The Memory and Attention Test

User's Guide

Team Focus Limited

Updated August 2011

Team Focus Limited
Heritage House, 13 Bridge Street,
Maidenhead, Berkshire SL6 8LR

T +44 (0)1628 637338
E teamfocus@teamfocus.co.uk
W www.teamfocus.co.uk

The Profiling for Success series is published by Team Focus Limited, Heritage House, 13 Bridge Street, Maidenhead, Berkshire, SL6 8LR, England, tel: +44 (0)1628 637338.

CONTENT

Section One - Introduction

The Memory and Attention test (MAT) is a test designed to assess a person's ability to follow and to retain in memory sets of complex instructions and to respond to these instructions rapidly and accurately. The test consists of a number of panels which contain shapes of different colours and the instructions ask the respondent to click on specific shapes according to the current instruction set.

As the respondent progresses through the shapes, the complexity of the instructions increases, so requiring the respondent to hold a relatively large amount of information in memory in order to be able to respond correctly. The respondent is able to refer to the current instruction set at any time during the test, but each time they refer to the instructions will count against them in relation to the assessment of the memory component of the task. The test is a speeded test and respondents are asked to complete the test as quickly as they are able to. In addition to the memory score based on the number of times they referred to the instructions, the test is scored in terms both of the accuracy with which they clicked on the correct shapes and also the time taken to complete the test.

The test is available in online format only and normally takes less than 20 minutes to complete. Scoring is carried out by the online administration system and reports are available for both respondent and test administrator.

The MAT simulates one of the most important aspects of the workplace: the need to quickly memorise and retain information in order to apply rules or procedures in a timely and accurate manner. It is a multi-faceted test that generates a rich profile of performance as individuals respond to increasingly complex instructions and screens of information. The facets measured are:

- Speed of working – the time taken to complete the test;
- Memory – the number of times the test-taker needs to check the relevant instructions;
- Accuracy – the number of questions (screens) completed correctly;
- Baseline response – a control for fluency with the computer mouse and speed of responding.
- Decisiveness - the number of times the respondent changes their mind regarding a given test shape
- Decision efficiency - an overall measure of the number of correct decisions per minute

Section Two - Background

The importance of understanding memory and attention

In the modern workplace, the acquisition of knowledge and skills and the application of these are increasingly important. One of the main reasons for this is that work has become more cognitively demanding over the past few decades, particularly with the advent of the information technology age, meaning that for organisations to be successful they require an increasingly skilled workforce (Besnahan, Brynjolfsson and Hitt, 2002). The acquisition of the necessary skills for the modern workplace can be studied from a number of perspectives including: the education that workers receive as children and young adults, the opportunities for specific skills training both prior to commencing work or whilst on-the-job; how governments and societies are seen to value skills training and embed this in their educational policies and the resources made available to support these. All of these perspectives, however, focus on high-level provision of opportunities for the development of skills and ignore the cognitive abilities that underlie the acquisition of skills..

As important as the structural provision of training in developing work-relevant knowledge and skills, is the ability of individuals to benefit from any training provided. For over a century educationalists have worked to understand what factors explain differences in the potential to benefit from education, with work in this area leading to the development of the first modern IQ test by Alfred Binet (Binet and Simon, 1905). Since Binet's work a range of factors including cognitive abilities, attitudes to learning and group factors (e.g. gender, race, and ethnicity) have been studied and shown to interact with educational attainment.

Aptitudes describe the fundamental cognitive processes that are important in the acquisition of higher-level abilities or skills. An individual's level of aptitude in a particular area predicts their likely level of learning in the corresponding area, and therefore the extent to which they will benefit from exposure to education (e.g. Ehrman, 1994) or training (e.g. Schmidt and Hunter, 1988). Aptitudes indicate the potential for learning experiences to be translated into more permanent retention of knowledge or skill, through the process of learning. This relationship between memory and learning is captured by Squire (1987) who describes this as: "Learning is the process of acquiring new information, while memory refers to the persistence of learning in a state that can be revealed at a later time".

Drawing together both case studies and experimental evidence, Colvin has recently argued for the importance of memory in expert performance in organisations. Memory serves both as a resource that can be drawn on for problem solving and as a structure for further, deep learning: "Top performers understand their field at a higher level than average performers do, and have a superior structure for remembering information about it." (Colvin, 2008). Whilst this memory may be founded on an aptitude for learning, "it is ultimately a skill acquired through many years of deliberate practice."

The ability to learn job-relevant information is important for jobs at all levels. In 2008, the CIPD reported that 70% of organisations across the public and private sector identified 'lack of necessary specialist skills' as their major recruitment difficulty, an increase of 5% from the previous year (CIPD, 2008). The most commonly used strategy to overcome this skills shortage is for organisations to identify people who they see as having the potential to grow into the role and develop the skills required. However, this strategy was only identified as having a positive impact by 65% of organisations. Both the initial shortage of skills and the failure of all candidates recruited for their potential to develop as hoped, means skills shortages place a major burden on organisations.

As well as helping understand differences in outcome from educational and training opportunities, fundamental process connected with memory and attention are important in their own right in the workplace. In work that requires employees to be focussed and remember facts, procedures or other information there is clear benefit in having an effective memory. Memory capacity is also highly relevant to work environments requiring multi-tasking for their safe and effective performance. As experimental evidence shows individuals with higher memory capacity to outperform those with lower capacity, it is relevant to understanding the likely employee performance across a wide range of tasks (Hilkemann, 2011).

Research on memory and attention

There are many models of memory and analogies that both lay-people and researchers have used to describe the processes and structure of human memory. One of the most important distinctions is between short-term and long-term memory (Atkinson and Shiffrin, 1968). Short term-memory refers to holding information from a few seconds to a few minutes and is a temporary store, whereas long-term memory refers to the more persistent types of memory and is more closely associated with the concept of learning. However, models of memory require that in most cases information must pass through short term-memory in order to be consolidated into a form that resembles long-term memories.

Retrieval, the process of bringing into conscious awareness stored information, relates to the long-term memory store and the results of learning. In contrast the contents of short-term memory are available immediately to conscious awareness, though the contents of short-term memory will rapidly decay if it is not actively rehearsed or maintained in other ways

The distinction between short-term and long-term memory is intuitive to many and provides a useful way of thinking about different types of memory. However it is primarily a structural description, whereas the working memory model of Baddeley and Hitch (1974) focuses more on the processes involved in memory. Working memory is a system with limited capacity for the temporary storage of information, consisting of visual and phonological stores controlled by the 'central executive'. It facilitates higher level skills such as verbal comprehension, reasoning and the ability to learn and encode new information (Baddeley, 2000).

