

050

Elizabeth Chapman

Is there a relationship between ultrasound scanning ability and visuospatial perception or psychomotor ability. Should this type of assessment be employed as a pre selection tool for ultrasound training?

£7,758.00 awarded

Lay Summary

Ultrasound examination is a safe and effective way of screening the population for potential fatal pathology such as abdominal aortic aneurysm or fetal abnormalities. The imminent implementation of a number of recent government screening initiatives leading to an increased demand for ultrasound examinations, coupled with an existing national shortage of sonographers has resulted in an increased demand for ultrasound training. The Scottish Government is significantly investing in training new staff by providing capital for training fees, backfill and funding Higher Education Institutes (HEIs) to develop and deliver ultrasound training. Given this high investment of public money, it is incumbent on Health Boards and HEIs to ensure that this is invested in training staff with a reasonable expectation of success. Ultrasound requires certain skills and knowledge obtained during training but also inherent abilities, which not all people possess to the same degree and thus some trainee sonographers will never be able to demonstrate the required standard of clinical competency to graduate and practice. Scanning ability is not only related to academic achievement but also visuospatial perception and psychomotor ability, which influence the capacity to manipulate and control objects including hand eye coordination and manual dexterity. Currently potential trainee sonographers are selected by interview only with no practical assessment or testing of their visuospatial perception and psychomotor ability. This study will assess if a group of identified tests can be employed as a pre-selection assessment for aspirant sonographers undertaking training to enhance successful completion of training enabling a more realistic prediction of success.

Principle aim

The aim of this study is to assess the feasibility and utility of visuospatial perception and psychomotor ability testing as a pre-selection tool for ultrasound training.

Primary Research question

Is it possible to apply visuospatial perception and psychomotor ability testing to the field of sonography and is it beneficial as a pre-selection tool in the recruitment of trainee sonographers?

Secondary Research questions

1. What is the relationship between visuospatial perception and the ability to perform ultrasound scanning?
2. What is the relationship between psychomotor ability and the ability to perform ultrasound scanning?

The outcome is to identify a range of psychometric tests as measures of innate psychomotor and visuospatial aptitudes to be used as predictive markers of success in achieving competence in the practical skills required by sonographers in order to enhance the likelihood of training success and reduce drop out rates for sonography trainees.

Review of literature and identification of gaps

The Scottish Government has recently recommended the implementation of a number of changes to the pregnancy and newborn screening programmes in CEL 31(2008). These changes and developments aim to strengthen and extend ultrasound-screening services and take account of the updated advice from the UK National Screening Committee (NSC) and the recommendations of the NHS QIS Health Technology Assessment Report 5 – Routine Ultrasound Scanning before 24 Weeks of Pregnancy (Ritchie et al, 2004). Currently there is great variation in service offered across Scotland and the intention is to offer all pregnant women in Scotland equal access to obstetric screening. Other new initiatives include NSC programmes for Abdominal Aortic Aneurysm (AAA) screening to be implemented in Scotland in phases over the period from 2011 to 2012 (NHS Scotland 2008) and the 18 week Referral to Treatment (RTT) programme. The anticipated increased caseload as a consequence of the implementation of CEL 31 and AAA screening will inevitably result in a much greater demand for trained sonographers who are currently already in short supply nationally (Ward, 2004, RCM 2008). Thus there is a pressing need to train more staff to undertake ultrasound examinations before the full impact is realized. In response to this, the Scottish Government is significantly investing in training of new staff by providing capital for training, backfill for mentors and funding Higher Education Institutes (HEIs) to develop and deliver ultrasound training within Scotland. Given this high investment of public money, it is incumbent on Health Boards (HB) and HEIs to ensure that this capital is invested in training staff with a reasonable expectation of success making it essential to introduce some form of pre-selection assessment of potential trainee sonographers. These assessments should not only consider academic profiles but should also take cognisance of the specialist attributes required to undertake ultrasound scanning. Some health boards already insist upon staff undergoing a probationary period of scanning experience prior to commencement of a formal academic training programme in order to establish whether or not the candidate has the visuospatial perception or psychomotor motor skills to scan effectively. This can take several months. Now due to increased pressure and demand a higher proportion of candidates are embarking on postgraduate ultrasound courses with no prior hands on scanning experience. Some research evidence exists that sonographers require good hand to eye coordination to perform ultrasound examinations, however in practice pre-

