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Stress, burnout and doctors' attitudes to work are determined by personality and learning style: A twelve year longitudinal study of UK medical graduates

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Published: 18 August 2004

Received: 27 March 2004

BMC Medicine 2004, 2:29 doi:10.1186/1741-7015-2-29

Accepted: 18 August 2004

This article is available from: <http://www.biomedcentral.com/1741-7015/2/29>

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Abstract

Background: The study investigated the extent to which approaches to work, workplace climate, stress, burnout and satisfaction with medicine as a career in doctors aged about thirty are predicted by measures of learning style and personality measured five to twelve years earlier when the doctors were applicants to medical school or were medical students.

Methods: Prospective study of a large cohort of doctors. The participants were first studied when they applied to any of five UK medical schools in 1990. Postal questionnaires were sent to all doctors with a traceable address on the current or a previous *Medical Register*. The current questionnaire included measures of Approaches to Work, Workplace Climate, stress (General Health Questionnaire), burnout (Maslach Burnout Inventory), and satisfaction with medicine as a career and personality (Big Five). Previous questionnaires had included measures of learning style (Study Process Questionnaire) and personality.

Results: Doctors' approaches to work were predicted by study habits and learning styles, both at application to medical school and in the final year. How doctors perceive their workplace climate and workload is predicted both by approaches to work and by measures of stress, burnout and satisfaction with medicine. These characteristics are partially predicted by trait measures of personality taken five years earlier. Stress, burnout and satisfaction also correlate with trait measures of personality taken five years earlier.

Conclusions: Differences in approach to work and perceived workplace climate seem mainly to reflect stable, long-term individual differences in doctors themselves, reflected in measures of personality and learning style.

Background

Sir William Osler (1849–1919), one of the most distinguished physicians of the nineteenth and early twentieth century, recognised that only some doctors are happy in their professional lives:

"To each one of you the practice of medicine will be very much as you make it – to one a worry, a care, a perpetual annoyance; to another, a daily joy and a life of as much happiness and usefulness as can well fall to the lot of man." [1]

The modern medical workplace is a complex environment, and doctors respond differently to it, some finding it stimulating and exciting, whereas others become stressed and burned out from the heavy workload. The medical workplace also provides an environment where new skills are continually being learned, both as a result of medical knowledge evolving and because a doctor's work changes, in part due to career development and progression through different jobs.

In an important study, Delva *et al* [2] used earlier research [3,4] to develop two separate instruments for studying how doctors work, the Approach to Work Questionnaire (AWQ) and the Workplace Climate Questionnaire (WCQ). In Canadian physicians [2,5] the AWQ showed three separate factors, which were called *Surface-Rational*, *Surface-Disorganised*, and *Deep* (see table 1). These approaches related to different methods and motivations for continuing medical education. Those with a deep approach preferred independent and problem-based learning and motivation was internal. Surface-rational and surface-disorganised approaches were primarily driven by external motivation, with the preferred mode of continuing education learning being independent for the surface-rational, and in consultations for the surface-disorganised.

The WCQ showed three dimensions, called *Choice-Independence*, *Supportive-Receptive*, and *Workload* (see table 1), which correlated with the AWQ. Doctors reporting Choice-Independence and Supportive-Receptive work environments had a Deeper approach, whereas those describing an environment dominated by Workload tended to be more Surface-Disorganised.

Some doctors are unhappy with their work, which can manifest as stress (usually assessed by the General Health Questionnaire) or burnout, which has three separate components of emotional exhaustion, depersonalisation and reduced personal accomplishment (see table 2). Greater stress and burnout in doctors are related to the personality trait of neuroticism or 'negative affectivity' [6].

The AWQ and WCQ provide a snapshot of a doctor's learning environment and approach to work at one particular time, as also do measures of stress and burnout. A key question, as Deary *et al* recognised [6] when considering stress, is the extent to which different approaches to work and the climate of the workplace are consequences of *the workplace* or *of the doctor*. At first sight it might seem that the workplace itself has to be the primary force driving both workplace learning and workplace climate. However, it is also possible that approaches to learning and work mainly depend upon pre-existing differences among doctors, differences that may already have manifested ear-

lier in the doctors' careers. The AWQ bears a strong formal similarity to the surface, deep and strategic study habits and learning styles identified by the Study Process Questionnaire (SPQ), which assesses the motivations and approaches used by students in higher education (see table 3). The similarity is not accidental since the AWQ was developed by adapting items from Entwistle and Ramsden's Approaches to Study Inventory [7], which has a similar factor structure to that of the Study Process Questionnaire [8]. It is therefore expected that there may be significant continuities across approaches to study and approaches to work.

In this paper we describe a large cohort of UK doctors, typically aged 29 or 30 at the time of the study, who have been qualified for five or six years, who are practising as SHOs or SpRs in hospital or are in general practice, and who previously had been studied when aged 17 or 18 at application to medical school in autumn 1990 [9], in their final year at medical school [10] and as PRHOs [11]. The main interest here will be in the extent to which a doctor's present approaches to work and their workplace climate, as well as their stress and burnout, relate to earlier measures of study habits and personality at application to medical school and subsequently.

Method

Participants

In the autumn of 1990 a questionnaire was sent to all individuals with European Community postal addresses who had applied to any of the five UK medical schools taking part in the study [9]; they represented about 70% of all applicants and acceptances for medical school in that year. The response rate was 93%. Students who were accepted for entry in 1991, 1992 or 1993 were followed up in their final year at medical school (1995–1998), when the response rate was 56%, and at the end of their PRHO year (1996–1999), when the response rate was 58%. In 2002 a tracing exercise searched the *Medical Register* and *Medical Directory* from 1995 to 2002 to find the addresses of as many doctors as possible who were in the original survey, and who were known not to have died, left medical school during basic medical sciences, or otherwise to be no longer in the survey. For study design see figure 1.

Questionnaire

Questionnaires were sent to all individuals with current or recent GMC addresses. The questionnaire consisted of a single folded A3 sheet of paper (4 A4 sides). Included in the present questionnaire (described in the results as '2002') were the 12-item General Health Questionnaire (GHQ) [12]; an abbreviated version of the Maslach Burnout Inventory (aMBI), which has three sub-scales, Emotional Exhaustion, Depersonalisation, and Personal

Table 1: Dimensions of the AWQ and WCQ [2].

Approaches to work questionnaire	
<i>Surface disorganised:</i>	Feeling overwhelmed by work. For example, being unsure what is needed to complete a task, finding it difficult to organise time effectively, reading things without really understanding them.
<i>Surface rational:</i>	Preference for order, detail, and routine. For example likes to know precisely what is expected, puts a lot of effort into memorising important facts when learning something new.
<i>Deep approach:</i>	Integrative approach that leads to personal understanding. For example, tries to relate new ideas to situations where they might apply.
Workplace climate questionnaire	
<i>Choice-independence:</i>	Perception of control over what one does and how one does it.
<i>Supportive-receptive:</i>	Perception that help is available in the workplace and colleagues are understanding.
<i>Workload:</i>	Perception of heavy workload and having to cope alone.

Table 2: The three separate components of burnout [42]. Note: burnout on the MBI is indicated by higher scores on the emotional exhaustion and depersonalisation scales, and lower scores on the scale of personal accomplishment.

<i>Emotional exhaustion:</i>	Reduced energy and job enthusiasm; emotional and cognitive distancing from the job.
<i>Depersonalisation:</i>	Cynicism; lack of engagement and distancing from patients; treatment of patients as inanimate, unfeeling objects.
<i>Personal accomplishment:</i>	A sense of efficacy and effectiveness; of involvement, commitment and engagement; of capacity to innovate, change and improve.

Table 3: Differences in motivation and process of the surface, deep and strategic approaches to learning assessed in the Study Process Questionnaire [41].

	Motivation	Process
Surface	Completion of the course Fear of failure	Rote learning of facts and ideas Focussing on task components in isolation Little real interest in content
Deep	Interest in the subject Vocational relevance Personal understanding	Relate ideas to evidence Integration of material across courses Identifying general principles
Strategic	Achieving high grades Competing with others To be successful	Use techniques that achieve highest grades Level of understanding Patchy and variable

Accomplishment [13,14]; a three-item scale modelled on the aMBI, which assesses Happiness with a Medical Career [15]; an abbreviated version of the Study Process Questionnaire, which has three sub-scales of Surface, Strategic and Deep learning [16,17]; an abbreviated questionnaire assessing the 'Big Five' personality dimensions of Neuroticism, Extraversion, Openness to Experience, Agreeableness and Conscientiousness [15,18]; and abbreviated versions of the Approach to Work Questionnaire (aAWQ) and the Workplace Climate Questionnaire (aWCQ) [19], each of which has three sub-scales, and for which a detailed description is provided in the **Supplementary Information** (see Additional file: 1) [2]. The GHQ, aMBI and personality questionnaire had also been administered previously in the PRHO survey, and the SPQ had

been administered in the Applicant and Final year surveys.