The central executive system is particularly important in explaining the link between attention and memory, as its functions include the control of attentional resources and the flow of information. Kahneman previously (1973) likened attention to an energy resource; tasks that place requirements on attention draw on this resource for their successful completion. Within Kahneman's work the idea of 'attentional capacity' is introduced. Attentional capacity has similarities with a number of models of memory, but also clearly introduces the idea that not everyone has equal attentional capacity.

Research into Baddeley's model of working memory supports the idea that capacity is not fixed or unlimited, but that working memory has a finite capacity and that this capacity differs between individuals. Central executive functioning has been related to performance on complex span tasks, requiring both the processing and storage of information, which have been used to indicate the capacity and limits of the central executive. Span tasks, in turn, are associated with more complex tasks requiring higher-order cognitive processing including reasoning abilities and verbal comprehension (Gathercole, 2008). Association between psychometric assessments of abilities and measures of working memory capacity further support argument that working memory is a vital element of both fluid and crystallised abilities. Kyllonen and Christal (1990) found that in four separate studies the association between psychometric tests of ability and tests of Baddeley's working memory model, performance on the two correlated in the order of 0.8.

Links from these more abstract measures to concrete performance comes from Carpenter, Just and Schell's (1990) analysis of the tasks required to successfully complete Raven's Progressing Matrices test, often regarded as a marker of 'fluid ability'. They argued that key demands of the test were to break down a more complex problem into a series of simpler problems, then manage the ordering and solution of the series of simpler problems. Effectively respondents were generating a 'systematic process for solving problems', a process which has direct parallels with many workplace tasks.

Assessing an individual's attention and memory through as assessment such as the MAT, therefore provides us with valuable information about an individual's attentional capacity. This, in turn, allows us to better understand about their likely learning potential and performance on cognitively demanding, work relevant, tasks.

Rationale for development of the Memory and Attention Test

The MAT has been designed to assess fundamental aspects of memory and attention in a user-friendly and engaging format. The basic requirement is for respondents to memorise instructions and then apply these quickly and accurately. An abstract format was chosen as being best for the MAT, as this removes the effect of any prior experience or knowledge that test takers may have and which would lead to construct-irrelevant variance in the test results.

The original version of the MAT was organised into 10 sets of 10 test screens, giving 100 screens in total. Since the publication of the original version, the test was modified to use only 5 screens per set, thus giving a total of 50 screens in the test. Each set of screens introduces a new instruction (e.g. 'click on yellow circles') and respondents are then asked to apply this instruction to each of the following set of screens as quickly and as accurately as they can. After the first set of screens has been completed, a further instruction is added (e.g. 'click on yellow circles', 'click on stars if they are above a square).

After five sets, an additional load is placed on the task by introducing a series of numbers and letters to each test screen and giving rules applying to both the shapes and rules. For example, the rules for the sixth set of screens may be 'click on white stars' and 'click on numbers divisible by three'. Further rules relating to numbers and shapes are then added after each set of 10 screens, up to a maximum of five rules for each.

Each of the instructions involves at least two elements; in the example given above these elements are a shape (circle) and colour (yellow). This was done to ensure that conscious processing of the information on each test screen was needed, so ensuring that the task required the use of controlled attention and working memory. Research on attention has shown that when searching for objects with single distinguishing features (e.g. circles amongst squares and triangles or yellow shapes amongst blue and red shapes); targets can be identified automatically, without the use of focussed attention (Treisman, 1988). When targets have two or more features that need to be combined (e.g. yellow circles), their identification requires focussed attention which is one of the key capacities being assessed by the MAT.

The four constructs assessed by the original version of the MAT are as follows.

1. Memory: Memory is an indicator of the respondent's ability to hold increasingly complex information in short-term memory. As the sets of screens progress, further instructions are added to increase the load on the respondent's memory capacity. Respondents have the option of reviewing the instructions for the set of screens they are on at any time. The memory construct records the number of times they review the instructions throughout the entire test. Lower scores therefore show that a respondent looked at the instructions fewer times during this test. The memory score should be interpreted in conjunction with attention. Good performance is indicated by a combination of both lower memory scores and higher attention scores.

2. Attention (now called 'Accuracy'): Attention indicates the number of correct responses given by the candidate. Attention scores result from candidates having correctly memorised and applied the rules relating to each set of screens, and showing this by clicking on the appropriate shapes. Higher scores on this construct indicate higher levels of attention.

3. Speed of working: The time taken to complete the MAT, minus the screens used to establish 'click speed' (see below), is recorded as 'speed of working'. This construct variable includes the time taken to complete all screens and any time the respondent spends reminding themselves of the instructions. Lower scores therefore indicate a faster speed of working.

4. Click speed: Considerable variations can be seen in how quickly people work at computers. As the MAT is a computer-delivered test that measures 'speed of working' as one of its constructs, speed of working will be affected by a respondent's natural rate of working with a mouse – the response format for the test. In order to allow speed of working to be put into context, a respondent's speed of working to very simple test screens is assessed early on in the assessment. These screens have been designed in the same format as the main MAT screens, but the simplicity of the instructions respondents have to remember means that they place minimal requirements on memory. The response times to these screens are presented under 'click speed' and allow a baseline measure of how quickly a respondent works to be established. This, in turn, allows an interpretation of speed of working relative to this baseline to be made.

Since the publication of the original version of the test, a further two constructs have been added as follows.

