European Journal of Personality
Eur. J. Pers. **15**: 143–152 (2001)
DOI: 10.1002/per.403

The Frequency Accrual Speed Test (FAST): Psychometric Intelligence and Personality Correlates

ULRICH ETTINGER* and PHILIP J. CORR
Department of Psychology, Goldsmiths College, University of London, UK

Abstract

Performance on a putative psychophysical measure of information processing related to intelligence (Vickers' 1995 Frequency Accrual Speed Test, FAST) was assessed in relation to two psychometric measures of intelligence (Raven's Advanced Progressive Matrices and the Mill Hill vocabulary test). Participants ($N = 57$) completed the Eysenck Personality Questionnaire – Revised (EPQ-R), and performed the FAST task under either low (70 dB) or high (90 dB) levels of white noise. FAST correlated with Raven's ($r = 0.56$) and Mill Hill ($r = 0.28$), as expected. FAST total scores were not affected by personality or personality-by-noise interactions. However, a measure of consistency of FAST performance (i.e. the standard deviation) was correlated negatively with total FAST scores ($r = -0.37$) and positively with (EPQ-R) extraversion ($r = 0.34$). The results are discussed in terms of the validity of the FAST to explicate the information processing variables in psychometric intelligence. Copyright © 2001 John Wiley & Sons, Ltd.

INTRODUCTION

In this article, we explore the interrelations between two measures of psychometric intelligence and a novel putative psychophysical measure of information processing (Frequency Accrual Speed Test, FAST; Vickers, 1995) designed to measure basic parameters related to variance in intelligence. In addition, given the known effects of personality and arousal on information processing performance, we examine the effects of personality on the FAST.

An enduring theme in biological intelligence research concerns the importance attached to basic information processing parameters underlying intelligence (see e.g. Galton, 1883; Spearman, 1904). In recent years, a number of theoretical perspectives have been proposed to account for the processes involved in the identification and processing of simple stimuli that are thought to underpin advanced cognitive processes.

*Correspondence to: Ulrich Ettinger, Department of Psychology, Goldsmiths College, University of London, New Cross, London, SE14 6NW, UK. E-mail: psp0lue@gold.ac.uk

Received 23 March 2000
Accepted 6 November 2000

The notion of mental speed, or efficiency, has provided one particularly influential perspective. Mental speed is postulated to be involved in the initial detection of stimuli, as well as the temporal integration of rapidly presented sequences of stimuli and their subsequent processing. According to this perspective, intelligent individuals are said to be more capable of rapid detection and processing of stimuli; and, in consequence of their superior mental speed, they are able to process more information per unit of time and, therefore, benefit more from experience – in common parlance, intelligent people are 'quick thinkers'.

Frequency Accrual Speed Test (FAST)

The FAST was devised by Vickers (1995) as a new measure of mental speed in order to overcome perceived difficulties of the Inspection Time (IT) paradigm, an established measure of speed of information processing (Deary and Stough, 1996). The FAST was designed to provide an '. . .estimate of the speed or efficiency with which sensory input is sampled – an estimate which seems likely to be insensitive to changes and variations in other parameters controlling elementary perceptual decisions, which is simple to measure and interpret, and which does not depend upon elaborate theoretical assumptions' (Vickers, 1995, p. 865).

The FAST requires participants to observe a quasi–random sequence of flashes on two adjacent lamps. Each trial (the macrostimulus) consists of a fixed number of flashes (the microstimuli), with one lamp flashing more frequently than the other. The participant's task is to decide which lamp has flashed more frequently. Accuracy on this task is interpreted as a measure of the rate of accrual of information about the frequency of occurrence; suboptimal performance '. . .may be assumed to be due to all-or-none random failure to register flashes, because they are presented too rapidly' (Vickers and McDowell, 1996, p. 464). Therefore, according to Vickers' (1995) discrete sampling model, FAST performance depends crucially on efficiency of identification and processing of visual stimuli. As expected, FAST performance correlates positively with standard psychometric measures of intelligence (coefficients reaching 0.52 for WISC-R block design test; Vickers, 1995; and 0.50 for Raven's Advanced Progressive Matrices; Vickers, Pietsch and Hemingway, 1995).

