Applying the socio-cognitive framework to the BioMedical Admissions Test (BMAT)

Insights from language assessment

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Introduction

The socio-cognitive framework of test validity originally outlined by Weir (2005) has served as a springboard to investigate the examination of writing (Shaw and Weir 2007), reading (Khalifa and Weir 2009), speaking (Taylor 2011) and listening (Geranpayeh and Taylor (Eds) 2013). These previous volumes have contributed to Cambridge English Language Assessment's approaches to test development and revision by comprehensively evaluating Cambridge English examinations. Similarly, the present volume represents a stock-taking of Cambridge Assessment Admissions Testing's approach to assessment, focusing on the potential for biomedical study as conceptualised in the BioMedical Admissions Test (BMAT). The issues identified here serve as a focal point for revising admissions tests in the future, and development of tests for other contexts.

Although the socio-cognitive framework was originally developed to evaluate language tests, Weir pointed out that the model would be useful in other fields of educational assessment: 'Though specifically framed with English for Speakers of Other Languages (ESOL) in mind, the blueprint has implications for all forms of educational assessment' (2005:2). In the present volume, we apply the framework to the admissions testing context. This extends use of the socio-cognitive framework outside of the language testing domain, but we are admittedly not the first to do so. According to O'Sullivan and Weir (2011), the socio-cognitive framework has been applied to examinations assessing art, physics and ophthalmology, due to its usefulness for guiding discussions of validity. However, to my knowledge, this volume represents the most comprehensive application of Weir's socio-cognitive framework to an assessment setting outside of the language testing domain.

As one might expect, some issues relating to the validity of tests are different in the admissions testing context when compared with language testing. Notably, cognitive validity is particularly complex in admissions testing, due to the range of constructs that are plausible to assess in this context. Another

way that the field of admissions testing diverges from language testing is the focus on prediction when investigating criterion-related validity. Also, the concepts of consequential validity and washback for admissions testing stakeholders are different from the topics commonly explored in language learning. These differences have not been barriers to applying the socio-cognitive framework; instead, they have highlighted that the aspects of validity identified by Weir (2005) can manifest in various ways, and that these aspects are important to consider across all assessments. Perhaps more surprisingly for readers, there are numerous areas where the issues in language testing and admissions testing are similar.

The chapters of this volume have highlighted one important parallel between language testing and admissions testing – the advantage of adopting holistic perspectives when evaluating tests and their use. The range of topics covered by authors for this volume has vanquished the myth of the validated admissions test, by showing that the test itself is one part of a much larger context that responsible test providers must consider. Only focusing on the test in isolation could result in claims about the assessment that are not defensible once the situation surrounding the test administration is taken into account. By assuming that tasks assess relevant cognitive processes or ignoring the testing context, test developers can risk unintended consequences arising from introduction of an assessment, particularly one that is used for high-stakes purposes. In this regard, an approach to evaluating the entire testing policy has been adopted throughout this volume, as advocated by Newton and Shaw (2014). Unlike Newton and Shaw, however, we propose that an existing framework of validity, Weir's (2005) socio-cognitive model, is a sufficient starting point for this approach, as it already extends evaluation of validity beyond the technical aspects of a test.

Many of Weir's (2005) ideas regarding validity and language testing can be applied appropriately to admissions tests; however, there is one place where the Cambridge Assessment Admissions Testing position diverges from the perspective adopted by Weir. He argues that 'practicality is simply not a necessary condition for validity' (2005:49). Whilst I agree that the test provider must focus on the construct to ensure that practicality does not intrude and distort what we are aiming to assess, validity lies in the appropriateness of inferences made using the assessment, and practical issues can impact on these. For example, if universities do not receive results of an admissions test within a timeframe that supports their shortlisting decisions, the validity of the test is compromised. Therefore, the practical aspects of marking and returning results must be considered as part of validity, and we have included them in Chapters 4 and 5 on context validity and scoring validity. Similarly, the cost of producing and marking an admissions test must not make registration prohibitively expensive for candidates, as this would impact on interpreting results where the self-selected candidate pool has been unduly shaped

by factors not relevant to the test constructs, such as socio-economic status. These issues are apparent in the context of selection to study medicine, where widening access to higher education is emphasised. Many of these topics are touched upon in Chapter 7's exploration of consequential validity.