Procedure

Questionnaires, along with a postage-paid return envelope, were posted at the beginning of December 2002. Two reminders were sent to non-respondents. Although the official closing date was 25th March 2003, a few questionnaires were returned up until the end of August 2003.

Statistical analysis used SPSS version 10.5, and structural equation modelling used LISREL 8.52.

Results

The tracing exercise looked for 2,912 individuals thought to have completed basic medical sciences and entered a clinical course. Eighty-nine had never been on the UK Medical Register, and either had failed finals, had never registered, or had emigrated. Of 2,823 individuals who were traced, 2,754 doctors were on the 2002 Register, 7 returned to the Register during 2002, and 64 were on an earlier Register. Of 2,823 questionnaires sent, 176 were returned by the Post Office as undeliverable, 10 doctors were travelling and hence uncontactable, and 2 had died. Of the remaining 2,635 doctors, 1,668 returned questionnaires, giving a response rate of 63.3%. There was no evidence of response bias (see **Supplementary Information** see Additional file: 1).

Respondents

The mean age of respondents on 1st December 2002 was 30.4 years (SD 1.86, range 28.3 – 49.2). There was substantial variation in the scores on the aAWQ and the aWCQ, and the factor structures of the aAWQ and aWCQ were similar to those reported elsewhere [19] (see **Supplementary Information** see Additional file: 1). There was also substantial variation on the measures of stress, burnout and satisfaction with medicine as a career, with 21.3% of doctors (345/1617) reporting GHQ scores of 4 or more, the conventional level of 'caseness'.

Approaches to work and learning were correlated with climate in the workplace, and as in the Delva *et al* study, the highest correlations were for a surface-disorganised approach correlating with high workload, and a deep approach correlating with a supportive-receptive environment and with choice-independence (table 4).

Approaches to work

Table 4 shows correlation of the stress measures with approaches to work and study habits. The largest correlations were of a surface-rational approach with a strategic learning style, and a deep approach to work with a deep learning style. In each case the correlations were not only highly significant when study habits were measured in the final year at medical school, six or seven years earlier, but were also very significantly correlated with study habits measured at selection, twelve years earlier. Correlations of approaches to work and stress, burnout and satisfaction with medicine were generally small, and generally were only with measures taken in 2002, and not with measures taken as a PRHO, five or six years earlier. The sole exception was that a surface-disorganised approach correlated with high stress as measured by the GHQ, both in 2002 and with stress when the doctors were PRHOs.

Workplace climate

Table 5 shows correlations between the workplace climate and study habits, stress, burnout and satisfaction with medicine. In contrast to the associations with approaches to work, the workplace climate showed only small correlations with study habits, but showed strong correlations with stress, burnout and satisfaction with medicine. In particular, high stress in the PRHO year showed very significant correlations with measures in 2002 of a perceived high workload, a less supportive-receptive environment, and less choice-independence. In addition, emotional exhaustion both in 2002 and in the PRHO year were related to a high perceived workload in 2002.

Personality

Table 6 shows the correlations of approaches to work and workplace climate with the 'Big Five' measures of personality, measured both in 2002 and also measured five to six years previously when the doctors were PRHOs. The surface-disordered approach to work is associated with high neuroticism and low conscientiousness, the PRHO correlations also being highly significant in each case. Neuroticism, both in 2002 and as a PRHO, is also associated with a perceived high workload (although in contrast to its prediction of a surface-disordered approach, conscientiousness is not a significant correlate of workload). The deep approach to work and learning is associated with being extravert and with greater openness to experience, and again the measures taken six years earlier are predictive. Finally a supportive-receptive work climate is associated with greater reported agreeableness, both in 2002 and six years earlier as a PRHO. There were no substantial correlations between personality and the surface-rational approach to work or choice-independence in work climate.

Multiple regressions

Tables 4 to 6 show a large number of correlations, which are not always straightforward to interpret, both because they are numerous and because many variables are themselves inter-correlated. Multiple regression was used to clarify the relationships (for technical details see **Supplementary Information** see Additional file: 1). Each individual measure of the aAWQ and aWCQ was regressed on the measures of study habits at application ($n = 3$) and in the final year ($n = 3$), of stress and burnout during the PRHO year ($n = 4$) and in 2002 ($n = 4$), and of personality in the PRHO year ($n = 5$) and in 2002 ($n = 5$). Alpha for entry was set at $p < 0.0001$ in view of the large sample size and the number of independent variables. The variables that were significant are shown in tables 4, 5 and 6 and 3 in italics. Of particular interest are variables that show not only show significant contemporaneous correlations but also significant correlations when measured five or more years previously.

Table 4: Pearson correlation (Significance; N) of background measures with the Approaches to Work Questionnaire. Correlations significant at $p < 0.05$ are in bold, and those with an absolute value of greater than 0.2 are underlined. Variables that are significant in the multiple regression (see text) are indicated in italics.

	Time of measurement	aAWQ Surface-Disorganised	aAWQ Surface-Rational	aAWQ Deep
aWCQ Workload	2002	<u>0.259</u> ($p < .001$; N = 1644)	0.045 ($p = .071$, N = 1642)	-0.068 ($p = .006$, N = 1638)
aWCQ Supportive-Receptive	2002	-0.112 ($p < .001$; N = 1636)	0.064 ($P = .009$; N = 1633)	0.102 ($P < .001$; N = 1630)
aWCQ Choice-Independence	2002	-0.125 ($P < .001$; N = 1647)	-0.001 ($P = .976$; N = 1645)	<u>0.209</u> ($P < .001$; N = 1641)
SPQ Surface Learning	Application	<u>0.119</u> ($P < .001$; N = 1591)	0.105 ($P < .001$; N = 1589)	-0.081 ($P < .001$; N = 1584)
	Final Year	0.105 ($P = .001$; N = 999)	0.101 ($P = .001$; N = 1001)	-0.109 ($P = .001$; N = 996)
SPQ Strategic Learning	Application	-0.101 ($P < .001$; N = 1591)	<u>0.203</u> ($P < .001$; N = 1589)	0.052 ($P = .038$; N = 1584)
	Final Year	-0.157 ($P < .001$; N = 999)	<u>0.215</u> ($P < .001$; N = 1001)	0.149 ($P < .001$; N = 996)
SPQ Deep Learning	Application	-0.078 ($P = .002$; N = 1591)	0.067 ($P = .007$; N = 1589)	0.192 ($P < .001$; N = 1584)
	Final Year	-0.131 ($P < .001$; N = 999)	0.152 ($P < .001$; N = 1001)	<u>0.240</u> ($P < .001$; N = 996)
General Health Questionnaire	PRHO	0.169 ($P < .001$; N = 974)	0.010 ($P = .761$; N = 974)	-0.079 ($P < .014$; N = 972)
	2002	<u>0.294</u> ($P < .001$; N = 1611)	0.018 ($P = .471$; N = 1608)	-0.119 ($P < .001$; N = 1604)
aMBQ – Emotional exhaustion	PRHO	0.062 ($P = .103$; N = 705)	-0.011 ($P = .777$; N = 704)	-0.042 ($P = .267$; N = 704)
	2002	<u>0.223</u> ($P < .001$; N = 1609)	0.007 ($P = .782$; N = 1607)	-0.157 ($P < .001$; N = 1602)
aMBQ – Depersonalisation	PRHO	-0.003 ($P = .939$; N = 661)	-0.033 ($P = .400$; N = 658)	-0.017 ($P = .672$; N = 659)
	2002	<u>0.224</u> ($P < .001$; N = 1598)	-0.071 ($P = .005$; N = 1596)	-0.151 ($P < .001$; N = 1590)
aMBQ – Personal accomplishment	PRHO	-0.137 ($P < .001$; N = 938)	-0.032 ($P = .335$; N = 937)	0.156 ($P < .001$; N = 936)
	2002	0.024 ($P = .335$; N = 1604)	-0.013 ($P = .610$; N = 1602)	0.095 ($P < .001$; N = 1596)
Satisfaction with medicine as a career	2002	-0.162 ($P < .001$; N = 1620)	0.037 ($P = .135$; N = 1617)	<u>0.211</u> ($P < .001$; N = 1612)

Table 5: Pearson correlation (Significance; N) of background measures with the Workplace Climate Questionnaire. Correlations significant at $p < 0.05$ are in bold, and those with an absolute value of greater than 0.2 are underlined. Variables that are significant in the multiple regression (see text) are in italics.

