

What variables can influence clinical reasoning?

Vahid Ashoorion, Mohammad Javad Liaghatdar, Peyman Adibi¹

Department of Educational Sciences, School of Educational Sciences and Psychology, Isfahan University, Medical Education Research Center, ¹Department of Internal Medicine, Integrative Functional Gastroenterology Research Center, Isfahan University of Medical Sciences, Isfahan, Iran.

Background: Clinical reasoning is one of the most important competencies that a physician should achieve. Many medical schools and licensing bodies try to predict it based on some general measures such as critical thinking, personality, and emotional intelligence. This study aimed at providing a model to design the relationship between the constructs. **Materials and Methods:** Sixty-nine medical students participated in this study. A battery test devised that consist four parts: Clinical reasoning measures, personality NEO inventory, Bar-On EQ inventory, and California critical thinking questionnaire. All participants completed the tests. Correlation and multiple regression analysis consumed for data analysis. **Results:** There is low to moderate correlations between clinical reasoning and other variables. Emotional intelligence is the only variable that contributes clinical reasoning construct ($r=0.17-0.34$) (R^2 change = 0.46, P Value = 0.000). **Conclusion:** Although, clinical reasoning can be considered as a kind of thinking, no significant correlation detected between it and other constructs. Emotional intelligence (and its subscales) is the only variable that can be used for clinical reasoning prediction.

Key words: Clinical reasoning, critical thinking, emotional intelligence, personality

INTRODUCTION

Clinical reasoning (CR) is one of the most crucial competencies that a physician should achieve. Most of specialty societies, licensing bodies and medical schools consider it in the list of competencies that their graduates should attain and they try to ensure its mastery in the learners.^[1-7] Many factors may influence (CR) as a construct and many researchers try to investigate factors that may improve, predict and illustrate it.^[8] Although, many factors may affect CR, because of scarcity in time and resources in this study only critical thinking (CT), personality, and emotional intelligent (EI) will be studied in depth.

Concerning the role of CT as a general competency in higher education, many educational workers argue that effective and meaningful education requires that all aspects of curricular and pedagogical strategies should be coordinated to promote cognitive skills associated with CT. They believe that educating students as critical

thinkers is fundamental for students and their society.^[9] Many resources necessitate CT as a crucial competency for nursing education and its association with CR has been magnified. On the other hand, association of CT and CR has not been explored for medical students.

Despite the numerous researches conducted about EI in the last decade, E.I. remains a controversial topic.^[10] Three main models of EI exist. The first model by Peter Salovey and John Mayer perceives E.I. as a form of pure intelligence, and as a cognitive ability. A second model introduced by Reuven Bar-On, which regards E.I. as a mixed intelligence, consisting of cognitive ability and personality aspects. This model emphasizes how cognitive and personality factors influence general well-being. The third model, introduced by Daniel Goleman, also perceives E.I. as a mixed intelligence involving cognitive ability and personality aspects.^[11]

EI has been investigated in various fields. It is found to be a predictor of life satisfaction, academic achievement, and healthy psychological adaptation, positive interactions with peers and family, and higher parental warmth. Lower EI has also been found to be associated with violent behavior, illegal use of drugs and alcohol, and participation in delinquent behavior^[11]

Meanwhile, several tests have been devised to measure EI. Bar-On (2000), however, recently revised his scale; he now views the general mood factor as a facilitator

Access this article online	
Quick Response Code:	Website: www.journals.mui.ac.ir/jrms
	DOI: ***

Address for correspondence: Dr. Vahid Ashoorion, Department of Educational Sciences, School of Educational Sciences and Psychology, Isfahan University, Medical Education Research Center, Isfahan University of Medical Sciences, Isfahan, Iran. E-mail: ashoorion@gmail.com

Received: 12-04-2012; **Revised:** 26-09-2012; **Accepted:** 14-11-2012

of EI rather than a part of it. Given the diverse factors that comprise the EI, it is important to know if the scales represent a one-dimensional or multidimensional construct.^[10]

According to Funder, "Personality refers to an individual's attribute patterns of thoughts, emotions, and behavior". Although, there are several different approaches to the study of personality, this paper will focus on the trait and type approach^[12]

