability. Delay discounting is defined as a systemic tendency to prefer smaller and immediate rewards instead of larger and later ones (Shamosh & Gray, 2008). As delay discounting is an important indicator of self-control, this negative correlation between delay discounting and cognitive ability might indicate that self-control can partly explain this link. Additionally, it could lead to the argument that a higher ability of self-control helps to achieve a better result of cognitive ability test. In line with this argument, Borghans et al. (2008) first investigated the effect of noncognitive skills on the performance in cognitive test. The research identified two kinds of noncognitive skills, namely personality traits (e.g. performance motivation, attitude towards failure, internal locus, and curiosity) and economic preference parameters (e.g. discount rate and risk attitude). The results show that the people with a higher motivation, a positive attitude towards failure and a better internal locus would have a higher probability of getting a correct answer in cognitive ability test, whereas undesirable personality traits are associated with a lower accuracy of choosing correct answers. This finding can not only prove the existence of the effect of noncognitive skills, but also support the argument that self-

control might have an effect on individuals' cognitive performance.

If these predictions hold, individuals with a higher cognitive ability can more easily acquire the ability of self-control, and they would have more healthy habits than those with a lower cognitive ability do. Thus, the ability of self-control could be a significant mediator between individuals' cognitive ability and healthy habits. These predictions lead to the second hypothesis:

*Hypothesis 2: Individuals' ability of self-control mediates the relationship between cognitive ability and health-related behavior.*

This second hypothesis focuses on a more in-depth relationship between individuals' cognitive ability and form of healthy habits. This part will try to complement previous findings by providing a mediator of the positive link between people's cognitive ability and health behaviors.

The subsequent study will be centered on the relationship between respondents' cognitive ability and form of healthy habits with regards to their ability of self-control and take a more in-depth look at this relationship by considering the ability of self-control as an important mediator.

## 3. Experimental Design

For the purpose of this study, an online survey was designed to measure people's cognitive ability, self-control, and healthy habits. Since this survey contained several personal questions, it was conducted under the premise of guaranteeing the respondent's anonymity, which may inspire more honest answers from respondents (Weaver & Prelec, 2013).

On the first page of the survey, emphasis was placed on the fact that the survey was completely anonymous, and that all the collected data would be utilized for research purposes only. The survey contained four parts in total. In the first part of the survey, respondents were asked seven general information questions, namely, gender, age, height, body weight, years of attending the gym, educational level, and household income. These questions were followed by eight questions on the respondents' health-related behaviors, which consisted of dietary habits and physical activities. After this, a cognitive reflection test was employed, so as to measure the respondent's cognitive ability, and the final part was a self-control scale to measure their self-control abilities.

The questions related to the respondent's healthy habits (see Appendix A) can be divided into two parts. The first part concerns the respondent's dietary habits, enquiring about the frequency of having breakfast, fruits and vegetables, unhealthy food and the average money spent on unhealthy food per week. These questions were derived from a related study of a Dutch institute of mental health and addiction (Van et al., 2003). For the first three frequency questions, respondents' answers were based on a 7-point scale. All the reversed item questions, such as the question about the frequency of consuming unhealthy food, will result in a reverse score, which means healthier dietary habits would lead to a higher score.

The two follow-up questions that were used to measure respondent's engagement in

physical activities were derived from Prochaska (2001), which are also called the '60 minutes Moderate-to-Vigorous Physical Activity' (MVPA). As a reliable and valid index to measure the engagement of physical activity, the MVPA first asked the respondents how many days they were physically active, for a total of at least 60 minutes over the past 7 days. Afterwards, in order to eliminate the effect of contingency, respondents were asked how many days they were physically active, for a total of at least 60 minutes over a typical or usual week. The average number of these two answers could indicate how active the respondents were in their psychical activities. Additionally, respondents were asked how many days they were planning to take part in physical activities per week, and the actual number of days they took part in physical activities. These two short questions were posed, so as to ascertain the respondent's inconsistency between planning and doing, which can also be utilized as an index for self-commitment.

In the next session of this survey, a Cognitive Reflection Test (CRT) was employed, so as to appropriately measure the respondent's cognitive ability. CRT is a sample measure concerning one type of cognitive reflection by creating an intuitively incorrect answer. The three questions in CTR (see Appendix B) were relatively easy to answer and explain; however, it requires a suppression of the wrong 'intuitive answer' that first comes to mind. Thus, CRT scores are predictive of one's behavior (Frederick, 2005). After the test, the respondents were split into different groups, according to their CRT score: 'low score' group (those who scored 0 out of 3), 'intermediate score' group (those who scored 1 or 2 out of 3) and 'high score' group (those who scored 3 out of 3). This allowed for the healthy habits and ability of self-control to be compared between the groups.

The final session contained a Chinese version (an adapted version of original statements to make them more suitable for Chinese respondents) of the Self-Control Scale from Tangney et al. (2004), which was designed to measure the respondents' ability of self-

control. The respondents were presented with thirteen statements (see Appendix C), which were regarding self-control and were required to elicit the degree of similarity between the statements (e.g., I am good at resisting temptation) and themselves on a 11-point scale (from 0=not at all like me to 10=very much like me). The reversed items (e.g., I have a hard time breaking bad habits) will provide a reverse score, meaning that the respondents with a higher ability of self-control will attain a higher score in the self-control scale.