Notwithstanding the divergent views on practicality, the arguments made by Weir (2005) about language testing are remarkably similar to those presented throughout this volume on an admissions testing context. This applies to the current approach adopted when developing admissions tests and also to earlier work, particularly in relation to BMAT. The history behind various aspects of BMAT's validity has been presented in this volume and this represents a snapshot of a moment in the lifetime of the test. There are currently 17 universities in the UK and internationally who use BMAT for admission to more than 25 courses of medical, biomedical or dentistry study. This number is steadily growing and it is likely that new developments in the administration, delivery and scoring of BMAT will emerge in the coming years, as it serves an increasingly global higher education arena. Further challenges are potentially on the horizon that will need to be addressed with an evidence-based approach that considers all the aspects of validity identified in the socio-cognitive framework.

The rest of this final chapter turns to each aspect of the socio-cognitive framework to summarise the validity of BMAT viewed through the lens of Weir's (2005) model. Importantly, these summaries also identify areas for future research that can support investigation of validity going forward. Validity exists on a continuum and should not be regarded as a binary concept (Messick 1989); therefore, it is important to acknowledge that continuing efforts are needed to ensure BMAT's fitness for purpose.

Test taker characteristics

Cambridge Assessment Admissions Testing routinely monitors the test taker population and their performance on the three sections of BMAT. This approach acknowledges that the test taker is at the heart of the assessment and that test development should recognise the physiological, psychological and experiential issues that can impact performance. An understanding of the test taker population is important for considering all aspects of validity identified in the socio-cognitive framework. From a quality assurance perspective, information about test takers' gender and school background is used to check for bias in test items. In the context of BMAT, the predictive equity of test scores for different groups is an issue to consider and continue investigating, particularly as the population taking BMAT changes. The authors of Chapter 2 highlight the need to understand shifting educational contexts to guide this work going forward. As changes to education policy can influence the ways that certain groups are categorised or focused upon,

the practical issues involved in classifying students should be carefully considered for future work. To support this, engagement with the users of an admissions test is crucial. Many of Chapter 2's more nuanced observations about proxies for socio-economic status came from Brenda Cross, whose experiences as a seasoned medical school admissions tutor revealed the care that medical schools take when selecting applicants, and the complex array of considerations that they face. Admissions tests are always situated in a wider selection process that can include access arrangements and influence from government education policies. These issues are easily missed by a test developer without the input of users who are actually making selection decisions, and Cambridge Assessment's approach recognises the need to engage with admissions tutors as part of understanding the test taker.

There are avenues for research on BMAT's test taker characteristics that would contribute to literature outside the admissions testing domain. Linking Cambridge Assessment data to other sources, such as UCAS data, could be useful for understanding group differences, not just in BMAT performance, but also in the choices made by school leavers and applicants to medical school. Some research on university choice indicates that there are complex relationships between gender, distance of the institution from home and A Level choice (Gill, Vidal Rodeiro and Zanini 2015). Monitoring of the test taker population is also crucial for evaluating the performances of an international candidature with a diverse educational background. Over the last five years, an increasing number of medical schools have recognised the attributes assessed by BMAT as important and decided to include the test as part of their selection procedures. Departments in the Netherlands, Spain, Malaysia, Thailand and Singapore now require BMAT to be taken as part of the selection process. Universities in other countries are also at various stages of trialling and evaluating how BMAT fits into their procedures and policies. Monitoring the test taker characteristics of future sessions will contribute to understanding the specific challenges of assessing candidates from different education systems. Furthermore, an understanding of how international group performance interacts with more traditional group differences, such as gender, will be crucial to ensuring that BMAT remains fit for purpose.

Cognitive validity

Understanding the cognitive processes elicited by BMAT tasks is crucial to investigating the validity of the test. As Weir and Taylor (2011:299) point out: 'It is hard to see how one can build a convincing validity argument for any assessment practice without assigning cognitive processing a central place within that argument.' Suitable interpretation of test scores relies on extrapolating from performance on test tasks to real-world behaviours. Therefore, BMAT should elicit the kinds of mental operations that are relevant for

biomedical study. Chapter 3 uses cognitive validity as conceptualised in the socio-cognitive framework to present a key question for developers of admissions tests: what are the skills and cognitive processes that a test should aim to elicit and assess?