	Time of measurement	aWCQ Workload	aWCQ Supportive-Receptive	aWCQ Choice-Independence
SPQ Surface Learning	Application	0.022 ($P = .389$; N = 1587)	0.042 ($P = .093$; N = 1578)	0.004 ($P = .874$; N = 1591)
	Final Year	0.037 ($P = .240$; N = 999)	-0.034 ($P = .287$; N = 998)	0.054 ($P = .090$; N = 1000)
SPQ Strategic Learning	Application	0.032 ($P = .196$; N = 1591)	0.043 ($P = .090$; N = 1578)	0.082 ($P = .001$; N = 1591)
	Final Year	0.063 ($P = .048$; N = 999)	0.020 ($P = .520$; N = 998)	0.036 ($P = .255$; N = 1000)
SPQ Deep Learning	Application	0.008 ($P = .738$; N = 1587)	0.029 ($P = .251$; N = 1578)	0.049 ($P = .051$; N = 1591)
	Final Year	-0.032 ($P = .306$; N = 999)	0.071 ($P = .026$; N = 998)	0.065 ($P = .041$; N = 1000)
General Health Questionnaire	PRHO	0.183 ($P < .001$; N = 973)	-0.134 ($P < .001$; N = 970)	-0.110 ($P = .001$; N = 972)
	2002	<u>0.354</u> ($P < .001$; N = 1606)	-0.239 ($P < .001$; N = 1597)	-0.259 ($P < .001$; N = 1609)
aMBQ – Emotional exhaustion	PRHO	<u>0.211</u> ($P < .001$; N = 703)	-0.056 ($P = .136$; N = 701)	-0.035 ($P = .348$; N = 703)
	2002	<u>0.400</u> ($P < .001$; N = 1607)	-0.164 ($P < .001$; N = 1607)	-0.220 ($P < .001$; N = 1609)
aMBQ – Depersonalisation	PRHO	0.057 ($P = .145$; N = 658)	-0.109 ($P = .005$; N = 656)	-0.020 ($P = .609$; N = 658)
	2002	<u>0.216</u> ($P < .001$; N = 1595)	-0.222 ($P < .001$; N = 1594)	-0.165 ($P < .001$; N = 1597)
aMBQ – Personal accomplishment	PRHO	-0.028 ($P = .393$; N = 937)	0.110 ($P < .001$; N = 933)	0.063 ($P = .055$; N = 936)
	2002	0.163 ($P < .001$; N = 1601)	0.143 ($P < .001$; N = 1600)	0.044 ($P = .079$; N = 1603)
Satisfaction with medicine as a career	2002	-0.256 ($P < .001$; N = 1617)	<u>0.317</u> ($P < .001$; N = 1616)	<u>0.294</u> ($P < .001$; N = 1620)

Table 6: Pearson correlation (Significance; N) of Approach to Work Questionnaire and the Workplace Climate Questionnaire with personality. Correlations significant at p < 0.05 are in bold, and those with an absolute value of greater than 0.2 are underlined. Variables that are significant in the multiple regression (see text) are in shaded boxes.

	Time of measurement	aAWQ Surface-Disorganised	aAWQ Surface-Rational	aAWQ Deep	aWCQ Workload	aWCQ Supportive-Responsive	aWCQ Choice-Independence
Neuroticism	PRHO	0.172 (P < .001; N = 993)	0.021 (P = .510; N = 993)	-0.050 (P = .113; N = 992)	0.111 (P < .001; N = 992)	-0.055 (P = .086; N = 989)	-0.017 (P = .592; N = 991)
	2002	<u>0.335</u> (P < .001; N = 1645)	0.021 (P = .405; N = 1643)	-0.111 (P < .001; N = 1638)	<u>0.307</u> (P < .001; N = 1642)	-0.180 (P < .001; N = 1632)	-0.168 (P < .001; N = 1644)
Extraversion	PRHO	-0.113 (P < .001; N = 991)	0.056 (P = .079; N = 991)	0.174 (P < .001; N = 989)	-0.090 (P = .004; N = 990)	-0.087 (P = .006; N = 987)	0.049 (P = .124; N = 989)
	2002	0.173 (P < .001; N = 1649)	0.037 (P = .133; N = 1647)	<u>0.288</u> (P < .001; N = 1643)	-0.164 (P < .001; N = 1647)	0.147 (P < .001; N = 1637)	0.119 (P < .001; N = 1649)
Openness to experience	PRHO	-0.011 (P = .729; N = 975)	-0.077 (P = .016; N = 975)	<u>0.263</u> (P < .001; N = 973)	-0.037 (P = .250; N = 974)	0.036 (P = .259; N = 971)	0.033 (P = .297; N = 973)
	2002	-0.063 (P = .010; N = 1646)	-0.108 (P < .001; N = 1644)	<u>0.346</u> (P < .001; N = 1643)	-0.096 (P < .001; N = 1643)	0.038 (P = .129; N = 1633)	0.080 (P < .001; N = 1649)
Agreeableness	PRHO	-0.034 (P = .285; N = 991)	0.048 (P = .130; N = 991)	0.038 (P = .235; N = 989)	-0.024 (P = .455; N = 990)	0.182 (P < .001; N = 987)	0.026 (P = .421; N = 989)
	2002	-0.108 (P < .001; N = 1650)	0.096 (P < .001; N = 1648)	0.038 (P = .121; N = 1643)	-0.057 (P = .021; N = 1647)	0.153 (P < .001; N = 1638)	0.017 (P = .498; N = 1650)
Conscientiousness	PRHO	<u>-0.353</u> (P < .001; N = 991)	0.124 (P < .001; N = 991)	0.084 (P = .008; N = 989)	0.023 (P = .467; N = 991)	0.057 (P = .074; N = 987)	0.056 (P = .077; N = 990)
	2002	<u>-0.477</u> (P < .001; N = 1645)	0.126 (P < .001; N = 1643)	0.136 (P < .001; N = 1638)	-0.088 (P < .001; N = 1641)	0.093 (P < .001; N = 1632)	0.092 (P < .001; N = 1644)

A surface-disorganised approach to work is predicted by surface learning in medical school and by higher neuroticism scores and lower conscientiousness (see tables 4 and 6). The surface-rational approach to work is predicted by strategic learning in medical school, and by less openness to experience and higher conscientiousness. The deep approach to work is predicted by a deep approach to learning at medical school, by greater extraversion, by greater openness to experience, and by lower emotional exhaustion.

A workplace climate dominated by a high workload is predicted by higher stress and emotional exhaustion measures five years earlier, and by lower openness to experience (see tables 5 and 6). A supportive-receptive workplace is predicted by lower stress and depersonalisation, and a higher sense of personal accomplishment when measured previously, and by a more agreeable personality. Choice-independence in the work environment is predicted only by lower previous measures of stress.

Stress, burnout and satisfaction with medicine

Although in the previous analyses, stress and burnout have been used as predictors of approaches to work and workplace climate, they are also important outcome measures in their own right. Table 7 shows the correlations of the five 'stress-related measures' (GHQ, the three burnout measures and satisfaction) with measures of learning style and personality, in each case measured on two separate occasions. Personality correlates with each of

the measures, as do study habits. Because of the complex inter-correlations between the dependent variables, multiple regression was used, as before, to find the most important relationships (for technical details see **Supplementary Information** see Additional file: 1). Doctors who are most stressed showed higher levels of neuroticism, both currently and previously, and those reporting most emotional exhaustion also had higher neuroticism levels, as well as being more introvert. High levels of depersonalisation related to lower levels of agreeableness. A greater sense of personal accomplishment related to previous deep approaches to study and learning, as well as to being more extravert. Overall satisfaction with medicine as a career related to lower levels of neuroticism.