However, the theoretical basis of the FAST, and its correlation with intelligence measures (as well as IT), has recently been criticized by Deary and Caryl (1997). They argued that the FAST is not an alternative measure of mental speed and does not tap the same underlying processes as IT; the FAST is seen as measure of working memory, and, therefore, discarded as a true measure of mental speed. The criticism by Deary and Caryl (1997) is congruent with an argument by Vickers *et al.* (1995) for the discrete sampling model to be replaced by memory-based explanations, which eventually led Pietsch and Vickers (1997) to suggest the FAST be renamed the Frequency Accrual *Storage* Test. These theoretical issues aside, no independent empirical replication of the FAST–intelligence correlation has been reported. One aim of this article is to provide such a replication.

Personality processes

There are empirical and theoretical reasons for believing that measures of intelligence (and related tasks) and personality may interact.

Firstly, there are claims that personality may play a key role in basic, IT-type information processing tasks (Howe, 1990). Secondly, personality factors, arousal, time of day, and the menstrual cycle have already been shown to affect measures of psychometric intelligence (as summarized by Saklofske and Zeidner, 1995, and shown by results from our own laboratory: Corr and Kumari, 1998; Kumari and Corr, 1996, 1998; Kumari, Corr and Gupta, 1995).

Although previous attempts at establishing a relationship between basic measures of information processing and personality have failed (Brebner and Stough, 1995; Stough *et al.*, 1996), it may be suspected that the FAST task may be affected by personality variables. For example, the model by Humphreys and Revelle (1984) of personality and cognitive performance predicts that increasing levels of arousal should impair short-term memory processing. Eysenck's (1967) biological theory of personality argues that introverts have higher resting levels of activity of the brainstem's ascending reticular activating system than extraverts. This makes introverts cortically highly aroused and easily arousable. Extraverts on the other hand have lower cortical arousal and therefore constantly seek stimulation in order to raise their levels of arousal to enable optimal functioning. Eysenck's model predicts that introverts are more easily aroused than extraverts when bombarded with external stimuli.

Now, the FAST requires processing of rapidly presented information and, to some as yet unknown degree, short-term memory resources. Thus, to the extent that FAST is arousal sensitive, the Humphreys–Revelle arousal performance model, coupled with Eysenck's arousal hypothesis of introversion–extraversion, suggests that individuals high in arousal (introverts) should show impaired performance under conditions of high external stimulation.

Aims

Our study had the following aims. (i) To confirm the construct validity of the FAST by correlating performance on the FAST with standard measures of nonverbal (Raven's Advanced Progressive Matrices) and verbal (Mill Hill vocabulary test) intelligence. (ii) To examine whether personality and arousal affect FAST performance. This study is the first independent replication of the FAST; and the first study to explore personality processes in FAST performance.

METHOD

Participants

The sample comprised 57 undergraduate students, who were required to have normal or corrected-to-normal vision. Twenty-six were males (mean age $=$ 25.92, SD $=$ 6.06), 31 females (mean age $=$ 23.10, SD $=$ 5.75). All participants were English native speakers. Students received course credits for their participation.

Design

Participants were allocated to either low ($N = 28$) or high ($N = 29$) noise conditions. Personality was randomly sampled, and these measures served as continuous factors in the statistical analysis (see below).

The experimenter was blind to the personality status of the participants (the questionnaires were scored after completion of the experiment). In order to avoid effects of fatigue or practice, the order of administration of the two psychometric intelligence tests was counterbalanced. Participants also performed a second psychophysical processing task, the Subjective Time Quantum measure (Ehmke, 1982; Lehrl and Fischer, 1988, 1990), counterbalanced with the FAST; however, these data are not reported here.

Information processing test

The FAST equipment consisted of a plastic box (base, 27 cm × 18.5 cm; height, 12 cm) with a black surface. Mounted on the surface were two adjacent (12 cm apart), horizontally aligned, light-emitting diodes with red covers of 1 cm in diameter. Below each lamp was one button of 2 cm in diameter. One trial consisted of 30 flashes quasi-randomly presented on the two lamps. For each trial one lamp was set to flash more frequently; the ratio was fixed at 17/13 (this quasi-random setting is referred to as the 'hypergeometric version' of the task; Vickers, 1995). Trials were defined as left (L) or right (R) trials depending on whether the frequency was higher on the left or right lamp. There were 100 L trials and 100 R trials; the sequence of trials was randomized for each participant. The duration of one flash was 45 ms; the interstimulus interval was also 45 ms (Vickers, 1995). The viewing distance was approximately 50 cm. Similar parameters have been demonstrated previously to produce high reliability of performance on this task (Vickers *et al.*, 1995).