According to trait theories, traits define the nature of personality as well as determine the actual operation of personality. Although, thousands of traits have been identified, Costa and McCrae suggested that five traits are central to personality: Neuroticism, extraversion, openness to experience, agreeableness, and conscientiousness. This led to the development of the Big Five model.^[13] The selection of these five traits was based on studies that demonstrated that the five traits were the most useful and recurrent when rating personality. One strength of the Big Five is that the model has shown cross-cultural consistency in studies in which measures based on the model, such as the Revised NEO personality inventory Neuroticism, Extraversion, Openness to Experience Personal Inventory Revised (NEO-PI-R), have been devised within one culture, and validated in other cultures.^[12]

The NEO-PI-R has been translated in to most western languages, as well as many Asian languages including Persian. The generalizability of the measure has been demonstrated across cultures.^[12] In literature, divergent trace of correlation between personality traits and problem solving can be found. In a study, neuroticism trait of personality perceived as a predictor of problem solving.^[14]

To date, little empirical research on the relation between CR, personality, EI and CT has been conducted. Theoretical links between personality, EI, and CT have been proposed as all of them may influence problem solving. D'Alessio has investigated the influence of EI, CT and personality on leadership competency. He found that personality traits might influence leadership style.^[15] CR is a kind of problem solving in medicine, and all above constructs influence problem solving, so each of them may influence CR, too. The combined influence of personality domains, critical thinking, and emotional intelligence on clinical reasoning does not appear to have been studied. This research was conducted to investigate the relationship between CR, emotional intelligence (EI), CT, and personality traits.

MATERIALS AND METHODS

The study was of a quantitative descriptive design, and surveyed 69 medical students (59% female and 41% male)

in two consecutive groups that enroll pediatrics clerkship rotations. Age ranged from 18 to 21 ($M = 19.21$, $SD = 2.32$) years. Students took part in this study as part of their coursework.

The intent of this study was to assess the individual and combined influences of personality domains, CT, and EI on CR. The study also explored the relationships that exist between students' personality traits, the cognitive abilities comprising CT, and the subscales associated with EI and CR. Personality domains, CT, and EI considered as the independent variables, and CR constituted the dependent variable.

All participants completed a battery of four measures assessing CR, CT, EI, and personality. All measures utilized in this study (considering CT, EI and personality) were chosen as they were available in Farsi and their test characteristics were examined thoroughly. These measures were as follow.

Clinical reasoning

To measure clinical reasoning (CR) competency of medical students a battery test were designed by faculties in pediatrics department. First, they were instructed about different test, then a blue-print devised by them and finally the battery test provided. This co-joint test was consisting of three sections: Comprehensive integrated puzzle (CIP), key feature exam (KF) and clinical reasoning problems (CRP). These test formats have been studied in literature thoroughly.^[9,16-18] To devise a CR battery test, a table of specifications was arranged by faculty members in pediatrics department considering the results of needs assessment. The table consisted of 7 columns and 42 rows. Columns were holding clinical problems; age and sex of the patients, involved organ system, the context of presentation (ambulatory, inpatient or emergency department), the field of clinical work (information gathering, diagnosis and management) and finally the type of exam (CIP, KF and CRP). In the rows, different features of 42 clinical scenarios completed according to the different fields in columns based on the goal and objectives of the course. All scenarios were chosen based on the needs assessment that has been conducted to define most usual and life threatening clinical situations that general practitioners may face with. The faculties devised different part of the test using the protocols provided by the researcher. These protocols were prepared considering the literature. All the process conducted by a curriculum specialist.

The first part of CR test compromise of "CIP". It was devised to measure the competency of script formation. The CIP has the format of an 'extended matching' crossword puzzle. Its answer sheet is a grid comprising rows and columns.

The left-hand column contains diagnoses or brief clinical vignettes. To complete the cells of the grid the student is required to match, stepwise, the various ‘disciplinary investigations’ to the diagnoses or clinical vignettes. When the puzzle is completed each horizontal row reflects a coherent medical case.

The second part of CR exam was arranged as “Key Feature” tests. A key-feature problem consists of a clinical case scenario followed by questions that focus on only those critical steps. The questions can be presented to require examinees either to write in their responses or to select them from a list of options. For each question, examinees are instructed to supply or select whatever number of responses is appropriate to the clinical task being tested, and answer keys can comprise one or several responses.