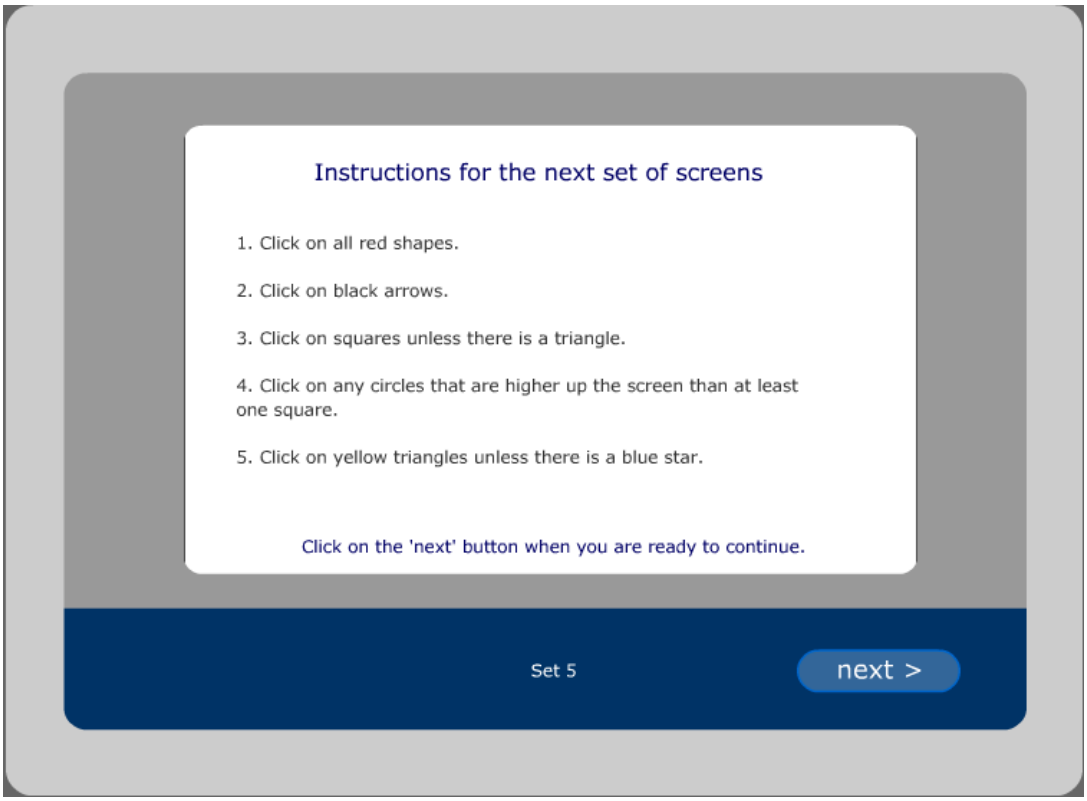
5. Decisiveness: Decisiveness is a measure of how infrequently the respondent changed their mind regarding any particular shape. If the respondent had clicked on a symbol to select it and had then clicked once again to deselect it, this will contribute to the Decisiveness score.
6. Decision efficiency: Decision Efficiency is an overall measure which combines both accuracy and speed and is computed from the number of correct items the respondent completed per minute.

It should be noted that for the variables Memory, Speed of Working, Click Speed and Decisiveness, lower raw scores indicate better performance and are therefore translated to high percentiles scores, with high raw scores translating to low percentiles.

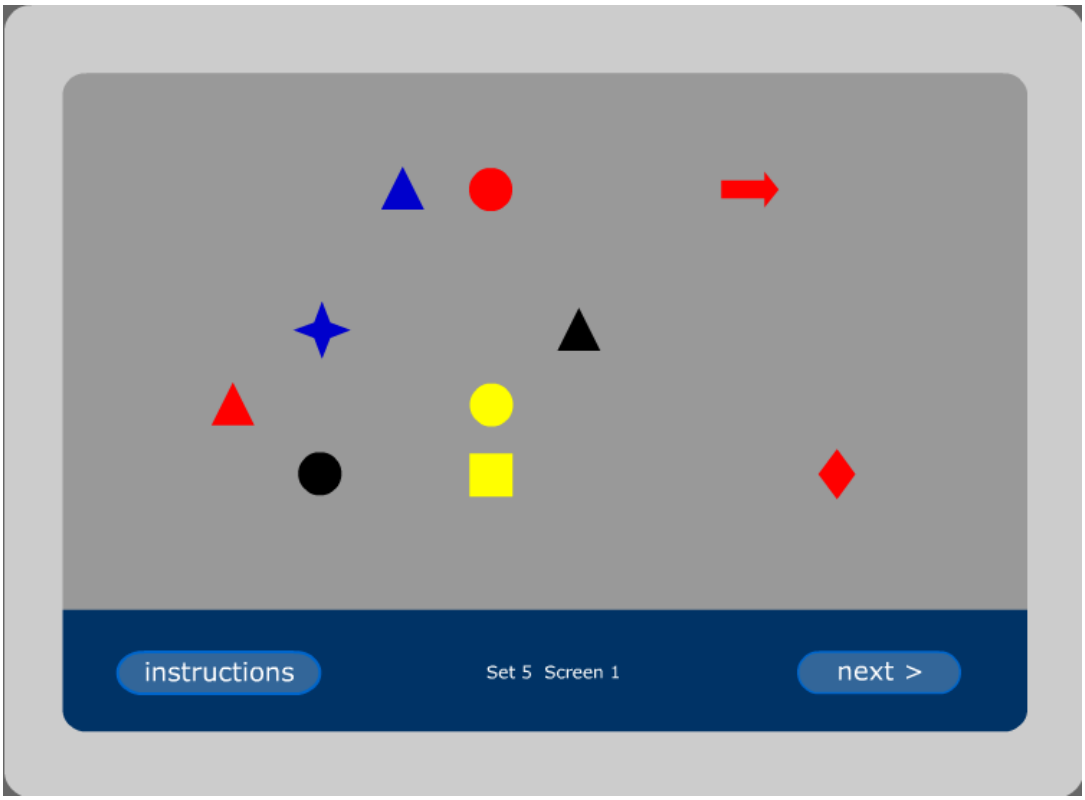
Screen shots of the test

Screen shots of two instruction pages from the test and two item panels corresponding to these are shown on the following page.