Participants were required to observe the flashes on both lamps and indicate, by pressing the corresponding button, for each trial which one of the lamps flashed more frequently. Twenty practice trials were given (10 L; 10 R), on which auditory feedback from the computer was provided to train participants. The whole task, therefore, consisted of 20 practice trials and 200 experimental trials. After 100 experimental trials a short break was provided. The dependent variable was the percentage of correct responses.

Personality and intelligence measures

The Eysenck Personality Questionnaire – Revised (EPQ-R), which forms part of the Eysenck Personality Scales for Adults (EPS Adult; Eysenck and Eysenck, 1991), was used to measure extraversion (E), neuroticism (N), and psychoticism (P). The UWIST Mood Adjective Checklist (UMACL; Matthews, Jones and Chamberlain, 1990) was used to measure state changes in energetic arousal (EA), tense arousal (TA), hedonic tone (HT), and anger/frustration (A/F). These state changes were taken to reflect the effects of the noise manipulation.

Psychometric intelligence was assessed following the widely recognized dichotomy of fluid (or nonverbal) and crystallized (or verbal) intelligence (Stankov, Boyle and Cattell, 1995). As a measure of nonverbal intelligence, Set I and II of Raven's Advanced Progressive Matrices (RAPM; Raven, Court and Raven, 1988) was used. The advanced version was chosen in order to avoid a ceiling effect in the present sample of university students. By including participants' results of the simpler Set I (which is thought of as a warm-up to Set II) in the analysis, a bottom effect was avoided. The RAPM were administered without time limit, as suggested by Raven *et al.* (1988). To assess verbal intelligence, Form 1 of the senior version of the Mill Hill vocabulary scale (Raven *et al.*, 1988) was administered. This paper test consists of an open-ended and a multiple choice scale of vocabulary (34 items each).

Procedure

Participants were tested individually in a sound attenuated cubicle. They received the tests in the following order: UMACL (pre-test, T1), FAST, UMACL (post-test, T2), psychometric intelligence tests (RAPM, Mill Hill; counterbalanced), and the EPQ-R. Participants were tested on the FAST either under low noise (70 dB (A)) or high noise (90 dB (A)). The noise consisted of white noise played from tape and was presented via headphones during the FAST (save during the practice trials). Upon arrival at the laboratory, participants were informed of the procedure. After completion of the UMACL, participants were introduced to the FAST, and provided with written instructions. For the FAST, practice trials ensured that participants understood what was required.

RESULTS

Descriptive statistics for FAST, intelligence, personality, and mood measures are shown in Table 1. The mean FAST score was 140.19, which represents 70.10% correct response and is close to the finding of Vickers and McDowell (1996). FAST scores ranged from 102 to 170 (51% to 85%).

Table 1. Means (*M*) and standard deviations (SD) for information processing, intelligence, personality, and mood measures

	M	SD
FAST (percentage of correct responses)	70.10	8.37
RAPM (*N* of correct answers)	26.54	7.60
Mill Hill (*N* of correct answers)	34.42	8.90
E	15.40	5.19
N	12.18	5.43
P	8.84	4.52
EA T1	21.63	4.30
EA T2	19.91	4.45
HT T1	24.96	4.78
HT T2	22.46	4.40
TA T1	15.56	4.04
TA T2	17.75	4.24
A/F T1	8.18	3.32
A/F T2	9.93	3.85

RAPM, Raven's Advanced Progressive Matrices (Raven *et al.*, 1988); E, Extraversion; N, Neuroticism; P, Psychoticism (EPQ-R; Eysenck and Eysenck, 1991); EA, Energetic Arousal; TA, Tense Arousal; HT, Hedonic Tone; A/F, Anger/Frustration (UMACL; Matthews *et al.*, 1990); T1, before test; T2, after test.

Intercorrelations between FAST, intelligence, mood, and personality

Pearson product-moment correlations between all variables are shown in Table 2.

As regards psychometric intelligence, Raven's and Mill Hill were significantly positively correlated, as expected, although the magnitude of this correlation ($r = 0.38$, $p = 0.004$) was modest.

FAST performance was significantly correlated with both RAPM ($r = 0.56$, $p < 0.001$) and Mill Hill ($r = 0.28$, $p = 0.03$) scores. None of the personality or pre-test mood measures was significantly correlated with total FAST performance.

For Mill Hill performance, correlations with E ($r = -0.27$, $p = 0.04$), tense arousal ($r = 0.36$, $p = 0.01$), and age ($r = 0.55$, $p < 0.001$) were found, indicating that verbal intelligence was superior in individuals who are introverts, tense, and older.