The last part of CR battery test consists of six challenging clinical reasoning problems (CRP). Each problem consists of a clinical scenario comprising presentation, history, and physical examination. Based on this information, subjects are asked to nominate the two most likely diagnoses and to list the clinical features that they consider in formulating their diagnoses, indicating whether these features supported or opposed the nominated diagnoses. For shortening the data, in this study, all parts of CR battery tests were added up and each student has a single mark in clinical reasoning.

California Critical Thinking Skills Test (CCTST)^[19]: A 34 multiple choices measure that assess CT in two different manners. Items have been categorized based on the cognitive abilities in two sets. A set of item measures analysis and interpretation, inference and evaluation and explanation. Considering the arrangement, measure inductive and deductive reasoning. Answering the questions needs some presumptions, thinking, and inference. Each item has one credit and the maximum credit is 34^[19-21] *Revised NEO Personality Five Factors Inventory (NEO-FFI)*^[22]: A 60-item, self-reported questionnaire designed to measure five major personality dimensions. Respondents indicate level of agreement with each item on a five point Likert scale (one = strongly agree, five = strongly disagree). Higher score designates higher incidence of each personality trait. This widely used inventory assesses the “Big Five” personality traits, namely neuroticism, extraversion, openness, agreeableness, and conscientiousness. Each trait includes six facets. Neuroticism indicates emotional stability and personal reaction to stress and anxiety. Extraversion/Introversion dimension point out if a person like social activities or s/he prefers to act by her/himself alone. Openness specifies how a person reacts with new experiments, new foods, and new places. Agreeableness trait measure if a person considers others and other people regard him too. Conscientiousness indicates if a person is

dutifulness and responsible. The reliability and validity of the NEO-PI-R is well established ($\alpha = 0.86-0.93$). Two-year test-retest reliabilities ranged from .83 to .91 for domains and from .64 to .86 for facets.^[12] A recent article using the NEO FFI to study perfectionism had the internal consistencies at $N = 0.85, E = 0.80, O = 0.68, A = 0.75, C = 0.83$ ^[13,22,23]

Bar-On Emotional Intelligence Questionnaire: A 90- item self-report measure. It requires individuals to rate the extent to which each statement represents them on a five point Likert scale. The individual’s responses render a total EQ score, as well as scores on the following 5 composite scales and 15 subscales:^[24-26]

- Intrapersonal
 - Self-regard
 - Emotional self-awareness
 - Assertiveness
 - Independence
 - Self-actualization
- Interpersonal
 - Empathy

Table 1: Descriptive statistics

Measure	Subscale	N	Range	Mean±SD	Reliability
Clinical reasoning ^[23]		69	32.33-59.85	50.31±5.25	
Critical thinking			7-21	14.25±3.14	62%
Neo personality five factor inventory	Neuroticism	64	13-40	27.65±6.6	67%
	Extraversion	62	32-54	39.87±5.53	
	Openness	62	26-48	39.38±5.13	
	Agreeableness	64	30-49	36.84±4.5	
	Conscientiousness	64	35-50	42.25±5	
Emotional intelligence	Problem solving	64	19-27	22.02±2.6	66%
	Happiness	64	14-22	17.52±1.69	
	Independence,	64	10-20	14.51±2.44	
	Stress tolerance	64	10-22	16.39±2.64	
	Self-actualization	64	13-24	15.87±2.16	
	Emotional self-awareness	64	13-23	17.93±2.21	
	Reality testing	64	11-25	16.03±2.86	
	Interpersonal relationship	64	17-30	23.64±3.83	
	Optimism	64	15-27	21.38±2.52	
	Self-regard	64	16-26	21.5±2.63	
	Impulse control	64	9-29	16.11±5.53	
	Flexibility	64	14-22	17.91±2.17	
	Social responsibility	64	22-27	25.05±1.38	
	Empathy	64	18-30	24.93±2.92	
	Assertiveness	64	14-25	18±2.44	