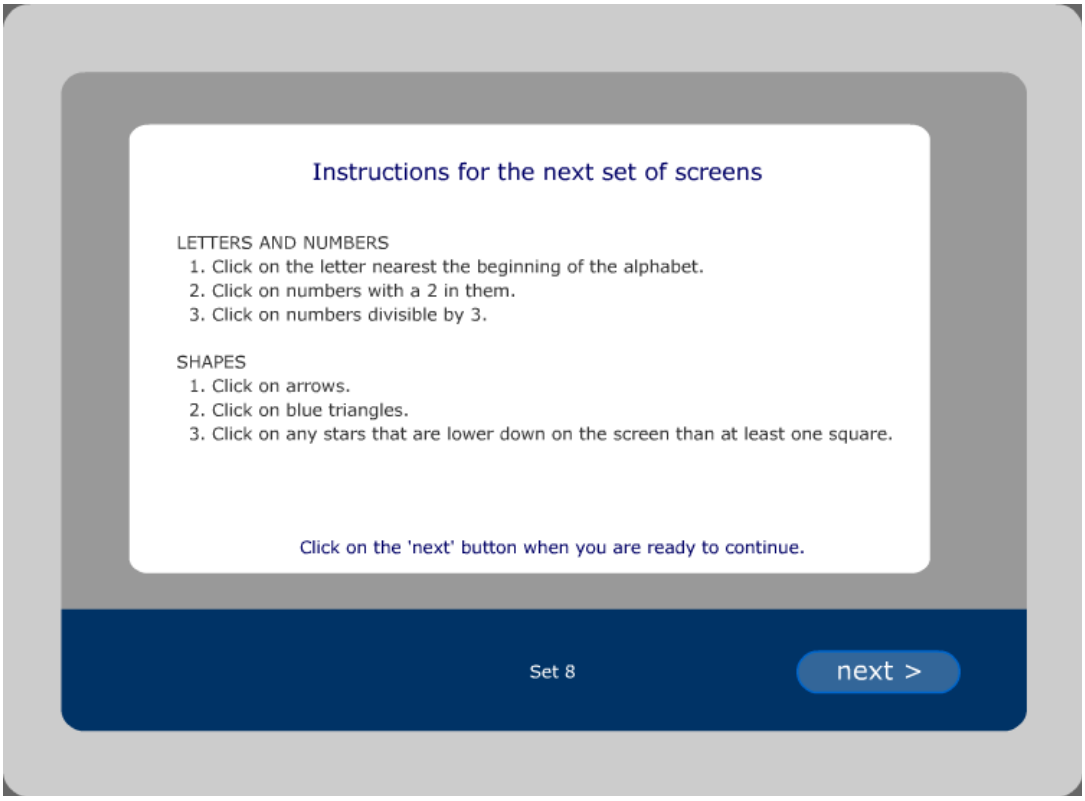
1. Instructions for the 5th set of test panels in the first part of the test



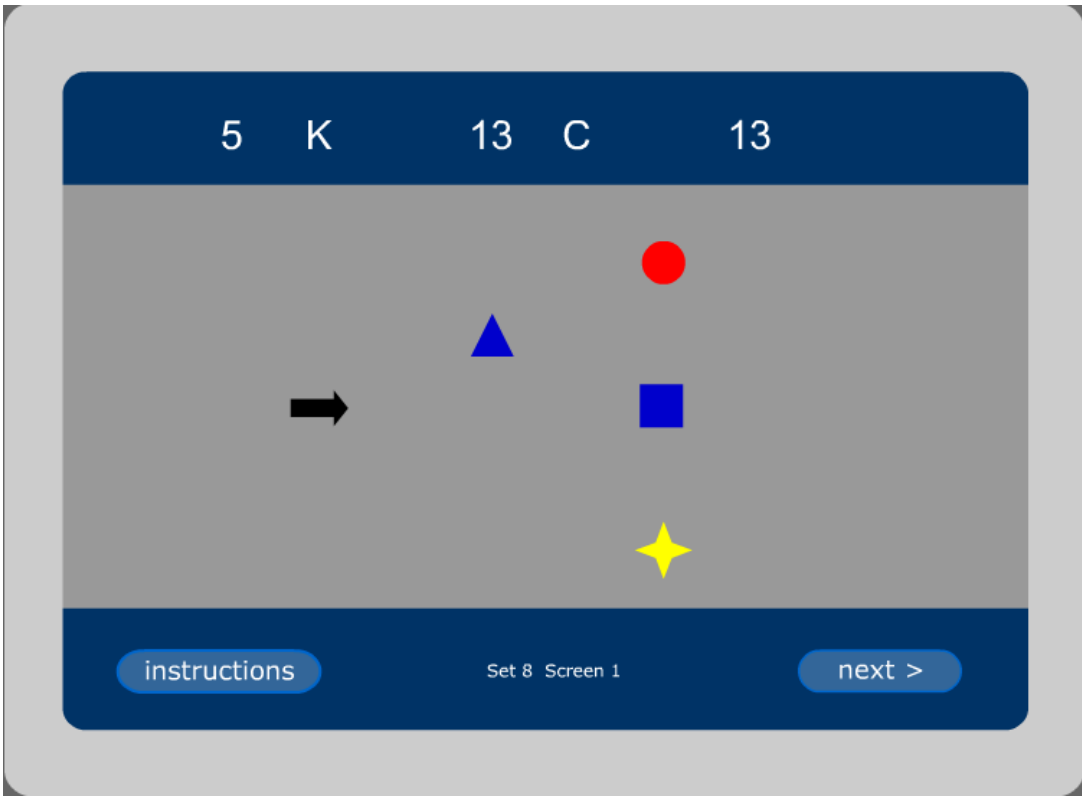
2. A test item from the 5th set of test panels in the first part of the test



3. Instructions for the 3rd set of test panels in the second part of the test



4. A test item from the 3rd set of test panels in the second part of the test



Section Three - Development of the MAT

Development of the MAT began in 2001 and the test was first published in 2003. The initial version of the MAT was designed to contain 10 sets of instructions, each of which would be associated with 10 sets of item screens, thus making a total of 100 item screens. In the first part of the test (5 instruction sets associated with 50 item screens), the item screens were to contain only shapes. In the second part of the test, the item screens were to contain both shapes and numbers.

For the first part of the test, the first set of instructions would contain only a single instruction - for example:

- Click on all yellow shapes.

The second set of instructions would contain the instruction from the previous set plus a new instruction - for example:

- Click on all yellow shapes
- Click on blue triangles

later sets of instructions would similarly add one further instruction as above. For the second set of instructions, a similar principle held, except that instructions for the numbers and letters in the item screens would also be given. For example, for the first set of instructions:

INSTRUCTIONS FOR SHAPES

- Click on red squares

INSTRUCTIONS FOR NUMBERS AND LETTERS

- Click on numbers divisible by 4

and for the second set of instructions:

INSTRUCTIONS FOR SHAPES

- Click on red squares
- Click on blue triangles

INSTRUCTIONS FOR NUMBERS AND LETTERS

- Click on numbers divisible by 4
- Click on the number which comes closest to the end of the alphabet

Writing of the instructions for the trial version of the test was therefore a relatively straightforward process involving writing the final set of instructions for each part of the test and then removing specific instructions for the preceding sets.

For the item screens, a grid template was constructed, for each item, and shapes were assigned to positions on the grid with number and letter sequences also assigned at the top of the panel in the case of items for the second part of the test. For any given item screen, shapes, numbers and letters were assigned in accordance with the specific instructions which would hold for that screen, ensuring that for most screens, there would be shapes which would need to be clicked on for each rule in the current instruction set but also for some screens there would be no shape which fitted a given rule (and hence no need for the respondent to click on any shape for that rule).