Path analysis

The complex relationships described by the various correlations are best analysed and described by means of path analysis or causal modelling [20], which analyses the entire set of correlations between variables, using plausible assumptions about causality and removing non-significant paths. The path diagram, which was analysed using LISREL 8.52 [21], is shown in figure 2. Measures to the left can causally influence measures to their right. Based on the time-lagged correlations reported previously, we assumed that stress causes different approaches to work, and we also assumed that approaches to work cause differences in workplace climate rather than vice-versa. (Nevertheless, we acknowledge that the causation may well be reciprocal, as suggested by the originators of

Table 7: Pearson correlation (Significance; N) of stress, burnout and satisfaction with medicine as a career in 2002 with study habits at application to medical school and in th final year of medical school, and with personality in the PRHO year and in 2002. Correlations significant at p < 0.05 are in bold, and those with an absolute value of greater than 0.2 are underlined. Variables that are significant in the multiple regression (see text) are in shown in italics.

	Time of measurement	Stress (GHQ) (2002)	Emotional exhaustion (aMBI) (2002)	Depersonalisation (aMBI)	Personal accomplishment (aMBI)	Satisfaction with medicine as a career
SPQ Surface Learning	Application	0.036 (P = .150; N = 1555)	0.105 (P < .001; N = 1552)	0.068 (P = .008; N = 1542)	-0.003 (P = .895; N = 1546)	-0.033 (P = .186; N = 1563)
	Final Year	0.008 (P = .792; N = 984)	0.090 (P = .005; N = 983)	0.094 (P = .003; N = 976)	-0.036 (P = .266; N = 980)	-0.023 (P = .471; N = 989)
SPQ Strategic Learning	Application	-0.011 (P = .671; N = 1555)	0.017 (P = .513; N = 1552)	-0.073 (P = .004; N = 1542)	0.021 (P = .416; N = 1546)	0.046 (P = .068; N = 1563)
	Final Year	-0.014 (P = .655; N = 984)	-0.052 (P = .102; N = 983)	-0.108 (P = .001; N = 976)	0.007 (P = .819; N = 980)	0.104 (P = .001; N = 989)
SPQ Deep Learning	Application	0.041 (P = .102; N = 1555)	-0.001 (P = .974; N = 1552)	-0.055 (P = .031; N = 1542)	0.123 (P < .001; N = 1546)	0.042 (P = .101; N = 1563)
	Final Year	-0.022 (P = .498; N = 984)	-0.105 (P = .001; N = 983)	-0.071 (P = .027; N = 976)	0.120 (P < .001; N = 980)	0.134 (P < .001; N = 989)
Neuroticism	PRHO	0.192 (P < .001; N = 972)	0.233 (P < .001; N = 972)	0.103 (P = .001; N = 972)	0.036 (P = .255; N = 975)	-0.188 (P < .001; N = 981)
	2002	0.461 (P < .001; N = 1610)	0.378 (P < .001; N = 1607)	0.235 (P < .001; N = 1596)	0.090 (P < .001; N = 1603)	-0.314 (P < .001; N = 1618)
Extraversion	PRHO	-0.111 (P = .001; N = 970)	-0.190 (P < .001; N = 970)	-0.137 (P < .001; N = 969)	0.077 (P = .016; N = 972)	0.228 (P < .001; N = 979)
	2002	-0.243 (P < .001; N = 1614)	-0.262 (P < .001; N = 1611)	-0.171 (P < .001; N = 1599)	0.152 (P < .001; N = 1606)	0.307 (P < .001; N = 1621)
Openness to experience	PRHO	0.012 (P = .721; N = 956)	0.017 (P = .604; N = 955)	0.009 (P = .777; N = 954)	0.096 (P = .003; N = 957)	0.042 (P = .194; N = 964)
	2002	-0.046 (P = .066; N = 1611)	0.010 (P = .677; N = 1607)	-0.028 (P = .262; N = 1596)	0.127 (P < .001; N = 1603)	0.066 (P = .008; N = 1618)
Agreeableness	PRHO	-0.028 (P = .376; N = 970)	-0.062 (P = .055; N = 970)	-0.240 (P < .001; N = 969)	0.091 (P = .005; N = 972)	0.101 (P = .002; N = 979)
	2002	-0.080 (P = .001; N = 1615)	-0.094 (P < .001; N = 1611)	-0.322 (P < .001; N = 1600)	0.082 (P = .001; N = 1607)	0.135 (P < .001; N = 1622)
Conscientiousness	PRHO	-0.045 (P = .165; N = 971)	-0.088 (P = .006; N = 970)	-0.121 (P < .001; N = 969)	0.010 (P = .767; N = 972)	0.045 (P = .160; N = 979)
	2002	-0.196 (P < .001; N = 1610)	-0.129 (P < .001; N = 1606)	-0.165 (P < .001; N = 1595)	0.031 (P = .209; N = 1602)	0.162 (P < .001; N = 1617)

the scale [2,19]; further longitudinal data will be required to test that hypothesis). Study habits are temporally and causally prior to stress, approaches to work and workplace climate. Personality, being a trait, was prior to all other measures. For technical details see the **Supplementary Information** (see Additional file: 1). Although several of our variables are measured at different time points, we have chosen not to present a model in which each variable has been included on each occasion that it is measured, as the resulting diagram becomes unmanageably complex.

Although the path diagram in figure 2 is complex at first sight, the paths are readily interpretable. The diagram divides into two broad sections, with the measures of learning style and approach to work at the bottom, and stress at the top. Here we have simplified the model by omitting the closely correlated measures of burnout, and only including paths with t-values greater than 3.6.

Estimates of all the paths are available in the **Supplementary Information** (see Additional file: 1).

Stress in our model is caused by personality differences, being greatest in those having high neuroticism scores, low extraversion scores, and low conscientiousness scores. It is unrelated to learning style.

Learning styles at medical school relate to different personality measures, in particular showing no relationship to neuroticism. Deep learning is highest in extraverts who are open to experience, whereas strategic learning is highest in highly conscientious individuals with low openness to experience. Surface learning style is higher in introverts who are low in openness to experience. These findings are similar to those of others [22].

Approaches to work are mainly but not entirely driven by learning styles. A deep approach to work occurs in

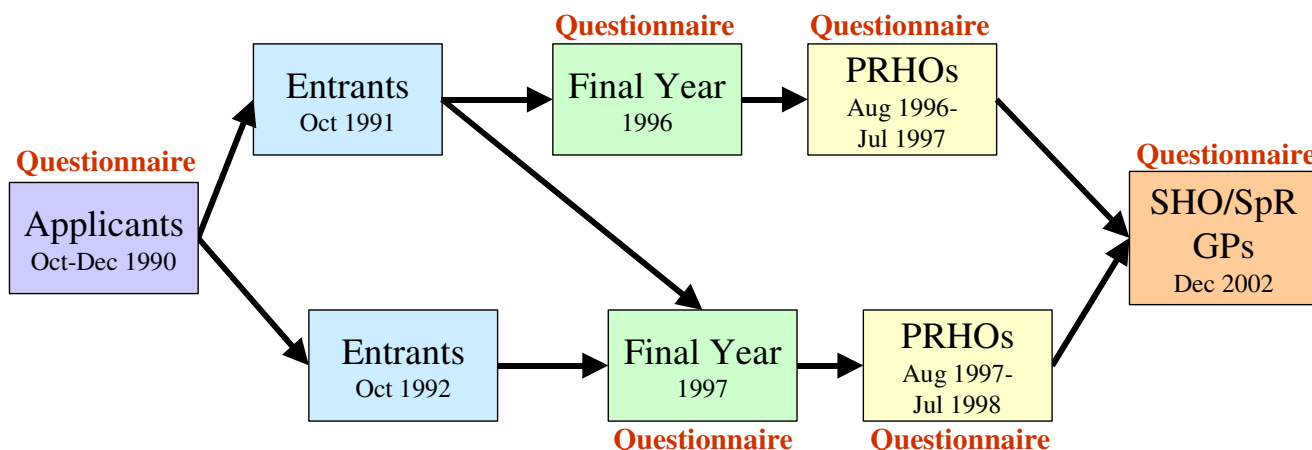


Figure 1

Diagram showing the timing of the various stages of the survey. Note that not all applicants entered in October 1991 (despite in most cases having applied to do so), and subsequent stages of the study therefore took place at different times. Some entrants also took a year longer because of taking an intercalated degree (represented by the diagonal arrow from entrants in Oct 1991 to Final year in 1997), and a few other students delayed for other reasons. All doctors were surveyed at the end of their PRHO year, whenever that had occurred. The cohort was finally brought back into step as a single cohort with the 2002 follow-up when all doctors were studied at the same time, irrespective of the time at which they qualified. Questionnaires were given out at all the boxes shown (with the exception of a questionnaire to Entrants, who are shown merely to make the flow clearer). It should also be noted that there was a follow-up of a subset of the students in their third academic year, which is not shown here because the data are not discussed in this study.

extraverts who are open to experience and have a deep learning style. The surface-rational and surface-disorganised approaches to work are both greater in those with a surface learning style. However, a surface-disorganised approach occurs in individuals with higher neuroticism scores, in those with lower conscientiousness scores, and in those who have been stressed, whereas the surface-rational approach to work occurs in strategic learners and in those who are low in openness to experience.