In the case of BMAT, this question is answered by presenting the rationale for assessing the skills targeted by the test, and the theoretical basis for conceptualising each skill as potential for biomedical study. The rationales for assessing generic thinking skills, scientific knowledge and application, and written argument were considered when designing BMAT as a successor to two earlier tests used for selection to medical study. The Oxford Medical Admissions Test (OMAT) and the Medical and Veterinary Admissions Test (MVAT) were used to select undergraduate students and deal with increasingly large pools of applicants. Both of these tests were designed to assess specific abilities theorised as important in biomedical study (James and Hawkins 2004, Massey 2004), which was identified as the real-world situation relevant for evaluating a biomedical admissions test. In Chapter 3, the original rationales were re-examined in the context of contemporary understandings of biomedical study. Although a wide range of topics are included in biomedical study, various sources agree that core skills are relevant for biomedical study. Trainee clinicians are engaged in rigorous learning and need to develop problem solving skills (Quality Assurance Agency 2015), scientific reasoning (General Medical Council 2009) and writing abilities (Goodman and Edwards 2014, McCurry and Chiavaroli 2013). This confirmed that the skills assessed by BMAT remain relevant to the contexts that the test is used for.

Relevant theoretical models were used to examine the thinking skills assessed by Section 1, the scientific reasoning skills assessed by Section 2, and the written communication targeted in Section 3. Theories of critical thinking and problem solving were used to present the cognitive processes assessed by Section 1 as abilities that can be developed, and to distinguish the test construct from models of intelligence (Black 2012, Fisher 1992). This exercise raised some interesting issues. In particular, we identified a need to explicitly define terms commonly used to describe the constructs assessed by admissions tests, and to situate BMAT in relation to these terms. Based on a review of literature from educational psychology and assessment (e.g. Kaplan and Saccuzzo 2012, Newton and Shaw 2012, Stemler 2012), key terms used in admissions testing were defined and applied to BMAT. As a result, the title of BMAT's Section 1 is currently being reviewed, to evaluate whether 'aptitude' is a suitable description of the abilities that are being assessed. Think-aloud studies conducted by Cambridge Assessment researchers on item types from Section 1 were also presented. This illustrated one of the ways that cognitive processes elicited by a test can be investigated, and also demonstrated how findings from research can inform the processes used in test design.

Theories of scientific problem solving (e.g. Dunbar and Fugelsang 2005) were used to consider the cognitive processes involved in answering Section 2 items, and to conceptualise them as searches in a problem space (Simon and Newell 1971). Linking Section 2 to theoretical perspectives on scientific reasoning identified complex interactions between subject-specific knowledge and more domain-general reasoning abilities (Klahr and Dunbar 1988, Zimmerman 2000), which are components acknowledged as important to consider during Cambridge Assessment's item authoring processes. However, it is recognised that further investigation of the balance between knowledge and novel problem solving could be beneficial for assessing scientific reasoning. This presents a possible avenue for further research that might be supported by technological advancements, which have been used to investigate scientific problem solving (Tsai, Hou, Lai, Liu and Yang 2011).

Consideration of the theories underpinning Section 3 was heavily informed by Shaw and Weir's (2007) work on examining writing. Section 3's Writing Task was investigated in terms of the cognitive processes that it aims to elicit. In particular, the discussion focused on knowledge transforming processes that are commonly assessed at higher levels of language proficiency (Scardamalia and Bereiter 1987). However, the retrospective review of example responses to BMAT Section 3 could be complemented with further research on the cognitive writing processes activated when responding to tasks. Key logging, eye tracking and verbal protocol analysis could potentially be used to investigate how candidates plan, organise and monitor whilst writing. The skills assessed by Section 3 are also regarded as examples of test takers' productive reasoning abilities, drawing on critical thinking and assessment research recommending that constructed responses are used to complement other formats commonly used in standardised testing (Butler 2012, Liu et al 2014).

The conceptualisation of BMAT sections as assessments of separate skills has also been investigated as part of cognitive validity. A key study confirming that it was valid to interpret Sections 1 and 2 as measures of two distinct skills was conducted by Emery and Khalid (2013a); this was presented to illustrate another method commonly used to investigate cognitive validity. Chapter 3 highlighted how important it is to consider the theory underlying an admissions test. It was argued that assessment providers have a responsibility to present theoretical reasons for assessing the cognitive processes targeted by examinations, and that theories should be investigated with research.

Context validity

BMAT's context validity was examined in Chapter 4, which stressed the relationship between context validity and cognitive validity. Designing tasks for

an admissions test such as BMAT requires careful consideration of various features, because the response format, test timing and task content can all influence the skills assessed by a test. These issues were considered in some detail when developing guidelines used to support context validity, so they are explored in some detail. Multiple-choice questions (MCQs) and tasks requiring constructed responses have specific advantages and disadvantages, so BMAT uses a combination of these task types across its sections.