selection evidence of this in students is often lacking. A literature review revealed several papers regarding selection criteria for aspirant surgeons, dentists and pilots (Bann et al, 2005), Schijven et al, 2004, Wanzel et al.2003, Anastakis & Matsumoto 2000) but in an extensive literature search of OVID, EBESCO and Pubmed databases none were found regarding selection criteria for sonographers. Many qualities and attributes are common to all four groups. Tests performed on the other three groups include visuospatial perception, psychomotor ability and manual dexterity. Visuospatial perception refers to the visual processing of spatial relations of image properties, normally depictions of objects. Processing of visual information occurs in a number of stages from simple edge and surface encoding to more complex whole object processing (Mountcastle 1998). Psychomotor ability influences the capacity to manipulate and control objects which includes arm-hand steadiness, control precision, finger dexterity, manual dexterity, multi limb coordination, rate control, reaction time, response orientation, speed of limb movement and wrist-finger speed(O*Net 2010). The literature review identified no evidence of a robust method for assessing visuospatial perception, psychomotor ability and manual dexterity in aspirant trainee sonographers.

Methods

Study design: A correlational design will be used to answer the proposed research questions. Two groups of participants will be recruited: Group 1 will be fully trained and experienced sonographers, and Group 2 will be trainee sonographer about to commence an accredited PgC in Obstetric Ultrasound. Pre and post data will be collected in Group 2 to assess change due to training.

Setting: Maternity ultrasound departments in NHS Fife, NHS Lothian and NHS Glasgow and Glasgow Caledonian, St Martin's and Leeds Universities

Participants: Group 1: Fully trained experienced sonographers (n=30)
Group 2: trainee sonographers (n= 30)

Inclusion criteria: Group 1: Sonographers trained to Postgraduate Certificate, Diploma or MSc level. Group 2: trainee sonographers who hold a primary degree in either radiography or midwifery with limited or no hands on experience in ultrasound.

Exclusion criteria: Group 2: more than 1 year practical experience in ultrasound

Sampling method: Convenience sample of volunteer participants recruited from three health boards and three-university intakes of student's beginning ultrasound training in September 2010 meeting the prescribed criteria.

Method of recruitment: Consenting volunteer participants will be recruited for Group 1 from the cited maternity unit, and for Group 2 from Glasgow Caledonian University, St Martin's University Lancaster and Leeds University. Testing will be explained to obtain consent

Data collection: In summary, there will be three main types of data generated for each participant (visuospatial test data, psychomotor test data, scanning ability data),

Data will be collected from trained sonographers once only and trainees collected at three possible time-points for the trainees (Week 1, 6 and 12 months). Week 1 represents the baseline and is the point at which Group 2 commence training. Follow-up data are collected at 6 and 12 months for scanning ability only. Training will be complete by 12 months.

Tests of visuospatial perception and psychomotor ability were identified through literature based on testing aspirant surgical trainees and dentists (Wanzel et al 2003, Yancosek & Howell 2009). The following test are considered most appropriate for this research: The Mental Rotation Test, Surface Development Test, Gestalt Completion Test and Snowy Pictures Test are tests from the Educational Testing Service, developed and researched by a team of researchers over several years, they have proven reliability and validity if conducted using recommendations provided in the Kit of Factor - Referenced Cognitive Tests (Ekstrom et al, 1975). These tests have been widely used in research including research of visual-spatial ability in aspirant surgeons, dentists and pilots (Bann et al, 2005, Schijven et al, 2004, Wanzel et al.2003, Anastakis& Matsumoto 2000). The Zigzag tracking test, which measures eye-hand coordination is a relatively new test used mainly to assess the effect of drugs on individuals performance but is easily administered and results logically documented for consistency and reliability. The Purdue Pegboard dexterity test developed in 1948 by Dr. Joseph Tiffin has been used extensively to aid in the selection of employees for various types of manual labor. It measures dexterity for 2 types of activities: gross movements of hands, fingers, and arms; and fingertip dexterity necessary in assembly tasks. The Purdue Pegboard was standardized after extensive experimentation in numerous plants involving the testing of several thousand employees in a wide variety of industrial jobs. Scoring is done by counting the number of pieces placed into the holes in the given time restraints. Results provided in the manual demonstrate that the test-retest reliability is good.

Abstract reasoning test measures concentration and the innate ability to perceive relationships and deduce co-relationships (Newton, 2009) there are numerous tests specifically developed to assess the population on which the test is intended for use.

Visual-spatial ability tests (VST)

1. The Mental Rotation Test (MRT) to assess high level visual-spatial ability,
2. Surface Development Test (SDT), high level visual-spatial ability,
3. Gestalt Completion Test (GCT) low level visual-spatial ability,
4. Phase Discrimination Test (PDT) intermediate visual-spatial ability.