Workplace climate has a range of influences. High perceived workload occurs in those with a surface-disorganised approach to work, who have been stressed and are more neurotic. In contrast, choice-independence and a supportive-receptive environment both occur in individuals who have not previously been stressed, the choice-independence approach occurring in those with a deep approach to work, whereas the supportive-receptive approach occurs in those who have higher scores on the personality trait of agreeableness.

Discussion

Many doctors at the age of 30 are unhappy in their jobs, and a fifth of our sample reached the conventional GHQ criterion of psychiatric 'caseness'. In contrast, many doc-

tors reported high levels of personal accomplishment, choice and independence in their work environment, satisfaction with medicine as a career, and intellectual and emotional satisfaction from their work. That is not new; Sir William Osler in 1905 contrasted doctors "whose stability of character and devotion to duty make one proud of our profession" with those who find it difficult to keep "the flame alive, smothered as it is apt to be by the dust and ashes of the daily routine" [1].

In 2001, Richard Smith asked "Why are doctors so unhappy?" and concluded that "The most obvious cause of doctors' unhappiness is that they feel overworked and undersupported" [23]. Certainly many doctors in our study report a high workload and a work climate that is neither supportive nor receptive, and those doctors also report more stress, burnout and dissatisfaction with medicine as a career. It is tempting therefore to conclude, as did an article in a special edition of *BMJ Careers* devoted to "Doctors' Wellbeing", that excessive workload and absence of support are directly caused by poor working conditions: "the way in which the NHS is run generates stress for members of the workforce every day" [24]. However, such an interpretation is not straightforward in general [25]. It is particularly difficult for the doctors in our

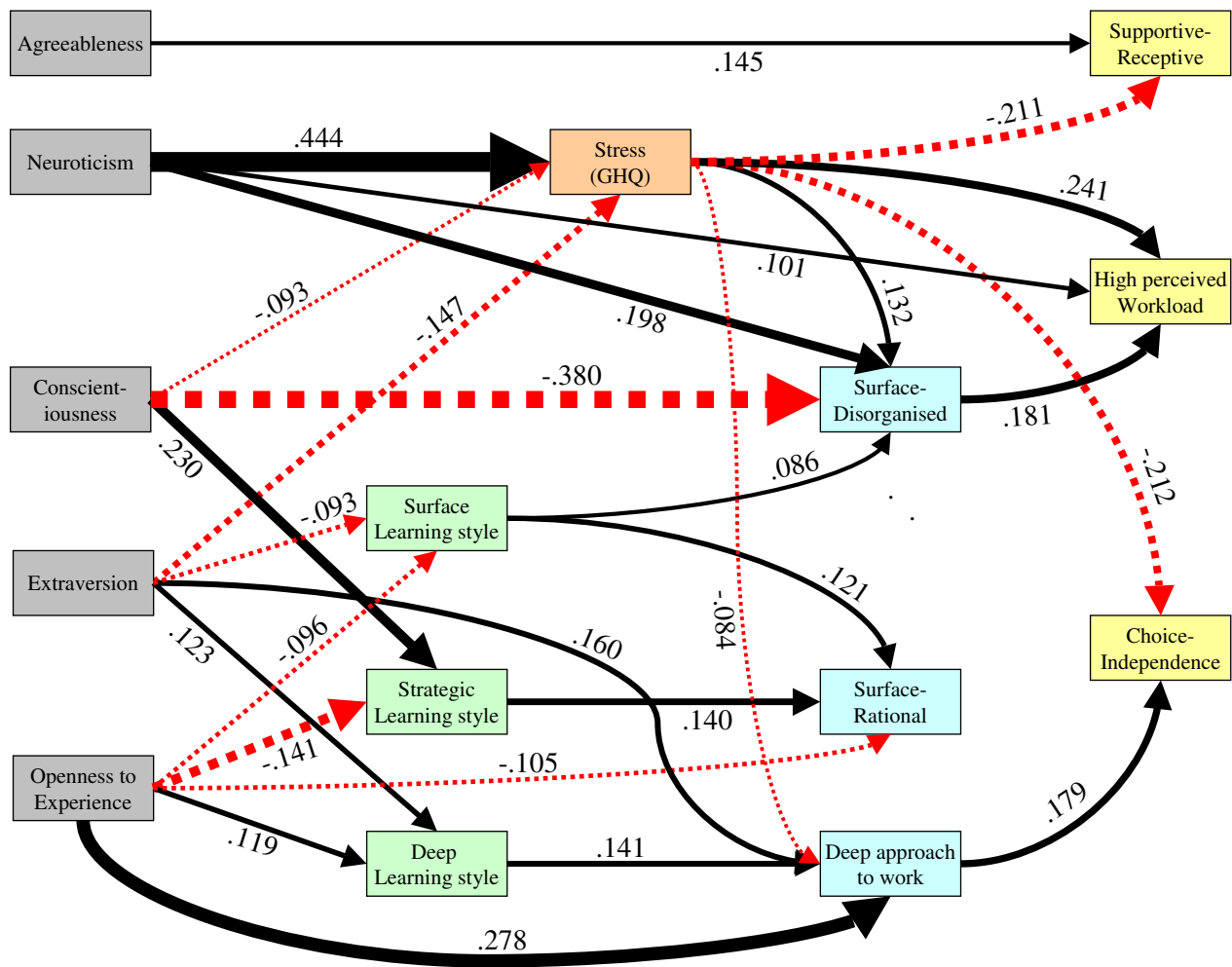


Figure 2
 Path diagram showing the relationships among the measures of personality, learning style, stress, approaches to work, and workplace climate. The width of arrows is proportional to the strength of an effect, which is shown alongside each line as a path (beta) coefficient. Negative effects are shown as red, dashed lines. For details of the statistical method and a fuller model incorporating all links, see **Supplementary Information**.

study because the study is longitudinal, and workload and lack of support correlate with stress and burnout reported five or six years earlier, when the doctors were PRHOs and carrying out entirely different jobs. High perceived workload and poor support are therefore determined as much by doctors themselves as by specific working conditions. That view was expressed in another article in the special edition of *BMJ Careers*: "A critical element contributing to the stress that many conscientious doctors experience is internal..." [26]. A similar conclusion was reached in a previous study of ours when these doctors were PRHOs, and multi-level modelling showed that stress is not a characteristic of jobs but of doctors, different doctors working

in the same job being no more similar in their stress and burnout than different doctors in different jobs [11].

If differences in reported workload are partly explained by differences among doctors, what in turn explains those differences? Doctors reporting a high workload also have what Delva *et al* [2] describe as a *surface-disorganised* approach to work, which in turn is correlated with being a surface learner at application to medical school, a dozen years previously. Surface-disorganised doctors are also high on the personality trait of neuroticism and low on the trait of conscientiousness; and again those correlations are with measures taken six years earlier when the doctors were PRHOs. Doctors reporting a work climate

low in support were lower on the personality scale of agreeableness in the measures collected when they were PRHOs.

Some doctors may be stressed and burned out, but what predicts those others who are happy in their work? Doctors reporting high satisfaction with medicine as a career have a deep approach to work, and that approach is more common in those who also had a deep learning style when they applied to medical school. Satisfaction with medicine also relates directly to the personality traits of greater extraversion and lower neuroticism, and the deep approach to work correlates with greater extraversion and more openness to experience. Doctors who describe their colleagues as receptive and supportive score more highly on the personality trait of agreeableness; and as in many other correlations reported here, that correlation is stable across time – those who are more agreeable at the age of 24 have a more receptive and supportive work environment when aged 30.

