Validating OSCE performance: The impact of general intelligence

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Abstract

Purpose: To investigate the relationship between medical students’ eductive ability as measured by the advanced version of the Raven’s Progressive Matrices (RPM) test, reproductive ability as measured by performance on the United States Medical Licensing Examination (USMLE) Step I, and Objective Structured Clinical Examination (OSCE) performance.

Method: Thirty-two third-year medical students took the Advanced Progressive Matrices (APM) online, which consists of two parts: (1) a practice set of 12 items, and (2) 36 items which become progressively more difficult as the test proceeds. Several models representing different causal structures are tested and compared.

Results: Comparison of the different structural models revealed that eductive reasoning ability better predicted OSCE performance than reproductive ability.

Discussion: The relationship between APM and OSCE performance indicates that more in-depth research in domain-general abilities is important.

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1. Introduction

The popularity of the Objective Structured Clinical Examination (OSCE) in medicine has grown substantially since its inception in the late 70s.\textsuperscript{1} A survey conducted by Hauer, Hudson, Kerr, Teherani, and Irby\textsuperscript{2} showed that approximately 84% of the medical schools in the US use standardized patients in the assessment of students’ clinical skills. And although the utilization and practicality of OSCEs are well-discussed in the literature, systematic investigations of validity and reliability are limited and show mixed results.\textsuperscript{3,4} OSCEs reliability coefficients commonly range between .4 and .8.\textsuperscript{5} Threats to reliability, in part caused by inconsistent performance of students across cases, could be avoided by increasing test time and the number of stations.\textsuperscript{6,7} For good reliability, minimum test lengths of 3–4 h and a minimum of 10 stations are suggested.\textsuperscript{8,9} The fact that clinical competence is measured over multiple (and often very short) stations and spread over various clinical tasks makes it hard to

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establish the validity of an OSCE. Comparing performance of a complex tool like an OSCE with a single construct will yield low-results. In the current study we use skill components of an OSCE and hypothesize that components of intelligence predict OSCE performance to some extent. Spearman identified a common or general underlying factor “g” in any mental ability. He further identified two components of g named “eductive ability” and “reproductive ability”. Eductive mental activity involves making meaning out of confusion; developing new insights; going beyond the given to perceive that which is not immediately obvious; forming largely non-verbal constructs that facilitate the handling of complex problems involving many mutually dependent variables. Reproductive ability involves mastering, recalling and reproducing the largely verbal material which forms a cultural store of explicit knowledge.

The Raven's Progressive Matrices Tests has been widely used for decades as a measure of eductive ability—“the ability to evolve high-level constructs which make it easier to think about complex situations and events”. Carpenter, Just, and Shell described the Raven's Progressive Matrices as “a classic test of analytic intelligence … the ability to reason and solve problems involving new information, without relying extensively on an explicit base of declarative knowledge derived from either schooling or previous experience”.

USMLE Step 1, on the other hand, is a knowledge-based test that assesses whether students understand and can apply important concepts of the medical sciences and in this study is used to identify students’ reproductive ability. Some studies have shown a weak till moderate relationship between OSCE performance and USMLE Step I.

Three hypothesized models that reflect different causal relationships between the OSCE components, USMLE Step I and the Raven Progressive Matrices were analyzed and compared via Structural Equation Modeling (SEM).

2. Material and methods

The data used in this study were collected from third-year medical students (class of 2011). Students were recruited by email. All third-year students received an email request to participate in study that looks at the effect of general reasoning skills on USMLE Step I and Clinical Performance Exam (CPX, or more commonly known as OSCE). Thirty-three took the Raven’s Advanced Progressive Matrices test. One student was excluded for exceeding the allotted test time without completing the test. Students received a $25 gift card for their participation.

2.1. Measurement instruments

2.1.1. Raven’s Progressive Matrices

Raven's Progressive Matrices (RPM) tests were designed to measure abstract reasoning ability. The tests are non-verbal, picture-based, and require minimal instructions to administer. RPM tests correlate well with many other measures of intelligence and in factor analyses have been found to be the most central measure of g, or general fluid intelligence.

Of the several versions of the RPM, the Advanced Progressive Matrices (APM) test is most appropriate for above average adults. Each APM test problem is comprised of black-and-white line drawings of figures in three-by-three arrays, with each part containing one or more figural elements—except for the lower right part, which is left blank. The task for the problem solver is to determine which part from a set of eight figure choices (which include perceptual and relational lures) would best complete the figure pattern.

Each part within an array is related to its neighbors by discernible rules, such that how the array should be completed (from the available options) can be determined by grasping and applying these rules. Simpler arrays can sometimes also be completed by perceptual pattern completion.

APM test items are divided into two sets, which differ only in difficulty. Both sets begin with easy problems, with each successive problem generally more difficult than the last. Most Set I problems are relatively easy (for above average adults), whereas Set II problems range from relatively easy to very difficult.

For this study, Set I, with 12 problems, was used to familiarize students with the format of the test. Set II, which has 36 items, were used for testing, proper. Experimental subjects had 45 min to complete the test. The score received on the APM and used in our analysis was the number of correctly solved problems on Set II.

2.1.2. USMLE Step I

United States Medical Licensing Examination (USMLE) Step I is a knowledge-based test that assesses whether students understand and can apply important concepts of the sciences basic to the practice of medicine, with special emphasis on principles and mechanisms underlying health, disease, and modes of therapy. The scores issued by USMLE are used in our analysis.

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