Shapes were placed on the grid in such a manner as to maximise the attention which would be required of the respondent in order to respond correctly. For example, if one of the rules was "Click on all yellow shapes which are higher up the screen than at least one square", then a yellow shape might be placed at the same vertical position as a square so as not to fit the rule, but to induce a less attentive respondent to click on it.

After internal trialling and review of the items, the test was administered online to several trial samples and respondents were asked to note down comments on the test screens. The items were then reviewed with the assistance of the written comments and item screens and test instructions were modified to remove ambiguities or to avoid untoward difficulties or complexities in the items. A second version of the test was then administered and data from this was subjected to item analysis to examine specific item properties and further adjustments to the items were made. The final set of items for the first version of the test was then prepared and was administered to a sample of 170 respondents. This sample was used for the development of norms for this version of the test and further updated norms were provided in 2005 based on a sample of 1047 respondents.

Subsequent to the development of the first version, a second version of the test was also developed along similar lines. This was identical in all respects to the original version but consisted of only five item panels for each set of instructions (50 in total). In 2007, the decision was taken to remove the original version of the test and use only the second version. This was due primarily to a perceived need to reduce the administration time of the test and the fact that the shorter version appeared to have more or less equivalent psychometric properties to the longer version.

Section Four – Administering the MAT

Introduction

For any test to play a valuable role in the decision-making process, it has to be matched to the abilities and competencies required by the job role. The first part of this section provides an overview of how to identify whether MAT is an appropriate test. Good administration is the key to achieving reliable and valid test results. When administering the test in person, a well-defined procedure is to be followed. However, computer administration offers test takers the opportunity to complete tests in their own time, at a location of their choosing, without an administrator being present. Since MAT is only available online it is important to recognise that this does not obviate the need for considering the conditions under which it will be taken and preparing the test taker for the experience such that they can genuinely show their ability without extraneous factors interfering. There is also the question of whether the procedure needs to be supervised or whether there are situations when it could be administered unsupervised.

Is the MAT an appropriate test?

As described in the rationale, the MAT is based on research into memory and attention. It requires an ability to attend to a range of stimuli and to follow simple instructions. It is therefore a measure of information processing speed and accuracy together with the ability to follow simple instructions efficiently without becoming overloaded or confused. This simulates many busy environments where the challenge is less to do with abstract thinking and more to do with efficient sequencing of tasks. There are many such environments where this might be appropriate such as call centres, busy offices, warehouses or any situation where the challenge is likely to involve multiple instructions and multi-tasking. It is the administrator's responsibility to have a clear rationale for how these skills are required in any job a person may be applying for.

Planning the test session

The test room needs to be suitably heated and ventilated (with blinds if glaring sunlight is likely to be a problem) for the number of people taking the tests and for the length of the test session. All the computer screens need to be clear and easy to read. The room should be free from noise and interruption, as any disturbances can affect test takers' performance. There should be space between each test taker's screen so that test takers cannot see others' progress or answers and the administrator should be able to walk around to keep an eye on progress or difficulties – especially during the examples where misunderstandings can be ironed out.

If the tests are to be taken as part of an assessment day, remember that performance tends to deteriorate towards the end of a long day. If a number of test sessions are being planned, those who take the tests towards the end of the day may be disadvantaged. If there are other mental challenges remember to organise appropriate breaks.

Test takers should be notified of the date, time and location of the test session and told which test(s) they will be taking. When test takers are notified about the session, it is essential that they are also asked to contact the administrator or other appropriate person, if they have any disabilities that will affect their ability to complete the tests and to specify what accommodation needs to be made for them to complete the tests. Under the Disability Discrimination Act (1995; 2005), test users are obliged to make changes to assessment procedures so that people with disabilities are not disadvantaged at any stage of the selection process. By obtaining information about any special needs well in advance of the test session, organisations can make the necessary adaptations to the testing session and have time to seek further advice if necessary. Further information on assessing people with disabilities can be found on the PfS website as:

www.profilingforsuccess.com/about/documents/Assessing_People_with_Disabilities.pdf

Access to the MAT online

Before the testing session, ensure that you have the correct Client Code, Access Code, Password and an ID number (optional) plus check that the codes are active (they may have a date after which they become inactive). Also check that the account contains sufficient credits to run the session. Make sure that all the computers are turned on and that the appropriate screen is ready. You should also keep a Test Log which reminds you of the materials needed, the process involved and it also allows administrators to record the room layout, any unusual occurrences during the test session and to summarise the test scores of a group of test takers. It is a useful document to keep for later review sessions or if any challenges are made to the test results or decisions that the results feed into.

The test session

A notice to the effect of 'Testing in progress – Do not disturb' should be displayed on the door of the test room. Ensure that chairs and desks are correctly positioned. There is no need to provide pens and rough paper for the MAT

If ID numbers are being used but have not already been allocated to test takers, allocate these outside the test room, then ask test takers to enter the room and find the corresponding desk. Otherwise, invite test takers into the test room and direct them where to sit.

Stage 1: Informal introduction

Invite test takers into the testing room and direct them where to sit. When all test takers are seated, the administrator should give the informal introduction to the test session. This needs to be prepared in advance to include the points given below, but should be delivered informally, in the administrator's own words. The aim here is to explain clearly to the test takers what to expect and to give them some background information about the tests and why they are being used. This will help to reduce anxiety levels and create a calm test setting. The administrator should aim for a relaxed, personable, efficient tone, beginning by thanking the test takers for attending.

The important points to include in the introduction are:

- Ask test takers not to touch the computers until they are told to do so.
- Give an informal introduction and tell the test takers that they will be taking the test on computer.
- At the end of the informal introduction, ask if there are any questions.
- Direct test takers to the PfS website and follow the appropriate link to take a test, then give them the Client code, Access code and Password to enter when prompted (or Licence number and Password if the project facility is used). Alternatively, prior to the beginning of the testing session, ensure that the PfS website has already been accessed on each computer and the entry codes entered in order that the PfS assessment facility is already displayed on screen when candidates take their places at their computers.
- Tell test takers that the computer will prompt them to enter their personal information before giving them the test instructions and practice and example items.
- Test takers should be allowed to work through the instructions at their own pace. In the case of an *unsupervised computer administration* they should begin the test when they are ready. For a *supervised computer administration* test takers should be told either to start the test when they are individually ready, or to wait until everyone is ready to begin.
- Explain that if they have any questions or experience any difficulties during the test, they should raise their hand.