An overview of our findings is that approaches to work are predicted by earlier measures of study habits and learning styles, whereas perceived work climate, and its pathologies such as stress and burnout, are predicted mainly by personality. Although unfortunately our study did not measure personality during selection, the high stability of the Big Five measures across the life-span [27-29] (and across our two measures six years apart), as well as their heritable component [30], means that we have little doubt that personality at selection would also have been predictive, particularly given that a similar pattern of correlations was found in a different cohort of doctors in mid-career [15]. Other studies on very different groups of students have also found, like us, that both strategic and deep learning correlate with conscientiousness, and that deep learning also correlates with extraversion and openness to experience [22,31]. Our study has, for various reasons, not looked at academic performance in relation to study habits, learning styles and personality, although previous work of ours has found clear correlations between learning styles and examination performance [32]. In contrast we have not found any correlation of undergraduate or postgraduate academic achievement with personality [15], and although some studies have found correlations of conscientiousness with academic achievement [33], this does seem to vary according to the learning context [34,35]. Although we will be looking at this question again in more detail in a further analysis, it does seem probable that personality mostly has an indirect effect upon academic achievement via approaches to learning [31,36].

If, as William Wordsworth said, "the child is father to the man", then the seeds of subsequent job satisfaction and

dissatisfaction in doctors may be visible in the personality, motivations and learning styles of medical school applicants. This argument may provide some justification for using such measures in selection, particularly given the general association of job performance and satisfaction with personality [37] and motivation [38], and learning styles with personality [22].

However, just as genes are not destiny, so neither personality nor learning style is destiny. Nurture interacts with nature [39], the environment building upon the genes, and the genes using what is provided by the environment; the poetic complement to William Wordsworth is therefore Alexander Pope, who said, "This education forms the common mind: Just as the twig is bent, the tree's inclined." Extreme introverts can, with sufficient insight, preparation and appropriate training become effective public speakers, less conscientious individuals can learn to be more organised and efficient, and those who are more neurotic can transcend their anxieties (and indeed neuroticism may be beneficial if sublimated into a professional concern for detail in critical situations, rather than merely being undifferentiated personal anxiety).

Formal education, particularly effective formal education [40], can also alter study habits and learning styles, which are less fixed and 'trait-like' than personality measures [17]. Intercalated degrees increase deep and strategic learning and decrease surface learning at medical school [41], making it likely that they also encourage surface-rational and deep approaches to work. Deep and strategic learning also relate to the clinical experience gained by medical students [32], making it possible that greater patient involvement during undergraduate clinical training, rather than mere reliance on textbook learning to pass exams, a characteristic of surface learners, will also reduce surface-disorganised approaches to work.

Conclusions

Longitudinal data suggest that personality and learning style are not merely *correlates* of approaches to work, workplace climate, stress, burnout and satisfaction with a medical career, but are *causes*, events later in time being predicted by events earlier in time [35]. Doctors with greater stress and emotional exhaustion, who were less satisfied with medicine as a career, had higher neuroticism scores and were more likely to be surface-disorganised. Lower conscientiousness on the personality measure also predicted greater stress. Extraverts reported more personal accomplishment and were more satisfied with medicine. The personality measure of agreeableness predicted a more supportive-receptive work environment.

These results imply that differences in approach to work and workplace climate in our study result from differences

among doctors themselves, as much as they do from differences in working conditions.

Competing interests

None declared.

Authors' contributions

The cohort study was designed by ICMcM. The present follow-up was designed by ICMcM and EP, who also prepared the questionnaire. AK was responsible for day-to-day running of the study, and for data entry and cleaning. ICMcM was primarily responsible for data analysis and for writing the first draft of the paper. ICMcM, EP and AK were all involved in preparing the final draft of the paper.

Additional material

Additional file 1

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Acknowledgments

We thank the many doctors who have participated in this study over the past twelve years. We are also grateful to the three reviewers for their very helpful suggestions. This follow-up of the 1991 cohort was funded by the London Deanery. The survey of applicants was funded by the Leverhulme Trust and the Department of Health, follow-ups during medical school were funded by the Nuffield Foundation and the Department of Health, and the PRHO follow-up was funded by North Thames Postgraduate Medical and Dental Education.

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Pre-publication history

The pre-publication history for this paper can be accessed here:

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Supplementary material

The abbreviated Approaches to Work Questionnaire (aAWQ).

The Approaches to Work Questionnaire described by Delva *et al* [1] had a total of thirty questions, ten on each of the three sub-scales. Based on their factor analysis [2] we reduced the scale to twelve items, four on each of the three scales. Table 1 shows the questions in the order in which they were presented. Factor analysis was carried out (principle component analysis followed by Varimax rotation). Three factors were extracted, that number being supported by a scree-slope analysis, the eigen-values being 2.068, 1.739, 1.532, 1.021, .891, .810, .787, .717, .668, .609, .596, and .562. The table shows the loadings on the three factors; absolute loadings less than 0.2 have been omitted for clarity. The pattern of loadings corresponds well with those described by Delva *et al* [1,2].

Table 1: Loadings of the twelve items of the aAWQ on the three factors.

	Factor 1: “Deep”	Factor 2: “Surface disorganised”	Factor 3: “Surface rational”
<i>i.</i> At work I find it difficult to organise my time effectively		.715	
<i>ii.</i> I find that studying new things can often be really exciting	.640	-.216	
<i>iii.</i> When I have something to do at work, I like to know precisely what is expected			.679
<i>iv.</i> Some of the issues that crop up at work are so interesting that I pursue them though they are not part of my job	.751		
<i>v.</i> My habit of putting off work leaves me with far too much catching up to do		.718	
<i>vi.</i> I prefer the work I am doing to be clearly structured			.688
<i>vii.</i> I like to play around with ideas of my own even if they don’t get me very far	.608		-.229
<i>viii.</i> Although I generally remember facts and details, I find it difficult to fit them together into an overall picture		.613	
<i>ix.</i> I think it’s important to look at problems rationally and logically without making intuitive jumps			.538
<i>x.</i> I spend a good deal of my spare time learning about things related to my work	.646		
<i>xi.</i> Often I have to read things without having a chance to really understand them		.544	.231
<i>xii.</i> When I learn something new at work I put a lot of effort into memorising important facts	.293		.485

The rubric for the questions said, “How well do the following statements describe your work style?”, and the answer columns were headed Definitely disagree, Somewhat disagree, Somewhat agree, and Definitely agree, which were scored 1, 2,3 and 4 respectively. No items were reverse scored. Questions are in the order in which they were used in the questionnaire. Deep approach is scored as the sum of items 2, 4, 7 and 10. Surface-disorganised approach is the sum of items 1,5,8 and 11. Surface-rational approach is the sum of items 3,6,9 and 12. All scores must be in the range 4 to 16. For the 2002 cohort, the means (standard deviation; range) of the scores are: Deep: 11.14 (1.97; 5-16); Surface-disorganised: 8.09 (2.02; 4-14); Surface-rational 11.47 (1.72; 5-16). Distributions of scores are shown in figure 1. The alpha reliability coefficients of the scales are .584 (Deep), .469 (Surface-Rational), and .564 (Surface-Disorganised). For scales based on ten items, Delva *et al* reported values of .68, .74 and .63.

The abbreviated Workplace Climate Questionnaire (aWCQ).

The Workplace Climate Questionnaire described by Delva *et al* [1] had a total of thirty questions, ten on each of the three sub-scales. Based on their factor analysis [2] we reduced the scale to nine items, three on each of the three scales. Table 2 shows the questions in the order in which they were presented. Factor analysis was carried out (principle component analysis followed by Varimax rotation). Three factors were extracted, that number being supported by a scree-slope analysis, the eigen-values being 2.847, 1.636, 1.192, .757, .742, .693, .528, .356 and .248. The table shows the loadings on the three factors; absolute loadings less than 0.2 have been omitted for clarity. The pattern of loadings corresponds well with those described by Delva *et al* [1,2].