Psychomotor tests (PMT)

5. The Zigzag tracking test, which measures eye-hand coordination, and
6. Purdue Pegboard dexterity test measures hand eye coordination and manual dexterity
7. Abstract reasoning test measures concentration.

8. Scanning ability

To assess scanning ability, an obstetric structured assessment tool (OSAT) is included. The CIRS Model 068 Fetal Ultrasound Biometrics Phantom will be utilized as an OSAT to facilitate the assessment of scanning performance. All participants will be timed and assessed using 4 methods of scoring:

1. Accuracy of measurement (against a known measurement),
2. Time taken to achieve measurement
3. Quality of image plane acquired for measurement
4. Overall quality of image (Loughna et al 2009).

The OSAT includes 4 measurement planes, fetal bi-parietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) These are all routine fetal screening measurements

The quality of the section acquired for measurement will be assessed against a reference image provided by the researcher. The participant will be timed in achieving each measurement and the overall quality of the image and image plane acquired will be assessed against the reference image. The accuracy of the measurement will be judged form a known reference measurement for HC, BPD, AC and FL supplied by the manufacturer if the phantom. The OSAT images for all participants will be assessed by the same person using pre stated quality criteria. For quality of image plane acquired and overall quality of image numerical values as indicated in the table below will be given as optimal, acceptable or sub-optimal. Each participant will be allocated a unique identification number, which will be used in data entry to anonymise the results.

Quality	Optimal	Acceptable	Sub –optimal
Score	1	2	3

Week 1 both trained and trainee sonographers will be assessed using the visuospatial perception and psychomotor ability tests and the Obstetric Structured Assessment Tool. At 6 and 12 months the trainees will be assessed using the OSAT only to compare performance midway through training and completion of training. This test has not been used for the purposes of assessing practical skills of sonographers previously therefore the reliability and validity will be assessed during this research.

The Quantative data generated will be subject to statistical analysis, providing empirical evidence of the relationships between visuospatial perception, psychomotor ability and scanning ability. The data will allow comparison between trained sonographers and trainee sonographers at week 1 and access development of skills in trainee sonographers at 6 and 12 months. Comparison of skills could also be made between individual trained sonographers

Data analysis: Descriptive statistics

1. Descriptive statistics will be used to summarize the statistics in terms of means and standard deviations or median and range presented in graphical

form for each of the 7 tests and the OSAT at each time-point for the trained and untrained sonographers.

2. Bivariate analysis

a) Correlation amongst the 7 tests will be demonstrated using a 7 x7 matrix

b) Regression models will be used to assess each test variable for the OSAT (independent variable) regressed on the OSAT at 12 months (dependent variable)

3. Multiple regression model including all 7 tests as independent variables regressed on the OSAT at 12 months (dependent variable) will allow interrogation of the combination of tests and how they might predict performance

With the data collection an additional regression analysis would allow assessment of changes in OSAT variables from week1 (baseline) to 6 months (mid training) to a year (full training).

The hypotheses will be tested using inferential statistics to accept or reject at the 5% level of significance. Statistical analyses will be performed using Statistical Package for Social Sciences (SPSS 17.0 for windows). The Academic Unit statisticians will support statistical planning and analysis. Correlation and analysis of numerical results including time taken to perform tests will be used for each of the 7 tests and will provide test result data significance testing will be performed on the data collected to assess each null hypothesis, with the p value produced used to reject or accept.

Tables and graphs of results of results will be produced. In addition to summary statistics to describe the data, statistical analysis will assess:

1. Relationship between scanning ability and visual-spatial perception (Research question 1)
2. Relationship between scanning ability and psychomotor ability (Research question 2)
3. Multiple regression to assess which test(s) (psychomotor / visuospatial) best predict improvement in scanning ability (research question 1)
4. Additional analysis not related to research questions
 - a) Differences between groups
 - b) Changes in visuospatial perception, psychomotor ability and scanning ability between week 1, 6 months and 12 months (trainees only)

Ethics

This study will involve collection of data from participants from 3 NHS centres in Scotland and three university sites. This will include the results of a visuospatial perception and psychomotor ability test for each participant and collecting data from images of a Fetal phantom measurements performed for the purpose of this research. Formal ethical approval for the study will be sought from Glasgow Caledonian School of Health and NHS integrated NRES. The conduct of the study following ethical approval will provide anonymity and confidentiality for the sonographers, which is embedded in the principles of beneficence and justice (Polit and Beck 2004) by issuing them with a unique identifying number code known only to the researcher. All information will be collected, managed and stored in accordance with the Data Protection Act (1998). As the group of participants is large (N= 50) and from 3

departments NHS Fife, NHS Lothian and NHS Glasgow different areas anonymity to all but the researcher is possible. To ensure participants give informed consent they will be given appropriate information to allow full understanding of their involvement regarding time commitment, activities required, areas covered and the physical and emotional risks which may potentially be involved (O'Leary 2007).