In order to obtain a measure of consistency of FAST performance 20 mean subscores were computed, each comprising ten successive trials. The standard deviation (SD) of these 20 means was entered into correlational analyses. SDs were correlated negatively with total FAST scores ($r = -0.37$, $p = 0.004$), indicating that small SDs, and, therefore, more consistent responding, were associated with higher FAST scores; and moderately negatively with RAPM ($r = -0.26$, $p = 0.05$) and Mill Hill ($r = -0.25$, $p = 0.06$), indicating that consistent FAST performance was modestly associated with better performance on intelligence measures. SDs were correlated with E ($r = 0.34$, $p = 0.01$), but not with N or P, indicating that higher E scores were associated with less consistent performance. SDs were not associated with mood state measures.

Effects of noise on self-reported mood

In order to confirm that the noise manipulation affected subjective state, we performed a multivariate analysis of covariance (MANCOVA) on post-test (T2) mood scores, controlling for mood at the start of the experiment (T1). The noise effect was significant, Wilks' $F(4,54) = 2.54$, $p = 0.05$. Under low noise, only hedonic tone showed a significant reduction ($M = -2.25$, SEM $= 0.78$) over the course of the experiment, $t(27) = 2.87$, $p = 0.008$. Under high noise, energetic arousal declined (-2.07, 0.87), $t(28) = 2.37$, $p = 0.03$, tense arousal increased (3.00, 0.91), $t(28) = 3.30$, $p = 0.003$, hedonic tone declined (-2.76, 0.066), $t(28) = 4.17$, $p < 0.001$, and anger/frustration increased (2.90, 0.68), $t(28) = 4.27$, $p < 0.001$.

Therefore, compared to low noise, high noise reduced positive affect and increased negative affect, indicating that the noise manipulation was effective in altering mood state. Previous research shows that the most consistent effect of arousal manipulations is on tense arousal (Thayer, 1989).

Effects of noise on FAST and intelligence test performance

To test for a main effect of noise on FAST (total score and SD), RAPM, and Mill Hill, we conducted a multivariate analysis of variance (MANOVA) with noise as a between-subjects factor and the above variables as dependent variables. None of the between-subjects comparisons were significant (all p-values > 0.10). This means that the noise manipulation in itself did not affect performance; consequently, analyses were carried out involving performance measures for both noise conditions combined.

Table 2. Pearson product-moment intercorrelations of all measures

	FAST	FAST SD	RAPM	Mill Hill	E	N	P	EA T1	HT T1	TA T1	A/F T1	Age
FAST	–	−0.37**	0.56**	0.28*	−0.11	−0.04	0.00	−0.04	−0.01	0.09	0.18	0.05
FAST SD		–	−0.26†	−0.25	0.34**	−0.07	−0.23	0.01	0.02	0.05	−0.15	−0.15
RAPM			–	0.38**	−0.03	0.03	0.18	−0.18	−0.15	0.22	0.24	−0.02
Mill Hill				–	−0.27*	−0.07	0.17	−0.22	−0.30*	0.36**	0.15	0.55**
E					–	−0.08	0.03	0.17	0.46**	−0.23	−0.39**	−0.20
N						–	0.20	−0.12	−0.44**	−0.44**	0.43**	−0.22
P							–	0.13	0.02	0.08	0.13	0.08
EA T1								–	0.24	−0.26	−0.21	−0.05
HT T1									–	−0.47**	−0.66**	−0.13
TA T1										–	−0.42**	−0.14
A/F T1											–	0.01
Age												–

** Correlation is significant at the 0.01 level (two–tailed); *correlation is significant at the 0.05 level (two–tailed); † $p = 0.05$.

Personality and noise

In order to explore possible interaction effects of personality and noise on FAST scores, we conducted a series of two-way analyses of covariance (ANCOVAs), comprising noise and one trait measure, and controlling for age. A regression approach was adopted in which personality measures were treated as continuous variables. This technique is preferable to taking median splits because of the preservation of statistical power (Cohen, 1968), and reduction of statistical artefact (Bissonnette, Ickes, Berstein and Knowles, 1990). No interactions of noise × personality were obtained for FAST total scores and SDs.

DISCUSSION

In this article, we explored several interrelated issues relating to the construct validity of the FAST: specifically, its relation to standard psychometric measures of intelligence, and its sensitivity to personality influences. Our aims were to replicate the correlation between FAST and psychometric intelligence (Vickers, 1995), and to investigate the possible influences of arousal induction and personality on this novel measure.