# 4. Data

This section provides a brief overview of the data collected from the online survey. Subsection 4.1 discusses the sample content and different characteristics of the respondents. Subsection 4.2 provides additional insight into the target groups.

## 4.1 The sample and variables

During the entire survey, a total of 182 respondents from the FYD gym took the survey. Of these 182 respondents, 44 are still in the process of completing it, as they did not complete the survey before the deadline. Moreover, another 19 recorded partial responses only finished the demographic information, which would not offer any contribution to further analyses, and were thus, excluded from the sample. Another response only lacked the height and bodyweight information; therefore, the final dataset consists of 118 complete responses and 1 partial response.

From the survey, several variables were derived: *gender*; *age*; *height*; *weight*; years of attending the gym (*years_gym*); educational level (*eud_level*); body mass index (*BMI*); *gap;* and household income (*house_income*). Furthermore, data obtained regarding the respondents' health behaviors, cognitive ability and self-control can be seen as the healthy score (*health_score*), cognitive reflection test score (*CRT_score*), and self-control (*SC_score*), respectively.

The *health_score* was computed from seven health-related questions, while the *SC_score* was generated from a 11-point self-control scale. Moreover, the *CRT_score* refers to the number of correct answers on the cognitive reflection test, ranging from 0 to 3. Finally, the variable, *gap,* indicates the difference between planning and doing, as respondents were asked how many days they planned to take part in physical activities per week, as well as the actual total number of days that they will take part in physical activities. The descriptive statistics are depicted in Table 1.

Table 1 – Descriptive Statistics

| Variable | Observations | Mean | S.D. | Min | Max |
|---|---|---|---|---|---|
| gender | 119 | 1.50 | .50 | 1 | 2 |
| age | 119 | 24.61 | 5.94 | 14.5 | 43 |
| height | 118 | 166.95 | 17.60 | 1.72 | 193 |
| weight | 118 | 62.33 | 15.45 | 40 | 120 |
| years_gym | 119 | 1.84 | 2.70 | 0 | 20 |
| edu_level | 119 | 3.54 | 1.08 | 1 | 6 |
| house_income | 119 | 2.55 | 2.18 | 1 | 11 |
| gap | 119 | 1.31 | 1.61 | -3 | 7 |
| BMI | 118 | 21.83 | 4.47 | 16.56 | 42.24 |
| health_score | 119 | 28.33 | 8.22 | 9 | 50 |
| CRT_score | 119 | 1.31 | 1.09 | 0 | 3 |
| SC_score | 119 | 68.44 | 23.31 | 10 | 178 |

Note: The decimal results are rounded to two decimal points.

The descriptive statistics revealed that the respondents were on average 24.6 years of age, 167 centimeters of height, 62.3 kilograms of bodyweight, and 1.8 years of being at a gym, while 49.58% of the respondents were male. As pertaining to the three questions in the cognitive reflection test, the respondents got 1.3 answers correct on average, and 30.25% of the respondents fell into the ‘low score’ group in which respondents scored 0 out of three questions, while 17.65% fell into the ‘high score’ group in which respondents scored 3 out of three questions. The remaining 52.1% fell into the ‘intermediate group’ in which respondents scored 1 or 2 out of three questions. Moreover, the average score that respondents achieved in health-related questions and the self-control scale were 28.3 and 68.4, respectively.

4.2 Extra insight in the CRT score group

When taking a closer look at the groups' split according to the score on the cognitive reflection test, all three groups seem to be rather similar according to age, gender, years of being at the gym, height and bodyweight. However, the scores concerning respondents' healthy habits and self-control might differ systematically among the three groups. It can also be observed that, in the 'low score' group, 36 respondents (30.25%) scored 25.4 on average in health-related questions, compared to 21 respondents (17.65%) who scored 31.2 on average in the 'high score' group. The average score of the 'intermediate group', fell between 25.4 and 31.2, and is 28 specifically (see Figure 1). Thus, it would seem that individuals' cognitive ability is positively correlated with their healthy habits.