At the end of the informal introductory talk, test takers should be told that from this point the tests will be administered according to a set procedure and that the instructions will be on screen. They will also have an example and some practice questions to ensure that they are all clear about what they are being asked to do. If they have any questions whilst reading these instructions or whilst completing the practice examples they should raise their hand and ask the administrator. They should be told whether to move on from the instructions to the test itself when they are ready, or whether to wait until everyone is ready to begin. They should also be told what to do when they have finished the test.

Stage 2: Supervised computer administration

In the case of test takers beginning the test when they are ready, they will finish the tests at slightly different times using this approach, as not everyone will work through the instructions at the same pace. If this approach is taken, administrators should judge which is the least disruptive between asking them to remain seated until everyone completes the test or whether they can leave the room when they have finished without disturbing other test takers. This is likely to depend on the number of people being tested and the room set-up (i.e. how easily people can leave the room without disturbing others).

Alternatively, test takers can be asked to work through the instructions, practice and example items, and then wait until everyone is ready to begin. When everyone is ready, the administrator should ask test takers to start. Everyone is more likely to finish the testing session at a similar time if this approach is used, thus reducing the possibility of test takers who have been slower to work through the instructions being disturbed by others leaving the room.

Finally, it should be noted that the tests which will be displayed on the screen when test-takers enter the PfS assessment area on the PfS web site will depend on the 'Access Code' which has been used to log in to the system. Administrators should therefore ensure that they have set up an Access Code which includes only the appropriate tests and test levels which they wish to be presented. A discussion of access codes is beyond the scope of this manual, though detailed information will be provided by Team Focus to users of the PfS online assessment system.

Stage 2: Unsupervised computer administration

The internet offers the potential to exploit the benefits of testing in new ways, but takes users into the less familiar territory of unsupervised assessment. There are many issues with unsupervised assessment: access to technology, fairness and the authenticity of test results being paramount. Despite the need to address these issues, the benefits of internet-based testing are many. Particularly notable are its efficiency and the opportunity to gather additional information to feed into the early stages of the decision-making process.

When planning an unsupervised testing session, administrators need to consider the target group and their likely access to technology. Certain groups (e.g. university students or those already working for an organisation) may have greater access to the necessary technology than others (e.g. people returning to work). Where it is anticipated that a number of potential test takers may not have access to the necessary technology, it may be advisable not to use internet testing unless other appropriate arrangements can be made. For example, it may be possible to direct test takers to places such as libraries, careers centres or an organisation's regional offices where they can take the PfS-Reasoning Tests under appropriate conditions.

Access to the necessary technology is also related to issues of fairness. If completing internet-based assessments is made a compulsory part of an application process, this may bias the process against those who do not have easy access to the necessary technology. In some cases it could also constitute deliberate discrimination and so be unlawful. Although many organisations use online application procedures, alternatives to these should be put in place (e.g. a paper-based test session available on request). Organisations may have to accept that, in some cases, test results will not be available for all applicants.

A major question with any unsupervised testing session concerns the authenticity of results. As the tests are unsupervised, there is no way of telling who has actually completed the tests or whether the intended test taker has received assistance. If the PfS Reasoning Tests are being used for development purposes or careers guidance, authenticity should be less of an issue. It is during selection that issues around authenticity are most critical.

One significant advantage of internet-based testing, as mentioned above, is that psychometric tests can be used early in a selection procedure, possibly at the same time application forms are completed. If used as part of a selection decision, it is essential to be confident that the test results are indeed the work of the applicant.

Ensuring the validity of test results requires that test takers are monitored during the test session. This removes many of the advantages of internet-based testing, so it is important to encourage honesty in test takers. One way in which this can be done is to position the tests as offering potential applicants valid feedback on their abilities and the demands of the job. This would imply on the one hand, suggesting to low scorers that the job may not be well matched to their abilities, and so would be unsatisfying for them and, on the other hand, confirming to higher scorers that they appear to have the necessary basic abilities required by the job. If test scores are used to make decisions at an early stage of an application process, it may be prudent to give them a lower weighting than normal and to set lower standards of performance.

The validity of test scores is more of an issue with high scorers. One approach to dissuade people from obtaining assistance with the tests is to view them as a 'taster' to the next stage of selection where further testing will take place under more controlled conditions. If test takers know that they will have to take a similar test under supervised conditions if they proceed to the next stage of the selection process, they may be less inclined to seek assistance with the unsupervised tests. In these circumstances it may be appropriate to initially use the open versions of the Reasoning Tests, then follow these up with the closed versions under supervised conditions if it is deemed necessary to verify results.

All the issues discussed above need to be considered when undertaking unsupervised, internet assessment. Despite this, in many ways, the actual test procedure is not that different from supervised administration. The main stages of the test process remain the same, although as it is not possible to give an informal introduction to the test session, the initial contact with test takers is very important. The contact letter, email or telephone conversation should include:

- why they are being asked to take the tests.
- what tests they have to take.
- how the results will be used.
- how they will receive feedback on their test results and who will have access to them.
- the hardware/software requirements of the tests.
- appropriate conditions for taking the tests (how long they should allow, the need for a quiet room, free from disturbances).
- how to access the testing site (website address and passwords).
- when the tests should be completed.
- either a copy of, or web link to, the Test Taker's Guide, recommending that this is used to help prepare for taking the tests.
- what will happen when the tests have been completed.
- the details of who should be contacted in case of queries or difficulties.

Particularly important under unsupervised test conditions will be the information on why the tests are being used. As discussed above, positioning the tests as providing applicants with an insight into their own suitability for the job can help to encourage honesty and acceptance of the remote testing experience when used for selection. If applicants who proceed to the next stage will have to take further tests, this should also be stated, again to encourage honesty.

Technical requirements for the MAT

If remote internet testing is being considered, the issue of access to technology needs to be addressed. Although the majority of people now have access to computers, it should not be assumed that this is the case for everyone. It also needs to be recognised that conditions should be conducive to completing a timed test; some computers that are accessible to the public may be in noisy environments and where test takers are liable to disruption.

To make the PfS Tests widely accessible, the system has been designed to make minimal demands on technology. The system will work on any internet-ready computer. The preferred browser is Internet Explorer with Adobe Flash® installed. The minimum screen resolution needed is 800 x 600 though a resolution of 1024 by 768 is recommended. Virtually all modern desktop computers and most modern laptop computers will meet the specifications needed to run the tests. Tests are accessed over the internet. As the whole test is downloaded before the test begins, timing for the test is unaffected by the speed of the internet connection.

It is not necessary for the internet connection to be maintained once a test has been downloaded. However, the internet connection does have to be active when the test results are submitted. Information about the need for test takers to be actively connected to the internet for their test results to be recorded is displayed at the end of the test.