Table 2:

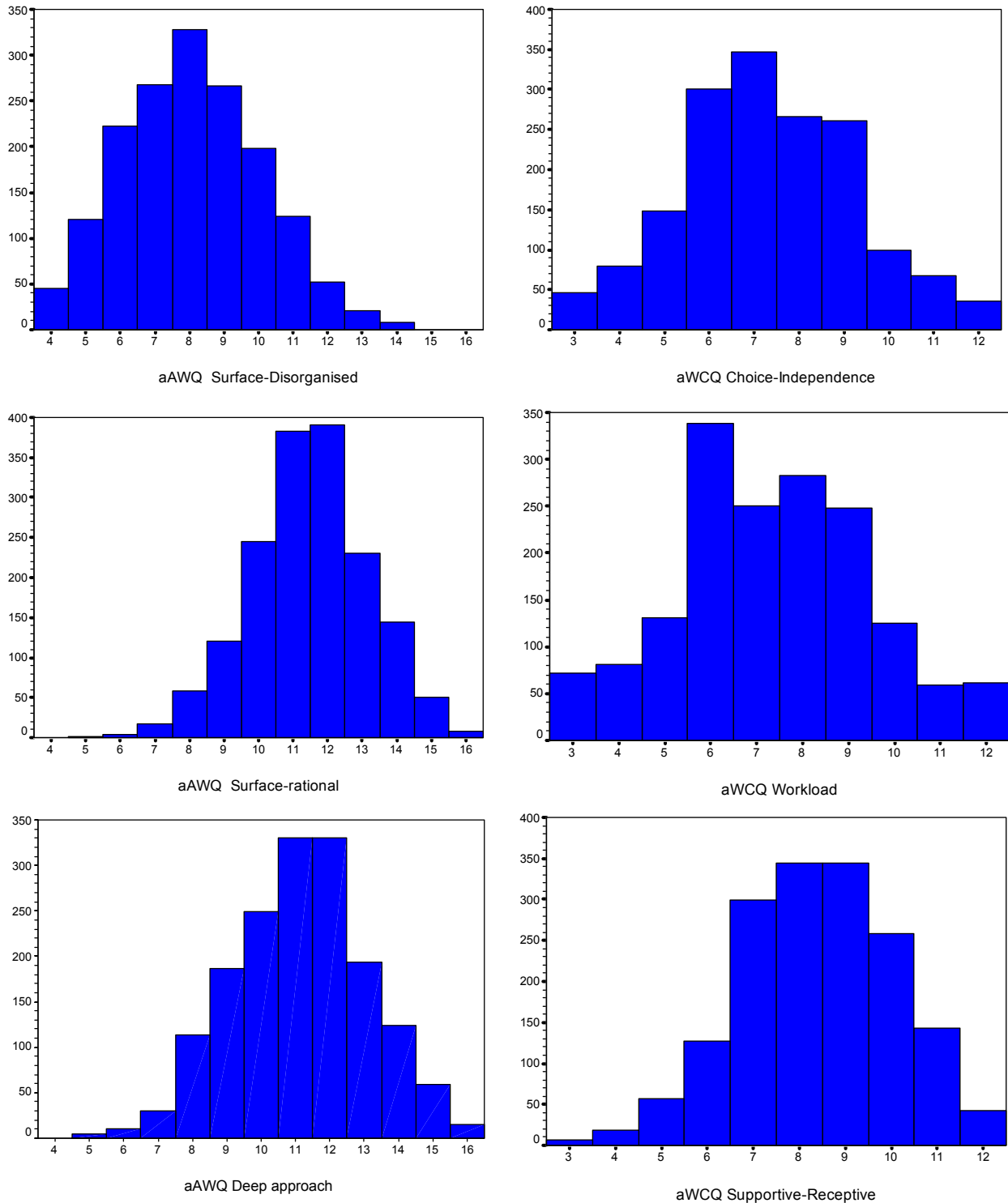
	Factor 1: "Choice- Independence"	Factor 2: "Workload "	Factor 3: "Supportive- Receptive"
<i>xiii.</i> There is a real opportunity in my job for me to choose the particular things I work on	.798		
<i>xiv.</i> My work colleagues really try hard to get to know one another			.778
<i>xv.</i> My work load is too heavy	-.237	.825	
<i>xvi.</i> I have a lot of choice about the work I do	.862		
<i>xvii.</i> The non-medical people I work with make a real effort to understand the difficulties doctors have with their work	.251		.600
<i>xviii.</i> My job requires me to do too many different things		.702	
<i>xix.</i> I pretty much decide how to do my work	.672		
<i>xx.</i> My coworkers are supportive and friendly towards me			.784
<i>xxi.</i> There seems to be too much work to get through in my job		.884	

The rubric for the questions said, "How well do the following statements describe your work style?", and the answer columns were headed Definitely disagree, Somewhat disagree, Somewhat agree, and Definitely agree, which were scored 1, 2, 3 and 4 respectively. No items were reverse scored. Questions are in the order in which they were used in the questionnaire, where they followed the twelve questions of the aAWQ. Choice-independence is scored as the sum of items 13, 16 and 19. Workload is the sum of items 15, 18 and 21. Supportive-receptive is the sum of items 14, 17 and 20. All scores must be in the range 3 to 12. For the 2002 cohort, the means (standard deviation; range) of the scores are: Choice-Independence: 7.31 (1.96; 3-12); Workload: 7.34 (2.12; 3-12); Supportive-Receptive 8.38 (1.72; 3-12). Distributions of scores are shown in figure 1. The alpha reliability coefficients of the scales are .725 (Choice-Independence), .744 (Workload), and .571 (Supportive-Receptive). For scales based on ten items, Delva *et al* reported values of .68, .70 and .56.

Distributions of scores on the aAWQ and aWCQ.

The histograms show the distributions of scores on the three sub-scales of the aAWQ and the aWCQ. The aAWQ has scores in the range 4 to 16, whereas the aWCQ has scores in the range 3 to 12.

Figure 1: Distributions of abbreviated Approach to Work Questionnaire and abbreviated Workplace Climate Questionnaire.



Response bias

The response rate in the present study was 63%, raising the possibility that those who responded to the survey were systematically different in important ways from those who did not respond. We investigated that possibility by comparing respondents and non-respondents in their responses to questions asked in previous surveys.

Of 2623 doctors sent questionnaires in the 2002 follow-up, 2501 (95.3%) had returned questionnaires in the survey of medical student selection in 1990, and of these 1615 (64.6%) returned the 2002 questionnaire, and 886 (35.4%) did not. Table 3 compares these groups on measures of study habits. Respondents had somewhat lower scores on all three measures, with the largest difference being on the measure of deep learning.

Table 3:

Measures at application in 1990 (mean (SD;N))	Respondents in 2002	Non-Respondents in 2002	Significance
Surface Learning	13.03 (3.62; 1605)	13.33 (3.91; 881)	t=1.96, 2484 df, p=0.050
Strategic Learning	22.71 (4.22; 1605)	23.14 (4.18; 881)	t=2.43, 2484 df, p=.015
Deep Learning	20.90 (4.15; 1605)	21.67 (4.39; 1605)	t=4.34, 2484 df, p<.001

Not all students had taken part in the final year follow-up study (in 1995 and 1996). Of the 1325 who returned the final year survey, 1019 (76.9%) had also returned the 2002 survey, and 306 (23.1%) had not. Table 4 compares these groups on measures of study habits. There were no significant differences between respondents and non-respondents.

Table 4:

Measures in final survey in 1995/6 (mean (SD;N))	Respondents in 2002	Non-Respondents in 2002	Significance
Surface Learning	14.00 (3.74; 1009)	14.13 (4.01; 304)	t=0.55, 1311 df, p=0.138
Strategic Learning	15.26 (5.01; 1009)	15.01 (5.05; 304)	t= -.766, 1311 df, p=.444
Deep Learning	18.34 (4.33; 1009)	18.68 (4.70; 304)	t=1.16, 1311 df, p=.245

1293 doctors who had replied to the questionnaire survey in 1996/1997 of PRHOs were sent the 2002 questionnaire, and of these 1007 (77.9%) replied and 286 (22.1%) did not. Table 5 compares the two groups in terms of stress, burnout and the five personality dimensions as measured at the time of the PRHO survey. None of the measures showed any significant differences.

Table 5:

Measures in PRHO survey in 1996/7 (mean (SD;N))	Respondents in 2002	Non-Respondents in 2002	Significance
GHQ score	12.49 (5.53; 982)	12.07 (5.31; 270)	t= -1.13, 1250 df, p=.268
Emotional exhaustion (aMBI)	10.92 (2.93;982)	11.15 (2.91; 270)	t= 1.02, 1250 df, p=.308
Depersonalisation (aMBI)	10.29 (3.37;982)	10.65 (3.22; 270)	t= 1.26, 1250 df, p=.209
Personal accomplishment (aMBI)	13.07 (2.61; 946)	13.21 (2.65; 258)	t= .76, 1202 df p=.450
Neuroticism	8.87 (2.25; 1001)	8.88 (2.20; 280)	t= .082, 1279 df p=.935
Extraversion	10.57 (1.89; 999)	10.58 (1.85; 282)	t= .075, 1279 df p=.941
Openness to experience	12.23 (2.36; 983)	12.35 (2.42; 279)	t= .705, 1260 df p=.481
Agreeableness	14.67 (1.62; 999)	14.57 (1.63; 279)	t= -.954, 1276 df p=.340
Conscientiousness	13.74 (1.79; 999)	13.66 (1.80; 282)	t= -.708, 1279 df p=.479

Taken overall there is very little suggestion of response bias, with the exception that respondents in 2002 had slightly lower deep learning scores at application than did non-respondents. Such a difference is unlikely to have any impact on the conclusions reached in the main paper, not least because the analyses are correlational, rather than comparing means of groups.