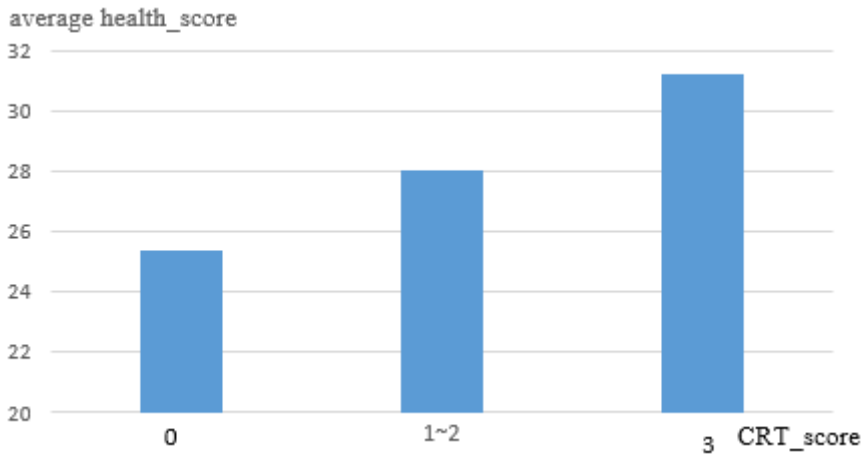


Figure 1 – The perceived *health_score* of respondents according to *CRT_score*

Moreover, when comparing the self-control score among the three groups, the data reveals that the average *SC_score* of 'high score' groups is higher than that of the 'low score' group, namely, 69.6 and 65, respectively, while the 'intermediate group' achieved the highest score with 70.7 (see Figure 2). Lastly, when looking at the differences individually, it seems that age, the cognitive ability score and self-control could exert a significant effect on forming healthy habits among respondents.

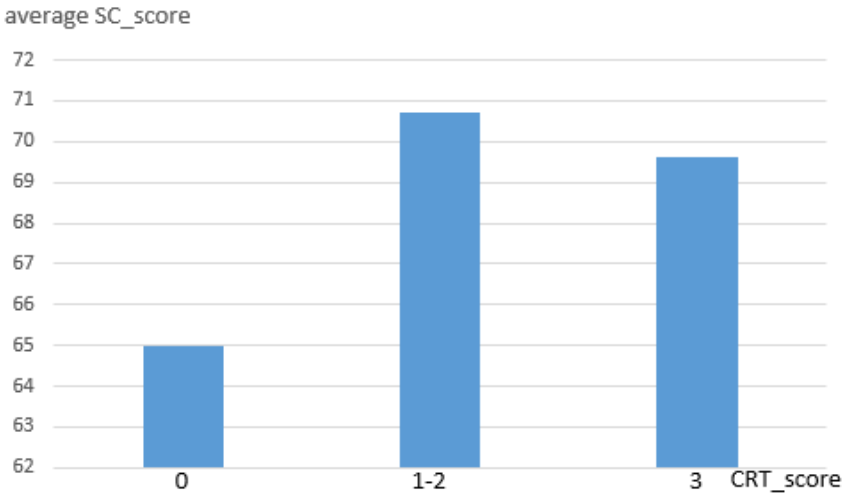


Figure 2 – The perceived *SC_score* of respondents according to *CRT_score*

# 5. Methodology

This section provides an overview of the methodology that used in data analysis. Two subsections will explain the methodology used to test the validity of the hypothesis 1 and hypothesis 2 respectively.

## 5.1 Hypothesis 1

The first hypothesis concerns the relationship amongst individuals' cognitive ability, healthy habits and self-control. To determine whether there is a positive correlation between cognitive ability and healthy habits and correlation between healthy habits and ability of self-control, the Spearman correlation is run to measure the direction and strength of association that exists among these three variables (*health_score*, *CRT_score* and *SC_score*). The Spearman correlation is chosen because the data format falls into the assumptions: all the three variables are measured at the continuous level and a monotonic relationship is expected between two variables. Moreover, Spearman correlation is a non-parametric test, which is consistent in the type of further tests.

In both Spearman correlations, the expectation is that the individuals' health score is both positively correlated with individuals' cognitive reflection test score and self-control score according to empirical findings. Thus, if these positive correlations could be found in the fitness crowd, the validity of previous findings will be confirmed in this paper.

Except for Spearman correlations, Jonckheere-Terpstra tests are also performed to confirm the potential trend of higher individuals' health score with higher cognitive reflection test score. As explained previously, respondents can be split into different groups according to cognitive reflection test score: 'low score' group (those who scored 0 out of 3), 'intermediate score' group (those who score 1 or 2 out of 3) and 'high score' group (those who score 3 out of 3). First, a Jonckheere-Terpstra tests is used to

determine whether a trend can be found between the healthy habits and the cognitive ability, with the expectation that people with higher cognitive reflection score also have higher health score. In addition, the same Jonckheere-Terpstra tests is applied to determine the trend of health score across different groups split by self-control score. This same test is to check whether it is in line with the expectation that individuals with higher ability of self-control are associated with more health-related behaviors on average. These Jonckheere-Terpstra tests are examined to confirm the effectiveness of Spearman correlation.

Besides, in order to find out a more in-depth relationship among individuals' cognitive ability, health and self-control, several multiple regressions analysis with *health_score* as dependent variable are computed. These Regressions are based on the main explanatory variables (*CRT_score* and *SC_score*) and the control variables (*gender, age, height, weight, edu_level, house_ income, years_gym and BMI*). In the first model, only *CRT_score* is used as independent variable, while in the second, *SC_score* is the only independent variable. Both *CRT_score* and *SC_score* are added in the third model and all the control variables are added in the final model.

### 5.2 Hypothesis 2

Hypothesis 2 states that ability of self-control mediates the relationship between individuals' cognitive ability and health behaviors. To determine whether this is the case, several analyses must be performed. First, the stepwise regression is used to find out the contribution of each predictive variables. A forward selection method is employed in this regression specifically to improve the fitness of the model.