Memory and Attention Administration Instructions

Give test-takers a general introduction to the testing session (as outlined on page 23) and answer any question arising.

Explain that from this point, the administration of the test will follow a set procedure and all instructions are to be followed on screen. Say:

Please go to: www.profilingforsuccess.com and click on the 'More' button under 'Taking an Assessment?' Click on 'Start Assessment', then choose 'English', then click on 'Client Code + Access Code + Password'. Enter the codes on the sheet you've been given, leaving the ID code box blank.

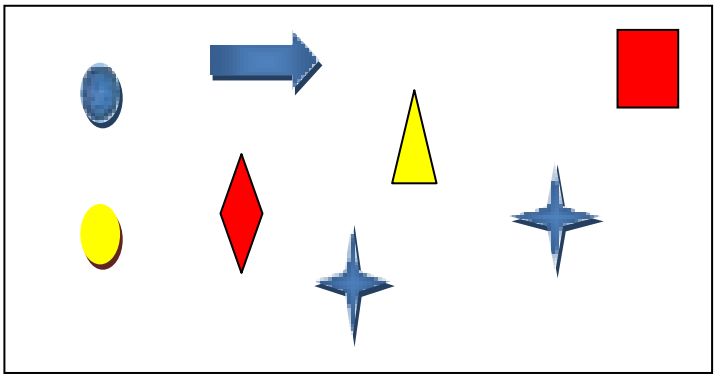
Once you've checked that all test-takers see the 'Welcome' screen, read this to them aloud:

"The following screen will ask you for some personal information. Your name and email address will be used to identify you and to generate a report of your assessment results. Other personal information, for example sex and ethnicity, will be used as part of our ongoing research and development to ensure the assessments used on this site are fair to all people. This personal information in no way affects your assessment results. All information will be stored in accordance with the Data Protection Act. If you agree to your personal information being used for these purposes please click on continue. Otherwise, close this window to exit the testing session."

Does anyone have any questions or objections? When everyone is happy to click on 'Continue', read the instructions on the next six screens as the test-takers complete them:

1. ***"Please enter the details requested and then click on the 'Continue button'. Fields marked with an asterisk (*) are compulsory."***
2. ***"Please indicate your ethnic background (used for monitoring purposes only) and continue."***
3. ***Click on 'Memory and Attention Test' "This test looks at your ability to memorise and follow instructions. Click on the 'Continue' button below to take this test/questionnaire."***
4. ***Click on 'Memory and Attention Test Version 1t'.***
5. ***Click on 'Begin'.***
6. ***Click on 'Continue'. "This test looks at your ability to memorise and follow instructions. Click on the 'Continue' button below to see the instructions for this test."***

In this test, you will see a number of screens. In the first part of the test, each screen will contain a number of shapes of different colours similar to those shown in the illustration to the right. In the second part of the test, the screens will also contain letters and numbers as well as coloured shapes.



When you click on a shape, it will become surrounded by a border to show you have selected it. If you click on it again, the border will disappear. Try clicking on some of the shapes in the illustration to see how this works.

Before each set of screens is shown, you will see some instructions telling you which of the shapes you should select. The purpose of the test is to follow these instructions as quickly and as accurately as possible. The instructions will become harder as you progress through the test.

Sometimes more than one instruction will apply to a particular shape. Where this is the case, you only need to click on the shape once to select it.

In the bottom left of the screens there will be an 'instructions' button. You can click on this button at any time to remind you of the instructions, Click on the 'Continue' button to have a go at some practice screens.

Please work through the practice screens and put your hand up if you have any questions about the practice screens. Do not click on "Begin Test" until I say so.

When you've answered all arising questions and everyone can see the 'Begin Test' button on their screen say:

This test is timed. You will have 6 minutes followed by 11 minutes. There is a timer at the bottom right hand corner of the screen. Work through from start to finish including the practice session in the middle.

I will be walking around to see that you are all working OK. Is everybody ready? Any final questions? Please click on the 'Begin test' button.

Section Five - Psychometric Properties of the MAT

This section of the manual deals with the psychometric properties of the current (50 item) version of the MAT.

Reliability

The internal consistency reliability of the MAT was assessed on a sample of 259 respondents assessed in a format training environment and was found to be 0.892 (Chrobach's alpha). The internal consistency estimated from an unselected sample of 818 respondents from the PFS data records was 0.835. Both these estimates are based on the MAT Accuracy score. The mean of the accuracy score from the latter sample was 29.323 (maximum score = 50) and the standard deviation was 7.0.

Validity

Evidence for the validity of the MAT comes from the correlation of the test with the PFS Verbal, Numerical and Abstract Reasoning tests. The following tables show the correlation of total scores on these three tests with various MAT indices and is based on a sample of 100 respondents undergoing a course of professional training. Marked coefficients are significant at p<0.05.

	Total Raw	N Swaps	Correct items Per Minute	Total Screen Time	Total Responding Time
Verbal Reasoning	0.01	0.08	0.24	-0.24	-0.22
Numerical Reasoning	0.30	-0.10	-0.00	0.14	0.11
Abstract Reasoning	0.32	-0.07	0.34	-0.14	-0.13

	Total Help Time	N Help Clicks	First Set Time	N Attempted
Verbal Reasoning	-0.19	0.19	-0.32	-0.14
Numerical Reasoning	0.15	-0.13	-0.25	0.26
Abstract Reasoning	-0.08	-0.25	-0.18	0.08

From this same sample, ratings of 'intellectual potential' were also obtained. These correlated 0.27 (p<005) with the MAT Total Raw score, 0.28 (p<005) with Correct Items per minute.

A further analysis was undertaken which compared MAT scores from this sample with predictions of training outcome from supervisors. An analysis of variance was carried out between two groups of subjects: those predicted to pass the training course and those who were considered in danger of not passing. The following two tables present the ANOVA results for those MAT variables where for which there was expected to be a significant difference between the two groups.

	Total Raw	Total B Shape Raw	Total B Lett Raw	Total Help Time	N
Mean: Pass	44.24	26.17	28.95	49.76	42
Mean: Risk pass	39.60	22.20	24.92	53.60	25
p	0.036389	0.020345	0.014086	0.709869	
F	4.566	5.6559	6.366	0.1396	

	First Set Time	N Help Clicks	Last Item	N Attempted	N
Mean: Pass	21.52	1645.45	69.73	69.67	42
Mean: Risk pass	24.72	1718.44	66.72	66.64	25
p	0.027183	0.742362	0.019206	0.019234	
F	5.107	0.1090	5.77	5.76	

It can be seen that significant differences in line with prediction were found on six out of the eight variables. For those variables where there was not expected to be a significant difference between the groups, the following results were obtained.