The number of tasks to include in a test section is another feature of context validity that was considered for BMAT Sections 1 and 2, alongside evaluations of the time needed to complete typical test items. These considerations were informed by early research studies that investigated speededness in BMAT (Shannon 2005), that ultimately led to changes in the number of items included in BMAT sections. More recent studies monitoring time pressure in BMAT have been conducted by analysing omission rates, and an example of this was presented as a key study (Emery 2013a).

A number of threats to validity can be introduced or overlooked when constructing test tasks, and various steps are used to ensure that BMAT assesses the correct skills as intended. Cambridge Assessment's approach to authoring tasks uses detailed test specifications, review by subject matter experts (SMEs) and standardised processes to safeguard against threats to context validity.

A particularly important feature checked for all tasks is the knowledge required to successfully complete the task. Some tests mistakenly claim to include tasks that do not require any knowledge, when they actually mean that test tasks assume a certain level of non-specialist knowledge. For BMAT, tasks destined for Section 1 or Section 3 are checked against a threshold of everyday knowledge. Section 2, on the other hand, assesses the ability to apply subject-specific science and maths knowledge to novel questions. This makes it important to identify the aspects and level of subject knowledge that a test taker is expected to have when they take BMAT. A recent review of the curriculum underpinning BMAT Section 2 was conducted and described in the chapter, to illustrate how assessment experts can explicitly define a pool of assumed knowledge for a test. Once defined, the subject knowledge curriculum was used to support suitable test taker preparation. Furthermore, it allowed SMEs to check the science needed to answer an item correctly against the topics included in the curriculum. However, the checks relating to subject knowledge are not the only ones required to ensure context validity.

BMAT items are commissioned and stored in item banks in preparation for constructing test papers. Various SMEs are recruited to author, edit and vet items before they are placed in a BMAT item bank. A description of the multi-stage question paper production process was presented to outline how different SMEs review specific issues, first in items, and then in papers. The checks conducted during item commissioning, item editing, paper

construction and paper vetting were described, alongside rationales for their inclusion.

Another important part of context validity refers to the administration conditions associated with a test. For BMAT, it is critical that the test is administered securely and in a standardised way, so that test takers experience similar conditions when completing tasks. Cambridge Assessment's approach to administration uses strict test regulations and centre approval processes to monitor these issues. Furthermore, the advantages and disadvantages of various administration methods are continuously reviewed. For example, the possibility of using a computer-based (CB) testing model is regularly evaluated with consideration of the security and access issues associated with a change from paper-based (PB) testing. Although the discussion currently presented in Chapter 4 concludes that BMAT should continue to be administered in PB format, it is entirely possible that this will change at some point in the future. In terms of BMAT's context validity, this is one area that will undoubtedly require further research. In particular, the equivalence of completing CB and PB tasks will likely form the focus of future work on context validity.

Scoring validity

Chapter 5 focused on the processes used to minimise error and ensure that BMAT scores are meaningful. A range of statistical methods are used to safeguard BMAT from threats to scoring validity, and these are presented to provide the reader with an overview of operational validation processes that monitor BMAT sessions.

For the MCQ sections of BMAT, analysis is used to check that items are appropriately difficult and that they discriminate between test takers with low and high abilities. This ensures that the test is targeted to a suitable level for Sections 1 and 2. Rasch analysis is used to score these sections and report them. The approach to scoring taken by Cambridge Assessment produces a scale ranging from 1.0 to 9.0, where equal intervals in BMAT scale scores represent equal differences in candidate ability.

In addition to analysis that is used to monitor and produce scores, a number of analyses are conducted regularly on BMAT Sections 1 and 2. These show that BMAT sections have acceptable internal consistency and also indicate that items are free from bias in relation to gender and school type. The limitations of commonly used statistical coefficients are also relevant to discussions of internal consistency, so they are presented with some of the reasons that estimates of reliability are necessary, but not sufficient, indicators of test quality. Although the internal consistency coefficients of the sections could be improved, this might not be appropriate for BMAT due to the relatively multidimensional nature of the sections and the cognitive

validity arguments for designing the sections in this way. Interestingly, there are parallels between recent developments in admissions testing and shifts in language testing observed by Weir (2005) over a decade ago. An overview of these issues is used to contextualise the approach to scoring validity adopted by Cambridge Assessment Admissions Testing, and to distinguish it from a more psychometrically led approach that is prevalent in the US.

For the scoring validity of BMAT Section 3, the marking criteria and marker training procedures are crucial. These safeguard scoring validity by systematically monitoring and evaluating the subjective marks awarded by examiners. These are detailed in Chapter 5 alongside some of the statistical procedures used to review marker reliability. These marker standardisation and training procedures for BMAT Section 3 are informed by research from language testing contexts (Shaw and Weir 2007). However, there are opportunities for further investigation of this area, because the impact of training on Section 3 examiners has not been investigated directly.