The correlation between FAST and RAPM was very similar to the correlations between nonverbal intelligence and FAST reported by Vickers (1995; Vickers *et al.*, 1995; Vickers and McDowell, 1996). As the first independent replication of Vickers' data, we conclude that the FAST–RAPM association is robust. These data, and those relating to the Mill Hill test, indicate that the FAST measures important intelligence variance as determined by nonverbal and verbal measures of intelligence.

Next, we explored the effects of personality on FAST performance. Total FAST scores were immune to arousal or personality effects. However, a measure of performance variability (or consistency) of the FAST, the standard deviation of subscore means, was correlated significantly with (EPQ-R) extraversion, indicating that high E individuals responded less consistently on the FAST. This finding can be integrated with previous research showing extraverts to employ less cautious response criteria in serial processing tasks (Eysenck and Eysenck, 1985). The finding of personality effects on consistency of FAST performance may be in accord with the assertion by Deary and Caryl (1997) that the FAST, relative to the IT task, is a 'complex, high-level task'. This implies that the FAST may suffer from one of the weaknesses that it sought to overcome (Vickers, 1995), *viz.* the use of strategy (in the case of FAST performance possibly related to the test-taker's personality characteristics). In this context, however, it is important to note that there was no strong association between E and total FAST scores. Overall task performance and the standard deviation may therefore reflect different sources of variance, resulting in differential correlations with E. Consistent, or diligent, performance may be only one characteristic related to successful performance on this task.

In addition to its correlation with E, the FAST standard deviation was correlated negatively with total FAST scores, pointing to an association between consistent responding and successful performance on this task. Moreover, FAST standard deviations were also found to be moderately associated with performance on Raven's matrices and Mill Hill. This finding, although of only moderate magnitude, is compatible with previous research by Jensen (e.g. 1992) demonstrating an association between performance variability on psychophysical reaction time (RT) tasks and overall intelligence.

The results of this study have thrown up a number of questions that deserve further attention. The finding of personality influences on a measure of performance consistency of the FAST challenges the proposed benefit of this measure in overcoming performance related weaknesses of the IT paradigm. The subtle personality effects found here are intriguing. It may be speculated that individual differences in levels of extraversion influence performance also on a number of other serial processing tasks that are otherwise not directly related to personality. This suggests it would be an important consideration to screen routinely for personality in experimental psychology research.

Our data do not address directly the underlying basis of the FAST. The FAST–RAPM correlation could be seen as consistent with the claim by Deary and Caryl (1997) that the FAST really measures working memory. It is true that the RAPM demands a heavy engagement of working memory: one must perform a variety of complex, simultaneous cognitive operations in order to determine which of the candidate shapes fit the missing part of the target stimulus. Equally compelling though is the argument that (i) the RAPM test is a good measure of general intelligence and (ii) the FAST is a good measure of the processes underlying general intelligence. Determining the causal relations between psychometric intelligence, the FAST, IT, and measures of (working) memory capacity presents a significant challenge to future research. In this regard, the experimental manipulation of putative intervening variables (e.g. memory load) would be valuable.

The present study has a number of limitations. The sample size is not very big. Detterman (1989) has pointed out that research into individual differences in intelligence requires large samples. Moreover, the sample in this study is likely to be somewhat limited in range. Future studies might benefit from including a more representative group of participants, not only drawing on student populations. However, it is also known that significant correlations are more difficult to obtain in a sample with a restricted range (Anastasi and Urbina, 1997). Therefore we would argue that the association between FAST and psychometric intelligence observed here is robust.

In conclusion, FAST performance was correlated with RAPM and Mill Hill scores. While total FAST scores were unaffected by personality or arousal, E was associated with variability of responding on this task. Although the FAST, by simple psychophysical means, seems to measure important intelligence variance, further work is required to elucidate the cognitive processes underlying this association.

ACKNOWLEDGEMENT

The authors would like to thank Rob E. Davis for technical support.

REFERENCES

Anastasi A, Urbina S. 1997. *Psychological Testing*, 7th edn. Prentice-Hall: Upper Saddle River, NJ.

Bissonnette V, Ickes W, Berstein I, Knowles E. 1990. Personality moderating variables: a warning about statistical artefact and a comparison of analytic techniques. *Journal of Personality* **58**: 657–587.

Brebner J, Stough C. 1995. Theoretical and empirical relationships between personality and intelligence. In *International Handbook of Personality and Intelligence*, Saklofske DH, Zeidner M (eds). Plenum: New York; 321–347.

Cohen J. 1968. Multiple regression as a general data-analytic system. *Psychological Bulletin* **70**: 426–443.