	Total Screen Time	Total Responding Time	N Swaps	Correct items Per Minute	N
Mean: Pass	848.96	799.07	9.62	3.19	42
Mean: Risk pass	757.28	703.80	8.88	3.432942	25
p	0.059570	0.024933	0.616623	0.296988	
F	3.677	5.270	0.2531	1.1054	

It can be seen that contrary to expectation, those subjects predicted to pass the course had significantly longer total responding times (time to complete the test) than those classified in the 'Risk Pass' category.

Intercorrelations between MAT scores and factor structure

The intercorrelations between the MAT scores were calculated from the training sample referred to above and are shown in the following table overleaf. Marked cells indicate correlations significant at $p<0.05$.

	Total Raw							
Total Screen Time	0.07	Total Screen Time						
Total Respond Time	0.11	0.91	Total Respond Time					
Total Help Time	-0.07	0.34	-0.09	Total Help Time				
First Set Time	-0.08	0.37	0.31	0.20	First Set Time			
N Help Clicks	-0.00	0.15	-0.24	0.88	0.11	N Help Clicks		
N Swaps (indecision)	-0.18	0.08	0.05	0.09	0.17	0.06	N Swaps (Indecision)	
Correct Decisions Per Minute	0.60	-0.62	-0.54	-0.25	-0.37	-0.09	-0.16	Correct Decisions Per Minute

The MAT score variables referred to in the above table are as shown below.

Variable	Explanation	Reported score
Total Raw	Number of items correct	Accuracy
Total Screen Time	Total time spent on the screens (including Help)	Speed (inverted)
Total Responding Time	Total time spent on the screens (not including Help)	Not reported
Total Help Time	Total time spent on Help screens	Not reported
First Set Time	Time spent on the simple items in Set 1	Click speed
N Help Clicks	No of times clicked on Help	Memory (inverted)
N Swaps (indecision)	No of times modified the selection of a shape	Indecision
Correct Decisions Per Minute	Total score divided by total screen time	Correct Decisions Per Minute

Note that the Help screens referred to in the table above are those which allow the person to see the current instruction set once again.

A factor analysis of the individual MAT scores was carried out on this same sample. This suggested a three factor structure accounting for 76.61% of common variance. The three factors were interpreted as Speed, Memory (i.e. reliance on the instructions) and Accuracy and are illustrated by the following factor loadings.

Factor 1	Speed
Total Responding Time	0.959311
Total Screen Time	0.955185
Correct Decisions Per Min	-0.622531 (-ve)
First Set Time	0.497180
Total Help Time	0.113169
Total Raw	0.107283
N swaps	0.044884
N help Clicks	-0.067243
% Variance	31.23 %

Factor 2	Memory (Reliance on Help)
N Help Clicks	0.969374
Total Help Time	0.963686
Total Screen Time	0.213307
First Set Time	0.198884
N Swaps (indecision)	0.079167
Total Raw	0.007567
Correct Decisions Per Min	-0.131099
Total Responding Time	-0.207320
% Variance	25.24%

Factor 3	Accuracy
Total Raw	0.929229
Correct Decisions Per Min	0.678794
N swaps (indecision)	-0.472959 (-ve)
Total Responding Time	0.029098
N Help Clicks	0.012822
Total Screen Time	-0.003876
Total Help Time	-0.073767
First Set Time	-0.239035
% Variance	20.14%

Norms

The norms currently available for the MAT are based on a sample of 675 candidates being assessed for selection for a variety of positions. The means and standard deviations of the MAT scores from this sample are as follows.

	Mean	SD
Total Raw:	29.292	7.041
Total screen time:	688.727	282.724
N Help Clicks	22.991	26.929
First set time	23.480	7.812
N Swaps	6.547	8.895
Correct Items Per Minute	2.777	.966

Reports

The reports currently available for the MAT consist of the Feedback Report and the Administrator's report.

The Feedback Report presents an introduction to the test followed by a graphic of results on each of the 6 principal scores generated by the test. This is followed by a description of each scale and a brief explanation of how the respondent's percentile score places them in respect of the comparison group. Finally a number of general points are made in relation to the interpretation of scores from psychometric tests.

The Administrator's Report provides the same graphic of results as the Feedback report but also provides raw scores on each scale along with more detailed results output.

References

Atkinson, R.C.; Shiffrin, R.M. (1968). Chapter: Human memory: A proposed system and its control processes. In Spence, K.W.; Spence, J.T. *The psychology of learning and motivation (Volume 2)*. New York: Academic Press. 89–195.

Baddeley, A.D. (2000). The episodic buffer: a new component of working memory? *Trends in Cognitive Science, 4,* pp 417–423.

Baddeley, A.D., Hitch, G.J.L (1974). Working Memory, In G.A. Bower (Ed.), *The psychology of learning and motivation: advances in research and theory* (Vol. 8, pp. 47–89), New York: Academic Press.

Binet, A., & Simon, Th. A. (1905). Méthode nouvelle pour le diagnostic du niveau intellectuel des anormaux. *L'Année Psychologique, 11,* 191-244.

Bresnahan, T. F., Brynjolfsson, E. and Hitt, L. M. (2002) Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence. The Quarterly Journal of Economics, 117, 339-376.

Carpenter, P. A., Just, M. A., and Schell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven Progressive Matrices test. *Psychological Review, 97,* 404-431.

CIPD (2008). Recruitment, Retention and Turnover: Annual Survey Report 2008. London: CIPD.

Colvin, G. (2008). Talent is Overratred. London: Nicholas Brealey.

Ehrman, M. (1994). The Modern Language Aptitude Test for predicting learning success and advising students. Applied Language Learning, 9, 31-70.

Gathercole, S. (2008). Working Memory. In Roediger, H. L. III (Ed.), Cognitive Psychology of Memory. Vol. [2] of Learning and Memory: A Comprehensive Reference, . 33-52. Oxford: Elsevier.

Kahneman, D. (1973). *Attention and effort.* Englewood Cliffs, NJ: Prentice-Hall.

Kyllonen, P. C. and Christal, R. E. (1990). Reasoning ability is (little more than) working-memory capacity?! *Intelligence, 14,* 389-433.

Squire, R. L (1987). *Memory and Brain.* New York: Oxford University Press.

Treisman, A. (1988). Features and objects: the fourteenth Bartlett Memorial Lecture. *Quarterly Journal of Experimental Psychology, 40A,* 201-236.