Second, the causal steps approach of Baron and Kenny (1986) will be used to confirm that individual's ability of self-control is indeed a significant mediator of the link between one's cognitive ability and health behaviors. As a classic mediation analysis, the causal steps approach contains four necessary conditions for an effective and valid

mediating mechanism. Specifically, in the present study, ability of self-control could be a significant mediator only when it meets the following four conditions:

1. Individuals' cognitive ability should significantly affect their acquisition of healthy habits;
2. Individuals' ability of self-control should significantly affect their acquisition of healthy habits when both cognitive ability and self-control are significant predictor of acquisition of healthy habits;
3. Individuals' self-control should significantly affect their cognitive performance;
4. If previous three conditions hold, the coefficient of variable relates to cognitive ability (*CRT_score*) should be smaller (absolute value) than previous value when variable related to self-control (*SC_score*) is added.

Another way to check this mediating mechanism is to test the effect of cognitive ability on acquisition of healthy habits when individuals' ability of self-control is controlled. Good mediation holds if individuals' cognitive ability has no significant effect on their health behaviors when keep ones' ability of self-control constant. If previous four conditions all satisfied, respondents could be split into different levels of self-control according to their score and additional regressions could be run to check the mediation.

## 6. Results

The results of previously mentioned analyses are presented in this section. Subsection 6.1 provides necessary results to answer hypothesis 1, while subsection 6.2 covers hypothesis 2.

### 6.1 Relationships among cognitive ability, healthy habits and self-control

To find the relationships among individuals' cognitive ability, healthy habits and ability of self-control, Spearman correlations are run to determine the direction and strength of these relationships. The results of Spearman correlation are presented in Table 2.

Table 2 – Spearman Correlation among *health_score*, *CRT_score*, *SC_score*

| | | | health_score | CRT_score | SC_score |
|---|---|---|---|---|---|
| Spearman's rho | health_score | Correlation Coefficient | 1.000 | .245** | .226* |
| | | Sig. (2-tailed) | . | .007 | .013 |
| | | N | 119 | 119 | 119 |
| | CRT_score | Correlation Coefficient | .245** | 1.000 | .082 |
| | | Sig. (2-tailed) | .007 | . | .377 |
| | | N | 119 | 119 | 119 |
| | SC_score | Correlation Coefficient | .226* | .082 | 1.000 |
| | | Sig. (2-tailed) | .013 | .377 | . |
| | | N | 119 | 119 | 119 |

**. Correlation is significant at the 1% level (2-tailed).

*. Correlation is significant at the 5% level (2-tailed).

According to the results of Spearman correlation above, there was a moderate positive correlation between individuals' cognitive ability scores and health score, with r=.245,

p<.01. Another moderate positive correlation could be found between individuals' ability of self-control and health-related behavior, with r=.226, p<.05. When looking at the relationship between individuals' cognitive ability and ability of self-control, the results showed that there was a tiny positive correlation with r=.082 which is not significant at 5% level (p-value=.377).

In additional to this, Jonckheere-Terpstra tests were run to test whether there is a statistically significant tendency of individuals' health-related behavior and cognitive ability across different groups split by their CRT score. The whole distribution of each group is compared in the test. The first test was run to determine the trend between individuals' cognitive ability and healthy habits.

According to the result of the Jonckheere-Terpstra test, there is a statistically significant trend of higher health score with higher levels of individuals' cognitive ability. (from 'low score', 'intermediate score' to 'high score' group), with p-value=.013 (see Appendix D). This implies that there is indeed a positive relationship between individuals' cognitive ability and healthy habits.

The relationship between individuals' healthy habits and ability of self-control was confirmed when looking at the second Jonckheere-Terpstra test in the table below, which performed trend analysis between health-related behavior and self-control score.

The second Jonckheere-Terpstra test revealed that there was a statistically significant trend of more healthy habits with higher ability of self-control, with p-value=.013 (see Appendix D).

In addition to these two non-parametric tests, the results of multiple regressions analysis with *health_score* as dependent variable are presented below (Table 3).

Table 3 – Regression of *health_score*

| Variable | B | SE B | β | t | p |
|---|---|---|---|---|---|
| **Model 1** | | | | | |
| CRT_score | 2.02*** | 0.67 | 0.27 | 3.00 | 0.00 |
| **Model 2** | | | | | |
| SC_score | 0.08*** | 0.03 | 0.22 | 2.48 | 0.01 |
| **Model 3** | | | | | |
| CRT_score | 1.90*** | 0.66 | 0.25 | 2.87 | 0.00 |
| SC_score | 0.07** | 0.03 | 0.20 | 2.33 | 0.02 |
| **Model 4** | | | | | |
| CRT_score | 1.80*** | 0.69 | 0.24 | 2.61 | 0.01 |
| SC_score | 0.07** | 0.03 | 0.20 | 2.25 | 0.03 |
| gender | -3.30 | 2.04 | -0.20 | -1.61 | 0.11 |
| age | 0.29** | 0.13 | 0.21 | 2.33 | 0.02 |
| height | -0.05 | 0.05 | -0.12 | -1.19 | 0.24 |
| weight | -0.08 | 0.19 | -0.16 | -0.45 | 0.66 |
| years_gym | 0.21 | 0.32 | 0.07 | 0.66 | 0.51 |
| edu_level | -0.46 | 0.75 | -0.06 | -0.62 | 0.54 |
| house_income | 0.22 | 0.35 | 0.06 | 0.64 | 0.52 |
| BMI | 0.46 | 0.57 | 0.25 | 0.81 | 0.42 |
| gap | -0.31 | 0.44 | -0.06 | -0.70 | 0.49 |