Corr PJ, Kumari V. 1998. Impulsivity, time of day, and stress: effects on intelligence test performance. *Journal of Research in Personality* **32**: 1–12.

Deary IJ, Caryl PG. 1997. Not so F.A.S.T., Dr. Vickers! *Intelligence* **24**: 397–404.
Deary IJ, Stough C. 1996. Intelligence and inspection time. Achievements, prospects, and problems. *American Psychologist* **51**: 599–608.
Detterman DK. 1989. The future of intelligence research. *Intelligence* **13**: 199–203.
Ehmke U. 1982. Ein Mikroprozessor als Meß- und Testgerät für informationspsychologische Größen [A microprocessor as apparatus for information psychological parameters]. *Grundlagenstudien aus Kybernetik und Geisteswissenschaft* **23**: 119–124.
Eysenck HJ. 1967. *The Biological Basis of Personality.* Thomas: Springfield, IL.
Eysenck HJ, Eysenck MW. 1985. *Personality and Individual Differences: A Natural Science Approach.* Plenum: New York.
Eysenck HJ, Eysenck SBG. 1991. *Manual of the Eysenck Personality Scales (EPS Adult).* Hodder and Stoughton: London.
Galton F. 1883. *Inquiries into Human Faculty and its Development.* Macmillan: London.
Howe MJA. 1990. Does intelligence exist? *The Psychologist* **3**: 490–493.
Humphreys MS, Revelle W. 1984. Personality, motivation and performance: a theory of the relationship between individual differences and information processing. *Psychological Review* **91**: 153–184.
Jensen AR. 1992. The importance of intraindividual variation in reaction time. *Personality and Individual Differences* **13**: 869–881.
Kumari V, Corr PJ. 1996. Menstrual cycle, arousal-induction, and intelligence test performance. *Psychological Reports* **78**: 51–58.
Kumari V, Corr PJ. 1998. Trait anxiety, stress and the menstrual cycle: effects on Raven's Standard Progressive Matrices Test. *Personality and Individual Differences* **24**: 615–623.
Kumari V, Corr PJ, Gupta BS. 1995. Interactive effects of trait anxiety, menstrual cycle, time of day and time pressure instructions on cognitive performance. *Pharmacopsychoecologia* **8**: 1–10.
Lehrl S, Fischer B. 1988. The basic parameters of human information processing: their role in the determination of intelligence. *Personality and Individual Differences* **9**: 883–896.
Lehrl S, Fischer B. 1990. A basic information psychological parameter (BIP) for the reconstruction of the concept of intelligence. *European Journal of Personality* **4**: 259–286.
Matthews G, Jones DM, Chamberlain AG. 1990. Refining the measurement of mood: the UWIST Mood Adjective Checklist. *British Journal of Psychology* **81**: 17–42.
Pietsch A, Vickers D. 1997. Memory capacity and intelligence: novel techniques for evaluating rival models of a fundamental information-processing mechanism. *The Journal of General Psychology* **124**: 229–339.
Raven JC, Court JH, Raven J. 1988. *Raven Manual*, 1988 edn. Oxford Psychologists Press: Oxford.
Saklofske DH, Zeidner M (eds). 1995. *International Handbook of Personality and Intelligence.* Plenum: New York.
Spearman C. 1904. General intelligence, objectively determined and measured. *American Journal of Psychology* **15**: 201–293.
Stankov L, Boyle GJ, Cattell RB. 1995. Models and paradigms in personality and intelligence research. In *International Handbook of Personality and Intelligence*, Saklofske DH, Zeidner M (eds). Plenum: New York; 15–43.
Stough C, Brebner J, Nettelbeck T, Cooper CJ, Bates T, Mangan GL. 1996. The relationship between intelligence, personality and inspection time. *British Journal of Psychology* **87**: 255–268.
Thayer RE. 1989. *The Biopsychology of Mood and Arousal.* Oxford University Press: Oxford.
Vickers D. 1995. The Frequency Accrual Speed Test (FAST): a new measure of 'mental speed'? *Personality and Individual Differences* **19**: 863–879.
Vickers D, McDowell A. 1996. Accuracy in the Frequency Accrual Speed Test (FAST), inspection time and psychometric intelligence in a sample of primary school children. *Personality and Individual Differences* **20**: 463–469.
Vickers D, Pietsch A, Hemingway T. 1995. Intelligence and visual and auditory discrimination: evidence that the relationship is not due to the rate at which sensory information is sampled. *Intelligence* **21**: 197–224.