It should be noted that the procedures used to evaluate BMAT's scoring validity are designed specifically for the context of the test's administration. Future changes to BMAT's administration may require greater focus on scoring validity. For example, BMAT's use in an increasing number of territories may require alternative scoring procedures to be considered. To date, groups of candidates have not been considered across BMAT sessions that occur at different points in a year, because these tend to take place in different locations and are accepted by different university departments. However, increasing globalisation and student mobility may necessitate scoring procedures that enable precise comparability of scores across sessions, most likely with statistical equating. These procedures sometimes require additional data to be collected, so developments will need careful consideration of logistical and security issues. Furthermore, Cambridge Assessment researchers may need to develop innovative methods of scoring to deal with use of BMAT in new contexts, and this represents a significant focus for development of the test.

Criterion validity

Investigating the relationships between test scores and other variables is a key consideration for assessments used in selection contexts, such as admissions tests. In particular, predictive validity is prioritised over many other aspects of validity when selecting applicants for job roles and university places. In medical selection, some researchers refer to correlations between on-course performance and test scores as 'the validity coefficient' (Cleland et al 2012:11), and predictive validity is emphasised over other forms when discussing admissions tests (e.g. McManus, Dewberry, Nicholson, Dowell et al 2013). In line with these established conventions, Cambridge Assessment has placed a historical emphasis on this aspect of validity. In particular,

our researchers have focused on BMAT's predictive validity and equity in published research (Emery and Bell 2009, Emery et al 2011). However, Cambridge Assessment Admissions Testing's contemporary approach to validity adopts the socio-cognitive framework (O'Sullivan and Weir 2011) and acknowledges that other aspects of validity are also relevant to admissions tests. This contrasts with the approach adopted by some other researchers, who treat predictive validity as the only form of validity that matters in selection contexts (e.g. Hopkins et al 1990).

In considerations of criterion-related validity, we heed Weir's (2005:13) warnings that 'no single validity can be considered superior to another. Deficit in any one raises questions as to the well-foundedness of any interpretation of test scores.' The tendency to primarily consider one type of validity over others has also been a concern for experts in the wider educational assessment community, who have reflected on some historical practices that prioritised particular forms of validity. For example, Newton and Shaw (2014) describe how conceptualisations of validity as the hypothetical agreement between test scores and a theoretical true proficiency led to an early focus on criterion validity. This developed almost accidentally, as researchers overlooked the limitation that operationalised criterion measures were flawed representations of true proficiency.

Therefore, Cambridge Assessment researchers consider a wide range of methodological and theoretical issues when planning predictive validity studies. A critical approach is required because various issues reduce the strength of relationships in selection contexts. Whilst corrections for attenuated coefficients are available (e.g. Sackett and Yang 2000), applying them uncritically in pursuit of a stronger 'validity coefficient' may not be appropriate in complex selection contexts. Indeed, corrected coefficients can hinder, rather than support, meaningful interpretation if applied without an understanding of common methodological challenges and how they might have impacted on the specific selection context of the study. In addition, concurrent validity in the context of BMAT was discussed to highlight that various admissions tests used for healthcare selection are assessing quite different constructs, rendering comparability studies unsuitable. Furthermore, there is little agreement on how potential for medical study should be conceptualised for an admissions test, so there is not an external framework suitable for benchmarking BMAT in concurrent validity studies. Development of a framework for selection to healthcare courses is a suitable area for medical educators to explore.

The authors of Chapter 6 present conceptual overviews of the theoretical issues and methodological challenges relevant to investigating criterion-related validity in selection contexts. Illustrative examples are used to introduce the issues to those who are unfamiliar with them, recognising that they tend to be exacerbated by common selection practices, and the impact of these procedures is easy to overlook.

Cambridge Assessment's approach to conducting and reporting predictive studies is also presented, in order to contextualise the research summarised in the chapter. This approach advocates reporting uncorrected coefficients alongside known information about the selection procedures used, which can be achieved by conducting situated studies in collaboration with admissions tutors. However, this is not presented as the only appropriate way of investigating criterion-related validity. Recently, Cambridge Assessment has been collaborating with the General Medical Council (GMC) to provide data for a UK Medical Education Database (UKMED). This initiative is described to illustrate how big data approaches can also contribute to understanding the relationships between test scores and other outcomes.