*Note*: Values in the table are rounded to 2 decimal digits; B: the unstandardized beta which represents the coefficient of each variable; SE B: the standard error for B; β: the standardized beta which represents correlation coefficient; t: test statistic; p: probability level.

***Significant at 1%;

**Significant at 5%;

*Significant at 10%.

According to the results of multiple regressions, *CRT_score* is positively correlated with *health_score* and has a significant effect on *health_score* at 1% level in all models. Meanwhile, positive correlation between *SC_score* and *health_score* also could be found, whereas *SC_score* has a signigicant effect on *health_score* at 5% level. Addtionally, *age* is found to be another significant preditor of health_score at 5% level. It thus appears that there is a significant positive relationship between individuals' cognitive ability and healthy habits at 5% level. Meanwhile, the positive relationship between individuals' healthy habits and ability of self-control is also significant. These findings seem to support the first hypothesis which states that individuals with higher cognitive ability and self-control will be more inclined to develop a healthy habit, compared with individuals with lower cognitive ability and self-control.

Besides, another group of multiple regressions were run to check the effect on self-commitment device. This regression used *gap* (different amount between planning and doing) as a dependent variable. In the first model, *health_score* was added and *CRT_score* was added in the second model. Then, *SC_score* was added in the third model and all control variables were added in the final model. The results are presented in Table 4.

The result shows that there is no significant predictor of *gap* among all variables, which means people's cognitive ability, self-control ability and healthy habits do not have significant effect on their self-commitment in present study.

Table 4 – Regression on *gap*

| Variable | B | SE B | β | t | p |
|---|---|---|---|---|---|
| **Model 1** | | | | | |
| health_score | -0.01 | 0.02 | -0.08 | -0.82 | 0.42 |
| **Model 2** | | | | | |
| health_score | -0.01 | 0.02 | -0.07 | -0.73 | 0.47 |
| CRT_score | -0.03 | 0.14 | -0.02 | -0.20 | 0.84 |
| **Model 3** | | | | | |
| health_score | -0.02 | 0.02 | -0.09 | -0.98 | 0.33 |
| CRT_score | -0.03 | 0.14 | -0.02 | -0.22 | 0.83 |
| SC_score | 0.00 | 0.00 | 0.12 | 1.24 | 0.22 |
| **Model 4** | | | | | |
| health_score | -0.22 | 0.02 | -0.07 | -0.70 | 0.49 |
| CRT_score | -0.03 | 0.16 | -0.02 | -0.17 | 0.87 |
| SC_score | 0.01 | 0.01 | 0.12 | 1.22 | 0.22 |
| gender | -0.07 | 0.45 | -0.02 | -0.16 | 0.88 |
| age | 0.01 | 0.03 | 0.03 | 0.29 | 0.77 |
| height | 0.01 | 0.01 | 0.09 | 0.80 | 0.42 |
| weight | -0.02 | 0.04 | -0.17 | -0.42 | 0.67 |
| years_gym | -0.02 | 0.07 | -0.04 | -0.35 | 0.73 |
| edu_level | -0.10 | 0.16 | -0.07 | -0.61 | 0.54 |
| house_income | 0.06 | 0.08 | 0.08 | 0.82 | 0.42 |
| BMI | 0.00 | 0.12 | 0.01 | 0.02 | 0.98 |

*Note*: Values in the table are rounded to 2 decimal digits; B: the unstandardized beta which represents the coefficient of each variable; SE B: the standard error for B; β: the standardized beta which represents correlation coefficient; t: test statistic; p: probability level.

***Significant at 1%;

**Significant at 5%;

*Significant at 10%.

6.2 Mediation analysis

Borghans et al. (2006) pointed out that, in the context of their own experiment, the personality traits of individuals could have a significant effect on their cognitive performance. They found that desirable noncognitive skills, such as positive attitude, curiosity, are associated with better cognitive performance. In the present case, a related personality trait (self-control) was studied in area of mediating mechanism.

In the previous analysis of hypothesis 1, an insignificant correlation could be found between individuals' self-control ability and healthy habits (with r=.082 and p=.377). To confirm this relationship, another multiple regression is run to predict individuals' cognitive reflection test score from self-control gender, age, height, bodyweight, educational level, household income, years of attending at gym (Table 5).