References

Anastakis D J, Hamstra SJ , Matsumoto ED (2000) Visual-Spatial Abilities In Surgical Training *The American Journal of Surgery* Vol 179 June P 469-471

Bann S, Darzi A, (2005) Selection of Individuals for Training in Surgery, *The American Journal of Surgery* 190 ;98-102

CEL 31 (2008) Whittle, P. *The Scottish Government Changes to the pregnancy and New Born Screening Programmes* available at: www.scotland.gov.uk [accessed 9/25/2008]

CIRS (2010) *Fetal Ultrasound Biometrics Phantom*. Model 068 available at http://www.cirsinc.com/068_ultra.html

Data Protection Act (1998) Elizabeth II, Chapter 29 8th Impression, October 2003 (incorporating corrections) reprinted April 2005. The Stationary Office, London

Ekstrom RB, French JW, Harman HH, Dermen D.(1975) *Kit of Factored-Referenced Cognitive Tests* available from <http://www.ets.org/media/research/pdf/Kit> of Factor-referenced Cognitive tests.pdf[accessed 30 july 2010 07:55

Gallagher AG, Ritter EM, Champion H, Higgins GH, Fried MP, Moses G, Smith C D, Satava RM. (2005) Virtual Reality Simulation for the Operating Room Proficiency –Based Training as a Paradigm Shift in Surgical Skills training. *Annals of Surgery* Vol 241 No 2: 364-372

Mountcastle VB. *Perceptual neuroscience: the cerebral cortex*. Cambridge (MA) Harvard University Press 1998.

Newton P (2009) Psychometric Success-Abstract Reasoning available at www.psychometric-success.com

NHS QIS (2004) -NHS Quality Improvement Scotland. Routine ultrasound scanning before 24 weeks of pregnancy. *Scottish Executive*

O'Leary Z. 2007 *The Essential Guide To Doing Good Research*. Sage Publications London.

O*Net 2010 Abilities –Psychomotor abilities available at <http://online.onetcenter.org/find/descriptor/browse/abilities/1.A>. [Accessed 12:08 24/09/2010]

Ritchie K, Boynton J, Bradbury I, Foster L, Iqbal K, Kohli H, Love C, Penney G, Quinn S, Reid M, Slattery J, Wright D. (2004). *Routine ultrasound scanning before 24 weeks of pregnancy. Health Technology Assessment Report 5 Glasgow: NHS Quality improvement Scotland*

Salomon LJ, Bernard JP, Duyme M, Dorion a Ville Y. (2003) Revisiting first-trimester fetal biometry. *Ultrasound in Obstetrics & Gynecology*. 22(1): 63-6, 2003 Jul.http://www.city.ac.uk/avrc/members/j.l.barbur/JAR_colour_study.pdf [accessed 29/7/2009]

Schijven M P, Jalimowicz JJ, Carter FJ. (2004) How to select aspirant laparoscopic Surgical Trainees; establishing concurrent Validity Comparing Xitact LS5000 Index performance scores with Standardised Psychomotor Aptitude Test Battery Scores. *Journal of Surgical Research* 121. 112-119

The Scottish Government (2008) *First male-only health screening programme* available at <http://www.scotland.gov.uk/News/Releases/2008/06/24113105> Accessed 16/1/10

The Scottish Government (2008) Diagnostics Collaborative Programme: *Delivering Better Patient Care in Diagnostics* available at <http://www.scotland.gov.uk/Publications/2008/02/25091928/3> Accessed 16/1/10 The Scottish Government *Changes to the pregnancy and New Born Screening Programmes* CEL 31 (2008) www.scotland.gov.uk [accessed 9/25/2008]

Walliman N. (2001) *Your Research Project: A step by step guide for the First time Researcher* Sage London Whittle, P (2008).

Wanzel K R, Hamastra S J, Caminiti M F, Anastakis D J, Grober E D, Reznick R K (2003) Visual-spatial ability correlates with hand motion and successful surgical performance. *Surgery* Vol 134 No 5 750-757

Royal College of Midwives, (2008). *Midwife shortages affecting UK public* June 2008-08-10 available at www.rcm.org/college/media/centre/pressrelease
Yancosek K E, Howell D (2009) A narrative reviews of Dexterity Assessments. *Journal of Hand Therapy*. 258- 264

Elizabeth Chapman
Sep 28, '10, 9:39 AM
Added: Paragraph Break