These developments present future research opportunities to investigate the criterion-related validity of admissions tests, particularly because inclusion of various other selection criteria could enable researchers to accurately describe the procedures that are used in practice. However, it must be recognised that large datasets do not eliminate the need to collaborate closely with admissions tutors and understand issues specific to their contexts. Therefore, the challenge for researchers conducting further work in this area is to embrace the opportunities provided by these developments, whilst remaining cautious in case of spurious findings that are not explained by theory. This can be achieved by guiding statistical analysis with *a priori* consideration of theory, and by complementing large-scale studies with smaller ones.

Consequential validity

In Chapter 7, the social impact of using BMAT was unpacked using the concept of consequential validity from the socio-cognitive framework. By applying a broad conceptualisation of consequential validity to the admissions testing context, McElwee, Fyfe and Grant extend arguments made in the field of language testing to the sphere of admissions testing, and also into medical education. In this regard, the social and ethical issues related to a test's use should be considered part of overall validity rather than as a separate element. Whether assessment experts refer to these issues as validity or not, it is generally agreed that they are important for the test developer to consider (Newton and Shaw 2014). In our view, omitting consequential validity from models of validity would allow test developers to argue that this aspect of assessment rests solely with test users, and this stance would be detrimental to educational assessment; therefore, consideration of social and ethical consequences should be integrated into models of validity. Integration with other aspects of validity is particularly important because the analysis of consequential validity presented in Chapter 7 showed that test use can impact on issues recognised as central to validity.

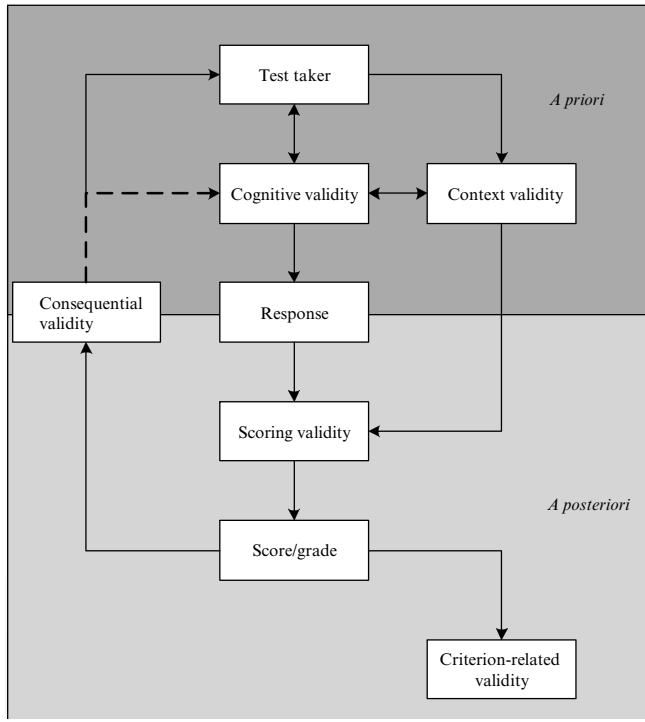
In previous applications of the socio-cognitive framework, much has

been stated about the symbiotic relationship between cognitive, context and scoring validity (e.g. Khalifa and Weir 2009) because these aspects constitute the core of construct validity. Revisions of the socio-cognitive framework have reflected this by explicitly referring to the two-way relationship between context and cognitive validity (O'Sullivan and Weir 2011). Similarly, this volume has emphasised how these elements interact for an admissions test; however, the admissions testing context presents an opportunity to identify other interactions that further extend the socio-cognitive framework, particularly in relation to consequential validity.

Methods used to select university applicants inevitably impact on widening access initiatives in higher education, which are important issues for policy-makers and society. In terms of access to the medical profession, the emphasis on widening participation is even stronger than in other disciplines. In a close examination of BMAT's consequential validity, the authors of Chapter 7 point out that consequential validity is considered not only as *a posteriori* to a test event as conceptualised in Weir's original framework, but also *a priori* due to the impact on following selection rounds and future cohorts of applicants. In this regard, it should be recognised that the test's impact on wider society can change the test taker population for further administrations of an admissions test. How the test is perceived can potentially change the applicant pool, which might have a knock-on effect for a professional workforce. Therefore, it is particularly important to investigate consequential validity and recognise this mechanism in the admissions testing context by revising the socio-cognitive framework (see Figure 8.1).