Table 5 – Regression on *CRT_score*

| Variable | B | SE B | β | t | p |
|---|---|---|---|---|---|
| health_score | 0.03*** | 0.01 | 0.25 | 2.61 | 0.01 |
| gap | -0.01 | 0.06 | -0.02 | -0.17 | 0.87 |
| SC_score | -0.00 | 0.00 | -0.03 | -0.30 | 0.77 |
| gender | -0.00 | 0.28 | -0.00 | -0.01 | 0.99 |
| age | -0.00 | 0.02 | -0.04 | -0.40 | 0.69 |
| height | 0.00 | 0.00 | 0.14 | 1.40 | 0.17 |
| weight | -0.02 | 0.03 | -0.26 | -0.70 | 0.49 |
| years_gym | -0.07 | 0.04 | -0.16 | -1.52 | 0.13 |
| edu_level | 0.31*** | 0.10 | 0.31 | 3.20 | 0.00 |
| house_income | 0.01 | 0.05 | 0.02 | 0.24 | 0.81 |
| BMI | 0.06 | 0.08 | 0.26 | 0.82 | 0.41 |

*Note*: Values in the table are rounded to 2 decimal digits; B: the unstandardized beta which represents the coefficient of each variable; SE B: the standard error for B; β: the standardized beta which represents correlation coefficient; t: test statistic; p: probability level.

***Significant at 1%;

**Significant at 5%;

*Significant at 10%.

The result shows there are only two significant predictors of individuals' cognitive performance, namely, educational level (p-value=.002) and health score (p-value=.01). Individuals' health score adds statistically significant to the prediction at 1% significant level, while ability of self-control was not significant at 10% level(p-value=.768). Thus, the third condition of a valid mediating mechanism is violated.

To summarize, individuals' ability of self-control is not significantly correlated with their cognitive ability (r=.082) and does not affect their cognitive performance significantly (p-value=.624). Therefore, ability of self-control could not be a valid mediator in the positive link between cognitive ability and health-related behaviors in present study.

## 7. Discussion

The empirical findings suggest that individuals' cognitive ability is positively correlated with health. Nevertheless, the real reason behind this phenomenon still needs to be ascertained. One widely accepted explanation is that people's cognitive ability would affect their health-related behaviors, which means people with a higher intelligence demonstrate healthier behaviors, compared to the people with a lower IQ. The present study aims to examine this explanation by analyzing the relationship between cognitive ability and healthy habits, and considering self-control as a mediator between them.

The study was based on a sample of 119 exercising people in China. It was discovered that people who got a higher score in the cognitive reflection test also had, on average, healthier habits than people who attained a lower score. Specifically, individuals with a higher cognitive ability engaged in more regular exercise and have more nutritiously balanced dietary habits. They, in general, more often have breakfast, fruits and vegetables, and spend less money on unhealthy food, compared to those who rarely exercise. Furthermore, it appears that people with higher self-control would also score higher in health-related questions than people with lower self-control abilities. Thus, there appears to be a positive correlation between cognitive ability and health-related behaviors, as well as a positive correlation between self-control and health-related behaviors. The first finding is in line with the expectations of Wyalley and Deary (2001) and Batty et al. (2007) who suggested that there is a positive relationship between people's cognitive ability and health behaviors, and attributed the differences found in people's health behaviors to the difference in their general intelligence, as intelligence would affect individuals' health-related behaviors, which in turn influences their health. The second finding pointed towards the fact that people's self-control ability is also a significant predictor of their health behaviors, which means people with higher self-control display a higher frequency of having fruits, vegetables and breakfast and engage in more physical exercises. This finding confirmed the results of previous researches

conducted by Jones (1968) and Tangney et al. (2004), which argued that self-control plays a crucial role in explaining individuals' health-related behaviors.

In the present study, both a positive correlation between cognitive ability and health behaviors and a positive correlation between self-control ability and health behaviors can be identified. The strength of these two associations are approximately the same, with r=.245 and .226, respectively. However, no significant correlation between people's self-control and cognitive ability can be determined (with r=.082, p=.377). Therefore, it violates the third necessary condition for a valid mediating mechanism, in other words, meaning that self-control ability could not explain the positive link between health behaviors and cognitive ability in the present case.

When controlling all the variables namely, gender, age, height, weight, years of attending in the gym, educational level and household income, the analysis revealed that both individuals' cognitive ability and self-control represent a significant predictor of health-related behaviors. Moreover, age also has a significant effect on health behaviors (with p=.02). The effect of cognitive ability, self-control and age are of approximate and equal strength, with β=.24 for cognitive ability, β=.20 for self-control ability and β=.21 for age. A related research conducted by Prus (2001) discovered that the gap in health status across different groups would vary with age, in other words, meaning that the difference between health condition across different groups of people would become smaller with their age increased, which highlights the fact that age has a significant effect on people's health conditions. This finding may also partially explain why age could be a significant predictor of health-related behaviors. Furthermore, it could be the case that elderly people have more opportunities to garner extra knowledge that helps them to avoid harmful behaviors and develop healthy habits.

In addition, based on the previous findings of Batty (1970), people with a higher cognitive ability are less likely to suffer from obesity. Hence, a relationship between

BMI and cognitive ability was also expected in the present case. However, no correlation could be found between them. This may be explained by the sample selection bias, as the BMI of the fitness crowd may not be distributed normally.