Correlation matrix of all measures

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
1	1.00																						
2	0.13	1.00																					
3	0.11	0.02	1.00																				
4	0.03	0.27*	-0.23*	1.00																			
5	-0.17*	-0.06	-0.15*	0.32*	1.00																		
6	-0.06	0.35*	0.28*	0.30*	0.27*	1.00																	
7	-0.12	0.11	-0.18*	0.61*	0.39*	0.38*	1.00																
8	0.07	-0.07	0.24*	-0.06	0.20*	-0.15	0.27*	1.00															
9	-0.18	0.33*	0.25*	-0.09	-0.16	0.11	-0.12	0.04	1.00														
10	0.17*	0.03	0.74*	-0.51*	-0.31*	0.17*	-0.31*	0.17*	0.09	1.00													
11	0.18*	0.04	0.69*	-0.42*	-0.19*	0.25*	-0.06	0.20*	0.28*	0.76*	1.00												
12	0.06	0.29*	0.34*	-0.29*	-0.02	0.35*	-0.29*	-0.03	0.41*	0.38*	0.39*	1.00											
13	0.32*	0.10	-0.11	0.13	0.28*	0.18*	0.26*	-0.02	-0.03	-0.01	0.12	0.29*	1.00										
14	0.25*	-0.10	0.48*	-0.09	-0.27*	-0.02	-0.11	0.02	0.31*	0.44*	0.59*	0.19*	0.13	1.00									
15	-0.08	0.23*	-0.24*	0.29*	0.23*	0.02	0.15	0.20*	0.16*	-0.14	-0.26*	-0.22*	0.14	-0.30*	1.00								
16	0.09	-0.13	-0.37*	0.23*	-0.02	-0.09	0.10	0.20*	0.08	-0.35*	-0.25*	-0.10	0.26*	-0.01	0.47*	1.00							
17	0.14	-0.28*	-0.43*	0.16*	0.38*	-0.29*	0.15	0.09	-0.20*	-0.35*	-0.41*	-0.10	0.48*	-0.19*	0.23*	0.35*	1.00						
18	0.15	-0.46*	0.39*	-0.28*	-0.10	-0.35*	-0.40*	0.11	-0.03	0.17*	0.21*	-0.04	-0.24*	0.26*	-0.33*	-0.03	0.04	1.00					
19	0.08	-0.03	0.21*	-0.13	-0.02	0.00	-0.13	0.07	-0.15	0.28*	0.32*	-0.01	0.06	0.22*	0.00	-0.04	-0.21*	0.07	1.00				
20	0.34*	0.14	0.21*	-0.01	0.07	0.02	0.01	0.25*	0.09	0.15	0.15	0.10	0.24*	0.07	0.27*	0.12	0.31*	0.09	0.05	1.00			
21	-0.01	0.14	0.20*	-0.24*	0.17*	-0.01	-0.13	0.38*	0.37*	0.22*	0.16	0.18*	0.09	0.00	0.48*	0.16	0.15	-0.14	0.19*	0.55*	1.00		
22	0.26*	-0.13	0.48*	-0.25*	-0.20*	0.11	-0.15	0.09	0.27*	0.54*	0.56*	0.25*	0.28*	0.64*	-0.18*	0.03	0.00	0.30*	0.26*	0.41*	0.20*	1.00	

1=Clinical reasoning, 2=Critical thinking, Personality 3=Neuroticism, 4=Extraversion, 5=Openness, 6=Agreeableness, 7=Conscientiousness, EI measure 8=Problem solving, 9=Happiness, 10=Independence, 11=Stress tolerance, 12=Self-actualization, 13=Emotional self-awareness, 14=Reality testing, 15=Interpersonal relationship, 16=Optimism, 17=Self-regard, 18=Impulse control, 19=Flexibility, 20=Social responsibility, 21=Empathy, 22=Assertiveness, *P value<0.05

- Social responsibility
- Interpersonal relationship
- Stress Management
 - Stress tolerance
 - Impulse control
- Adaptability
 - Reality testing
 - Flexibility
 - Problem solving
- General mood
 - Optimism
 - Happiness

RESULTS

Descriptive statistics

Descriptive statistics is presented in Table 1.