Cambridge Assessment has not ignored the consequential validity of admissions tests, and the key studies presented in the volume are evidence of that, but it is fair to say that this area has only been focused on relatively recently. This has partly been prompted by adoption of the socio-cognitive framework, but also because BMAT users have sought to understand how prospective medical students prepare their applications for medical school. This trend is reflected more widely in recent medical education research looking at selection, which has investigated how assessments are perceived by applicants and members of the medical profession (Cleland, French and Johnston 2011, Kelly, Gallagher, Dunne and Murphy 2014, Stevens, Kelly, Hennessy, Last, Dunne and O'Flynn 2014). Despite general worries that selection procedures might deter potential applicants from certain groups, these issues have not been viewed as aspects of validity. In medical education, consequential validity is only used to refer to issues that stem from test score interpretation (Downing 2003). We argue that conceptualising consequential validity in a broader sense would support the development of theoretical frameworks about the consequences of test use in medical education, where there have been calls for more theory when evaluating initiatives to widen access (Nicholson and Cleland 2015). This theory-based approach has

Figure 8.1 A revised socio-cognitive framework



been adopted by some medical education researchers looking at admissions; Niessen, Meijer and Tendeiro (2017) framed qualitative findings on the consequences of using selection methods as part of organisational justice theory. Survey research on test taker perceptions of selection methods was presented as a key study in Chapter 7 (Emery and McElwee 2014) and it may be useful to consider the results in light of wider social theories.

Selection to study medicine and dentistry is a key place where attention to theory can have an important impact. In addition to considering the technical and predictive components of selection methods, policy-makers should recognise that assessments at this stage potentially shape the attitudes and beliefs of future healthcare professionals (Röding and Nordenram 2005). In the Netherlands, research has compared the motivation and self-beliefs of medical students entering through competitive selection with those selected by lottery. Wouters et al (2016) found that the strength of motivation was higher in competitively selected students. Although these differences were not shown to be pervasive in the long term, they do warrant further investigation in other selection contexts. There is also evidence that the relationship

between selection procedures and motivation varies across studies, indicating that contextual factors could be important when investigating motivation in medical students (Wouters, Croiset, Schripsema, Cohen-Schotanus, Spaai, Hulsman and Kusurkar 2017).

Research from educational psychology may also present insights into these issues. Experimental work with children indicates that motivation and resilience are influenced by beliefs about the fixedness of their academic abilities (Dweck 2012, Yeager and Dweck 2012). Whilst it would be a mistake to apply these ideas uncritically to adolescents applying for university study, we should consider the self-beliefs promoted by selection procedures, and whether their impact might differ on the subgroups present in applicant pools. Consequential validity poses specific questions about how the constructs we assess can influence those being assessed. Answering these theoretical questions can potentially inform the ways that universities communicate about selection to prospective applicants.

Researchers should investigate how assessment constructs are perceived, not just by university stakeholders, but also by test takers. Cambridge Assessment's approach to admissions testing recognises that scores on all such tests, even those grounded in the psychometric approach to intelligence, are 'a function of innate talent, learned knowledge and skills, and environmental factors that influence knowledge and skill acquisition' (Kuncel and Hezlett 2010:339). Therefore, Cambridge Assessment's admissions tests, which are constructed with a focus on skills that can be developed, should not be conceptualised purely as measures of innate attributes. This has been communicated to admissions tutors and other assessment experts; however, we do not fully understand how test takers perceive tests such as BMAT and, importantly, how they understand their performances on them. Despite BMAT's explicit focus on skills that can be developed, do admissions tests encourage biomedical trainees to believe they were born smart enough to become a doctor or dentist, and that other people were not? If so, what is the impact of this, if any, on their learning and their future clinical practice? Perhaps even more crucially, what impact is there on test takers who come to believe they were not born with the genetic endowment to become a doctor? Furthermore, these considerations must inform the current search for evidence-based 'non-cognitive' criteria (Hecker and Norman 2017). Bearing in mind that tutors will need to communicate decisions to those who are ultimately unsuccessful at entering the healthcare professions, what does it mean to not have the integrity for entering medical study? Understanding these issues can potentially develop theories about student motivation and also inform higher education policy.

The reflections on consequential validity presented in this volume, and particularly in Chapter 7, are initial steps towards addressing this aspect of validity in admissions tests. There are many directions and areas of

investigation that stem from the questions posed by consequential validity. One example is represented by the dashed line (to indicate a tentative relationship for investigation) linking consequential validity to cognitive validity in Figure 8.1. In the admissions context, if the selection policy of a university treats an assessment in a way that is incompatible with the targeted construct, then the meaning of the score can potentially be changed. Consider a university's policy on accepting results from examinations that have been sat more than once. If the assessment targets an ability that is beneficial for a particular field of study, the rationale for using the selection method is normally that the ability is associated with study success, either incrementally or to a pre-requisite level. In this situation, previously achieved scores are indicators of ability from earlier in the developmental process; they are not relevant to decision making at the point of application, and the selector should accept results from the most recent sitting of the exam.