Self-control was determined to be an invalid mediator of relationship between healthy behaviors and cognitive ability in present study, which is in line with the findings of Junger and Kampen (2010), who examined relationships of cognitive ability, healthy habits and self-control in adolescents. The results suggested that cognitive ability and self-control are two independent predictors of health-related behaviors, which means no significant correlation between cognitive ability and self-control was found in their study. No correlation between self-control and cognitive ability that was found in the present study as well. There were only two significant predictors of people's cognitive ability, namely, health score (with p=.01) and educational level (with p=.002), which were in line with the expectation, as people's cognitive ability is highly related to their educational level in general. The possible explanations of this invalid mediation concern two aspects: first, cognitive ability and self-control are indeed two independent characteristics that can explain health-related behaviors. Second concerns the validity of self-control scale, as all the data were based on self-reports, which may lead to biases. Alongside with the argument of Vigna and Malmendier (2006), who found that the primary reason behind the phenomenon of people paying, but not going to the gym, is that they were overconfident about self-control in the future, the reliability of data on self-control is somewhat questionable due to the possible inaccurate evaluation of self-control.

Furthermore, an additional regression analysis was conducted to examine the possibility that cognitive ability and self-control could have an effect on self-commitment. The regression utilized *gap* as the dependent variable, which indicates the different resulting amounts between those planning on going to gym and the actual numbers of going to gym. Cognitive ability and self-control were expected to affect the

self-commitment device, because self-commitment is highly correlated with cognitive ability (Aisyah, 2012). However, no such relationships were discovered in the analysis. Possible explanations could be that emotional intelligence was applied in Asiyah's study, which is different from the cognitive ability that is studied in the present case and the sample size was relatively small to run a valid regression.

The present study might also suffer from several limitations. The first limitation stems from the sample selection, such as the fact that the respondents were from one particular gym in China; therefore, they were more easily reachable. However, this easily reachable resource might have led to an underrepresentation of the fitness crowd. The second limitation comes from the survey itself. The online survey was forwarded in different ways: some of them were sent as a personal message from the manager of the gym, or the respondents' indirect messages when they shared the survey, while some were posted on social network platforms. It is possible that the way of accessing the survey could influence their response. Namely, respondents who received the online survey personally might have more incentives to engage or respond to it, which might also encourage them to put more mental effort in the cognitive reflection test and self-control scale. Another limitation concerns the overall content of the survey. Some respondents offered feedback stating that they chose randomly when they could not fully comprehend the questions or the statements. This could be because they might not have been willing to exert more mental effort on it, while others argued that statements regarding the self-control scale were too abstract to fully understand. All these misunderstandings would contribute to the invalidation of this survey method.

## 8. Conclusion

The central focus of the present study was to determine whether there is a relationship between people's cognitive ability and health behaviors, while providing a possible explanation by considering self-control as a mediator. The findings suggest that the positive correlation between cognitive ability and health may be partly explained by the fact that cognitive ability would stimulate more health behaviors, while self-control does not mediate this relationship. Thus, further research should attempt to employ a different methodology and subject pool and measure health conditions at the same time, so as to enhance the exploration concerning the relationship between cognitive ability and health, and attempt to minimize various confounders at the same time.

Findings in the present study can also be utilized by the managers of gyms. They can consider the fact that less educated members achieved a lower score in the cognitive reflection test than the higher educated members did and they engaged in less physical activities than the average. Thus, the importance of exercise and healthy diets should also be emphasized when providing extra support to them, which also encourages them to be a more loyal customer.

## Reference


1. Batty GD, Deary IJ, Gottfredson LS: Premorbid (early life) IQ and later mortality risk: systematic review. Annals of epidemiology. 2007, 17 (4): 278-288.
2. K. S. Joseph, Michael S. Kramer: Review of the Evidence on Fetal and Early Childhood Antecedents of Adult Chronic Disease. Epidemologic Reviews. 1996, 18(2): 158-174.
3. Whalley LJ, Deary IJ: Longitudinal cohort study of childhood IQ and survival up to age 76. British Medical Bulletin. 2001, 322 (7 April): 1-5.
4. Deary I.J., Whally L.J., Starr J.M. (2003) IQ at Age 11 and Longevity: Results from a Follow-Up of the Scottish Mental Survey 1932. In: Finch C.E., Robine JM., Christen Y. (eds) Brain and Longevity. Research and Perspectives in Longevity. Springer, Berlin, Heidelberg
5. Taylor MD, Hart CL, Davey Smith G, Starr JM, Hole DJ, Whalley LJ, Wilson V, Deary IJ: Childhood mental ability and smoking cessation in adulthood: prospective observational study linking the Scottish Mental Survey 1932 and the Midspan studies. J Epidemiol Community Health. 2003, 57:464-465.
6. Gottfredson LS, Deary IJ: Intelligence Predicts Health and Longevity, but Why?. Current Directions in Psychological Science .2004, 13(1): 1-4.
7. Tangney JP, Baumeister RF, Boone AL: High Self-Control Predicts Good Adjustment, Less Pathology, Better Grades, and Interpersonal Success. Journal of Personality. 2004, 72 (2): 271-324.
8. Jones MC: Personality correlates and antecedents of drinking patterns in adult males. 1968, Journal of Consulting and Clinical Psychology. 32(1):2-12.
9. Storey FS: Childhood abuse and self-regulation: Risk factors for heroin addiction.1999
10. Baumeister RF, Heatherton TF, Tice DM: Losing control: How and why people fail at self-regulation. 1994, San Diego, CA, US, Academic Press, xi: 307
11. Shamosh NA, Gray JR: Delay discounting and intelligence: A meta-analysis.