Correlation between EI, personality, CT and CR

Correlations (available data using pair wise correlations)

Table 3: Hierarchical regression of CR on CT, personality and EI

Regression step	Predictor variable	β	B	R ² Change
Step 1	Critical thinking	0.128	0.124	0.016; F=1.724, P=0.192
Step 2	Personality			0.065; F=1.382; P=0.238
	Neuroticism	-0.317	-0.145	
	Extraversion	0.386	0.2	
	Openness	0.384	0.211	
	Agreeableness	0.394	0.236	
	Conscientiousness	0.758	0.384	
Step 3	EI			0.46; F=6.538; P=0.000
	Problem solving	0.46	0.633	
	Happiness	-0.295	-0.547	
	Independence	-0.109	-0.129	
	Stress tolerance	0.361	0.383	
	Self-actualization	0.33	0.416	
	Emotional self-awareness	0.496	0.664	
	Reality testing	0.256	0.27	
	Interpersonal Relationship	-0.173	-0.139	
	Optimism	-0.167	0.2	
	Self-regard	0.142	0.165	
	Impulse control	0.161	0.086	
	Flexibility	-0.121	-0.145	
	Social Responsibility	0.245	0.464	
	Empathy	0.044	0.04	
	Assertiveness	-0.184	-0.214	

between all measures are shown in Table 2. The reliability of this data was confirmed by comparing with list wise correlations, which revealed markedly similar outcomes.

The results indicate that clinical reasoning is the most significant correlate of some EI subscales (independence, stress tolerance, emotional self-awareness, reality testing, social responsibility, and assertiveness); but there is low correlation between CR, CT and personality subscales. On the other hand, correlation coefficient for clinical reasoning and problem solving (subscale of EI) is only.07. Low to moderate correlation observed between many personality and EI subscales observed.

Hierarchical regression analysis

Hierarchical regression analysis estimated shared variance attributable to each EI and personality measure. For each regression model, CR was dependent variable, with personality, EI, and critical thinking measure as independent variables (Step1 = critical thinking; Step 2 = personality; Step 3 = EI measure). Results of all multiple regression s are summarized in Table 3, which shows the significant contribution to clinical reasoning by EI measures (R² change = 0.46)

DISCUSSION

Clinical reasoning is the main competency that a physician should attain. Medical schools and licensing bodies need to understand the nature of this construct and predict it and find influential factors to improve it. This study has investigated the clinical reasoning and other pertaining variables including critical thinking, emotional intelligence, and personality.

Considering previous literature CT is a meta-cognition competency and is pre-requisite for CR.^[27] Many studies, especially those pertaining clinical reasoning in nursing,^[28] considered CR and CT two interrelated variables, and suppose that CT predicts CR. The results in this study indicate that not only CT is not correlated to CR but also considering the regression model, CT does not contribute to CR variance. Articles tried to evaluate Critical thinking as a cognitive ability did not interpret it as a cognitive construct.^[29]

It was presumed that some personality traits (especially neuroticism) may predict problem solving and consequently CR.^[14] In our study, different result was achieved. CR is not only correlated to personality and its subscales, their contribution to CR variance was negligible,

The results show that emotional intelligence subscales provide most contribution to CR variance. Subscales (such as problem solving, stress tolerance and self-awareness) may predict CR variance considerably.

CONCLUSION

Clinical reasoning can be considered as a unique and specific construct that may not be predicted easily. The only measure that can be used for its prediction is EI. Although, the sample volume participated in this study may be not sufficient to provide significant results. It is suggested to conduct similar studies in learners with different level and larger samples.