One example that illustrates how this issue manifests in practice is when universities decide whether to accept A Level grades achieved in resits. If the grade at first attempt is the only one considered, this changes the nature of the construct that the score represents. The A Level cannot be conceptualised as mastery of a knowledge-based curriculum in this situation, because the policy dictates that the first attempt stands. Mastery of a knowledge-based curriculum can theoretically be improved upon and developed, but the policy has instead changed the meaning of the A Level grade that is accepted. Of course, A Level grades at first attempt are influenced by many different factors and universities may have good reasons for treating them in this way. McManus et al (2005) observe that A Levels could be indirect indicators of motivation or commitment, and conceptualising them in this way may be predicated on the applicant studying multiple subjects at the same time. However, universities should consider the theoretical reasons for using an assessment outcome in a particular way.

These issues also apply to assessments that claim to assess innate abilities. For these measures, as the trait being assessed is theoretically fixed, test scores should not vary across multiple attempts. In fact, multiple test attempts can be conceptualised as parallel evaluations of the same innate trait, and the most valid score to consider would be some kind of average across the attempts. Decisions about accepting resits are often made due to practical concerns about the number of applications that a university can consider in a cycle. Biomedical courses sometimes provide empirical reasons for not recognising A Levels that have been re-examined, using data to show poorer outcomes for students admitted with resits. However, policy-makers should also attempt to understand the mechanisms that drive these outcomes. The idea that consequential validity can influence cognitive validity highlights the need to reflect on the ways that commonly used selection criteria are conceptualised. The interactions between consequential validity, other aspects of

validity and wider social theory represent areas to be explored with future research.

Conclusion

In Chapter 1, Saville proposed that the socio-cognitive framework developed in language testing could guide comprehensive evaluation of BMAT's validity. This volume has used Weir's (2005) socio-cognitive framework to present key aspects of test validity, and demonstrated how they can be used to consider validity of an assessment used in selection for medical study. Application of the socio-cognitive framework to BMAT demonstrates its flexibility as a model for test evaluation, and provides an example of how it can be used to focus attention on aspects of validity, in an assessment other than a language test. Some aspects of validity identified in the socio-cognitive framework are commonly overlooked in the admissions testing context, despite being considered regularly by researchers working in language testing. However, none of the issues covered can be considered trivial and each chapter successfully argues that the aspect of validity focused upon is important. By considering each aspect in turn, we have shown how they relate to the ways BMAT was developed, how it is currently administered, and how its validity is continuously monitored.

Throughout the volume, we have reiterated that the separate chapters of the book do not represent isolated issues relating to the use of BMAT. Rather, the chapters, and the socio-cognitive framework itself, provide a structure for systematic investigation of validity as a unitary concept. Nevertheless, organising the issues in this way can give the mistaken impression that they are discrete topics. Therefore, it is important to reiterate that the aspects of validity described throughout this volume are interconnected. This volume demonstrates that Cambridge Assessment's approach to admissions testing fits particularly well with a socio-cognitive framework that conceptualises validity as unitary. Various aspects of BMAT's validity are considered necessary but not sufficient to ensure that inferences based on test scores are valid. In this approach, validity is conceptualised on a continuum, but test quality is not linked simply to isolated coefficients representing psychometric quality. Evidence that each aspect of validity has been considered for BMAT contributes cumulatively to the confidence associated with use of test scores. This dissuades test developers from focusing blindly on one or two aspects of validity at the cost of others, which has been a historical issue in educational assessment, as demonstrated by a quote from the 1966 edition of the *Standards*: 'Too frequently in educational measurement attention is restricted to criterion-related validity' (1966:6).

This collection of chapters is not intended to be an exhaustive compilation of research on BMAT, but rather to give an insight into some of the ways

that the test has been evaluated. Hopefully, readers from various disciplines will have found the description and discussion of Cambridge Assessment's approaches useful. This volume has demonstrated how a multidisciplinary approach spanning language testing and admissions testing can be beneficial. It would be good if sharing this work with medical educators, language testing researchers and admissions test developers could encourage collaboration across subgroups of educational assessment experts, to share expertise and best practice in a way that benefits various forms of assessment.

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