Intelligence. 2008, 4 (4): 289-305.

12. Borghans L, Meijers H, Ter Weel B: The role of noncognitive skills in explaining cognitive test scores. Economic Inquiry. 2008, 46 (1): 2-12.
13. Prus S G. The Relationship between Age, Socio-Economic Status, and Health among Adult Canadians[J]. Social & Economic Dimensions of An Aging Population Research Papers, 2001.
14. Vigna S D, Malmendier U. Paying not to go to the gym[J]. The American Economic Review, 2006, 96(3): 694-719.
15. Aisyah A R. The Influence of Self-Efficacy, Emotional Intelligence, Innovativeness and Organizational Commitment on the Performance of the Echelon III Employees in Palembang[J]. International Journal of Science and Research, 2012, 3(12): 223-229.
16. Logue AW: Self control: An alternative self-regulation framework applicable to human and nonhuman behavior. Psychological Inquiry. 1996, 7 (1): 68-72.
17. Ter Bogt T, Van Dorsselaer S, Vollebergh W: Psychische gezondheid, risicogedrag en welbevinden van Nederlandse scholieren. (Mental health, risk behaviour and life satisfaction among Dutch adolescents). 2003, Utrecht, The Netherlands, Trimbos National Institute of Mental Health and Addiction.
18. Frederick S. Cognitive reflection and decision making[J]. The Journal of Economic Perspectives, 2005, 19(4): 25-42.
19. Weaver, R., and Prelec, D., (2013). Creating Truth-Telling Incentives with the Bayesian Truth Serum. Journal of Marketing Research, Vol. L (June 2013), 289–30.
20. Prochaska JJ, Sallis JF, Long B: A physical activity screening measure for use with adolescents in primary care. Archives of Paediatrics & Adolescent Medicine. 2001, 155 (5): 73-81.
21. Junger M, van Kampen M. Cognitive ability and self-control in relation to dietary habits, physical activity and bodyweight in adolescents[J]. International Journal of Behavioral Nutrition and Physical Activity, 2010, 7(1): 22.

## Appendix A: health-related questions

- How often do you usually have breakfast before 9 am? (7-point scale, ranging from 0= never to 7=7 days)
- How often do you usually have the following unhealthy food? e.g: candy, chocolate, soft drinks, fries and hamburger (7-point scale, ranging from 1=never, 2=less than once a week, 3=once a week, 4= 2-4 days a week, 5=5-6 days a week, 6=once a day, 7=more than once a day).
- On average, how much money do you spend on unhealthy food per week?
- How often do you usually have fruit and vegetables? (7-point scale, ranging from 1=never, 2=less than once a week, 3=once a week, 4= 2-4 days a week, 5=5-6 days a week, 6=once a day, 7=more than once a day).
- Over the past 7 days, how many days were you physically active for a total of at least 60 minutes per day?
- Over a typical or usual week, how many days were you physically active for a total of at least 60 minutes per day?
- How many days are you planning to take part in physical activities per week?
- How many days do you actually take part in physical activities per week?

## Appendix B: Three-item cognitive reflection test

- A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?
- If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?
- In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

## Appendix C: simple version of self-control scale

- I am good at resisting temptation
- I have a hard time breaking bad habits ®
- I am lazy ®
- I say inappropriate thing ®
- I do certain things that are bad for me if they are fun ®
- I refuse things that are bad for me
- I wish I had more self-discipline ®
- People would say that I have iron self-discipline
- Pleasure and fun sometime keep me from getting work done ®
- I have trouble concentrating ®
- I am able to work effectively toward long-term goals
- Sometimes I can not stop myself from doing something, even if I know it is wrong ®
- I often act without thinking through all the alternatives ®

Subjects rate their self-control on a 11-point scale (ranging from 0=not at all like me, 10=very much like me). The Reversed items are coded with '®', which will give a reverse score. So the subjects with higher self-control score means they have greater ability of self-control.

## Appendix D: Results of Jonckheere-Terpstra tests

Table 6 – Jonckheere-Terpstra Tests on Health_score of CRT_score and SC_score

| | Health_score[a] | Health_score[b] |
|---|---|---|
| Number of levels | 3 | 59 |
| N | 119 | 119 |
| Observed J-T statistic | 2633.5 | 3989.5 |
| Mean J-T statistic | 2145 | 3449.5 |
| SD of J-T statistic | 197.2 | 217.3 |
| Std. J-T statistic | 2.5 | 2.5 |
| Asymp. Sig. (2-tailed) | .013 | .013 |

*Note:* [a] represents grouping variable CRT_score;

[b] represents grouping variable SC_score.