REFERENCE

- Swing SR. Assessing the ACGME general competencies: General considerations and assessment methods. *Acad Emerg Med* 2002;9:1278-88.
- Xue-hong W, Zhang Z, Gan-di LI, Tong-fu Z. Global minimum essential requirements in medical education" and its experimental implementation in China [J]. *Med Educ (China)* 2005;2:125-129.
- Association of American Medical Colleges. Medical School Objectives Project Learning Objectives for Medical Student Education: Guidelines for Medical Schools. Washington DC: Association of American Medical Colleges; 1998.
- Wojtczak A, Schwarz MR. Minimum essential requirements and standards in medical education. *Med Teach* 2000;22:555-9.
- Norman G. Research in clinical reasoning: Past history and current trends. *Med Educ* 2005;39:418-27.
- Behdash DV. Sanade hadeaghal tavanmandihaye pezeshekane Omomi. Tehran: Shoraye amoozeshe pezeshki Omoomi; 1388.
- General Medical Council. Tomorrow's doctors: Recommendations on undergraduate medical education. General Medical Council. 2003 - [last access on 2013 Feb 17]. Available from: http://www.gmc-uk.org/Tomorrows_Doctors_1993.pdf_25397206.pdf.
- Anderson KJ. Factors affecting the development of undergraduate medical students' clinical reasoning ability. South Australia: University of Adelaide; 2006.
- Facione PA. Critical Thinking: A Statement of Expert Consensus for Purposes of Educational Assessment and Instruction. Research Findings and Recommendations. NA 1990.
- Brackett MA, Mayer JD. Convergent, discriminant, and incremental validity of competing measures of emotional intelligence. *Pers Soc Psychol Bull* 2003;29:1147-58.
- Stys Y, Brown SL. A review of the emotional intelligence literature and implications for corrections. Canada: Correctional Service Canada; 2004.
- Johnsson F. Personality measures under focus: The NEO-PI-R and the MBTI. *Griffith University Undergraduate Psychology J* 2009;1.
- Costa PT, McCrae RR. Neo PI-R professional manual. Vol. 396. Odessa, FL: Psychological Assessment Resources; 1992. p. 653-65.
- Chartrand JM, Rose ML, Elliott TR, Marmarosh C, Caldwell S. Peeling back the onion: Personality, problem solving, and career decision-making style correlates of career indecision. *J Career Assesst* 1993;1:66-82.
- D'Alessio FA. The influence of personality, critical thinking, and emotional intelligence attributes in peruvian managers' leadership. Proquest information and learning company. Phoenix, USA: University of Phoenix; 2006.
- Groves M, Scott I, Alexander H. Assessing clinical reasoning: A method to monitor its development in a PBL curriculum. *Med Teach* 2002;24:507-15.
- Bordage G, Brailovsky C, Carretier H, Page G. Content validation of key features on a national examination of clinical decision-making skills. *Acad Med* 1995;70:276.
- Ber R. The CIP (comprehensive integrative puzzle) assessment method. *Med Teach* 2003;25:171-6.
- Athari Z, Sharif M, Nematbakhsh M, Babamohammadi H. Evaluation of Critical Thinking Skills in Isfahan University of Medical Sciences' Students and Its Relationship with Their Rank in University Entrance Exam Rank. *Iranian J Med Educ* 2009; 9(1):5-11
- Jacobs SS. Technical characteristics and some correlates of the California Critical Thinking Skills Test, Forms A and B. *Res Higher Educ* 1995;36:89-108.
- Khalili H, Soleimani M. Determination of reliability, validity and norm of California critical thinking skills test, form B. *J Babol Univ Med Sci* 2003;5:84-90.
- Costa PT, McCrae RR. Psychological Assessment Resources I. NEO Personality Inventory-revised (NEO PI-R). Psychological Assessment Resources; 1992.
- McCrae RR, Costa PT. A contemplated revision of the NEO Five-Factor Inventory. *Pers Individ Dif* 2004;36:587-96.
- Ahmadian M, Nezam TS, Badvee I, Homayouni A. P03-69 Comparison the emotional intelligence components of suicidal patients and non-clinical samples. *Eur Psychiatry* 2009;24:S1068.
- Bar-On R. Bar-On Emotional Quotient Inventory. New York: Multi-Health Systems; 1996.
- Bar-On R. The Bar-On model of emotional-social intelligence (ESI). *Psicothema* 2006;18:13-25.
- Christensen N, Jones M, Higgs J, Edwards I. Dimensions of Clinical reasoning capability. In: Higgs J, Jones M, Loftus S, Christensen N, editors. *Clinical reasoning in the health professions*. 3rd ed. Amsterdam: Elsevier; 2008. p. 101-12.
- Silva Bastos Cerullo J, Cruz D. Clinical Reasoning and Critical Thinking. *Rev Latino-Am Enfermagem* 2010;18:124-9.
- Harasym PH, Tsai T, Hemmati P. Current trends in developing medicalstudents' critical thinking abilities. *Kaohsiung J Med Sci* 2008;24:341-55.

How to cite this article: Ashoorion V, Liaghatdar MJ, Adibi P. What variables can influence clinical reasoning?. *J Res Med Sci* 2012;17:1170-75.

Source of Support: Nil, **Conflict of Interest:** None declared.