Multiple regression analyses.

The various correlations in main text tables 4 to 6 are not always straightforward to interpret, not only because of their number, but because many of the variables which one wishes to treat as 'independent variables' are themselves correlated, as are the variables which one is interested in as dependent variables. Multiple regression was used to clarify the relationships. One at time, each of the three measures of the aAWQ and aWCQ was used as the dependent variable, and the other five measures in the set used as dependent variables were then entered into the equation, to remove any effects due the correlation between the measures themselves. Forward entry regression was then used to find those independent variables which predicted that dependent variable, from the measures of study habits at application (n=3) and in the final year (n=3), of stress and burnout during the PRHO year (n=4) and in 2002 (n=4), and of personality in the PRHO year (n=5) and in 2002 (5). In view of the large sample size and the number of variables, and the desire to find the most important relationships, the entry criterion was set at $p < .0001$. Variables which are significant using this method are shaded in main text tables 4, 5 and 6. Since the particular emphasis was on correlations across time, variables are only described in the main text if the contemporaneous correlation is significant, and also the time-lagged correlation between a measure in 2002 and a measure at a previous time point is significant.

The surface-disorganised approach to work was predicted by surface learning at application to medical school ($\beta = .076$, $t=3.76$), by lower conscientiousness (independent effects when measured in the PRHO year ($\beta = -.140$, $t=-6.70$) and in 2002 ($\beta = -.392$, $t=18.17$)), and by greater neuroticism ($\beta = .205$, $t=9.51$). The surface-rational approach was predicted by strategic learning at application ($\beta = .161$, $t=6.59$), by higher conscientiousness ($\beta = .114$, $t=4.13$), and by lower openness to experience ($\beta = -.131$, $t= -5.14$). A deep approach to work was predicted by deep learning at application to medical school ($\beta = .117$; $t=5.32$), by higher openness to experience ($\beta = .301$; $t=13.26$), by higher extraversion ($\beta = .171$, $t=7.28$), and by less emotional exhaustion ($\beta = -.103$, $t= -4.18$). Approaches to work are therefore predicted mainly by previous study habits and by personality measures, particularly conscientiousness and openness to experience. In contrast, workplace climate measures are predicted mainly by measures of stress and burnout. A high perceived workload is predicted by greater emotional exhaustion ($\beta = .286$, $t=11.94$) and by a high GHQ score ($\beta = .173$, $t=7.03$), and by lower openness to experience ($\beta = -.091$, $t= -3.92$). A more supportive-receptive environment is predicted by higher personal accomplishment ($\beta = .157$, $t=6.87$), by lower depersonalisation ($\beta = -.127$, $t= -5.26$), and by a lower GHQ score ($\beta = -.119$, $t= -4.75$), as well as by higher agreeableness ($\beta = .099$, $t=4.36$). Choice-independence is predicted only by a lower GHQ score ($\beta = -.125$, $t= -5.04$).

As well as being treated as predictor variables in the previous paragraph, the measures of stress and burnout were also treated as dependent variables in their own right. Each of the five 'stress' measures was used in turn as dependent variable, and the other four stress measures entered into the analysis to remove any effect due to correlations between the set of dependent variables. Forward entry regression was then used to find predictors of the dependent variable, from the background measures of study habits at application (3) and in the final year (3) and personality in the PRHO year (5) and in 2002 (5). The entry criterion was set at $p < .0001$.

Stress, as measured by the GHQ, was predicted by higher neuroticism ($\beta = .321$, $t=13.92$), and by lower conscientiousness ($\beta = -.088$, $t= -4.12$). Emotional exhaustion was predicted by higher neuroticism ($\beta = .105$, $t= -4.96$) and introversion ($\beta = -.131$, $t= -6.69$), and the inverse pattern was showed by satisfaction with medicine as a career, which was predicted by lower neuroticism ($\beta = -.108$, $t= -4.49$) and extraversion ($\beta = .096$, $t=4.30$). Depersonalisation was predicted by low scores on the personality trait of agreeableness ($\beta = -.261$, $t= -12.48$), and a higher sense of personal accomplishment was predicted by extraversion ($\beta = .176$, $t=7.59$) and a higher deep learning score ($\beta = .093$, $t=4.26$). In all but one case, when a variable was a significant

predictor there was also a highly significant prediction in the same measure on an earlier occasion.

It should be noticed that in all of the above analyses, the correlations reported are particularly ‘pure’ in the sense that although normally measures of stress, and the burnout subscales are inter-correlated, the analysis means that, say, any component of stress, emotional exhaustion, personal accomplishment and satisfaction with medicine as a career has been removed from the measure of depersonalisation. It is for that reason that depersonalisation only relates to agreeableness, the simple correlations with neuroticism, extraversion and conscientiousness being shared with other aspects of stress and burnout.

Structural Equation Modelling

Structural equation modelling (SEM) was carried out with the four stress variables (GHQ, and the three burnout measures) represented only by the single GHQ measure, since it correlates highly with the other three measures. That is the version of the model presented in the main paper. However data for the three burnout measures are also presented in the correlation matrix at the end of the Supplementary Information for readers who are interested in reworking a more complex model.

Causal ordering. The causal ordering of variables in path analysis is always potentially controversial. As is conventional in the SEM literature, the program and the correlation matrix are therefore presented below, so that those interested can rework the model using different assumptions. Causal ordering, the principles of which are described elsewhere [3-6], relies on a mixture of temporal ordering, logical necessity, and theoretical understanding, particularly when that understanding is based in previous empirical research. In the present case, there is general agreement in the literature that the majority of personality variance is stable across the life-span, and hence the five personality measures are placed prior to other variables. Learning style measures follow, both because they are temporally early, being assessed during medical school, and because they also have moderate long-term stability; they follow personality, because it seems more reasonable to propose that personality determines learning style rather than vice-versa. The measures of work environment are placed late in the causal hierarchy, both because they are temporally late, employment occurring after training, and because they are known to correlate with personality and learning style measures assessed far earlier in time, and hence are probably caused by those earlier variables. Approaches to Work are assumed to have more long-term stability than Workplace Climate, and hence Climate is placed after Approaches to work. Stress has been measured on two separate occasions in our study, and previous stress in the PRHO year correlates with subsequent measures of Workplace Climate and Workplace Learning suggesting that a stress response causes Workplace measures, rather than vice-versa. We have therefore placed Stress before the Workplace measures.

Variables. Although a number of variables have been measured on two separate occasions, including both measures would unduly complicate the presentation of the model (which is already complex enough as it is). We have therefore chosen to reduce our several measures of personality, learning style and stress/burnout, to a single measure. For most subjects we have averaged the two separate variables which assess each measure. If subjects provided only one measure, because of questionnaire non-response, then that measure was used as the estimate of personality, learning style or stress. Missing values otherwise were handled by mean substitution. The full correlation matrix is shown at the end of the supplementary information.

The LISREL program. The raw data are represented in LISREL as Y variables, the directed, causal effects are placed in the *beta* (**B**) matrix, and the undirected synchronous correlations between variables measured at the same time are placed in the *psi* (**Ψ**) matrix. The *lambda* (**Λ**) matrix is a

fixed, identity matrix, and the error matrix, *theta-epsilon* (Θ_ϵ) is diagonal and free. The data analysed consist of the correlation matrix, and hence the diagonals of the *psi* matrix are fixed at one. Model fitting proceed by beginning with a fully saturated model in which all off-diagonal, synchronous correlations in the *psi* matrix were free, and the *beta* matrix was saturated in the sense that all variables to the left could have a causal influence on all other variables to the right. Non-significant *beta* paths were then removed from the model sequentially, removing the least significant first, and re-estimating the model. In the final model all *beta* paths included in the model were significant with $p < .05$ ($|t| > 1.96$). That non-included *beta* paths were indeed non-significant was confirmed by individually re-entering into the model each of those with high modification indices. The program shown below is that which was used for the final fitted model as described in the main paper. Abbreviations of variable names are shown at the end of **the Supplementary Information**.

```
McManus et al, Stress Burnout and Approaches to Work - simplified model
DA NI=18 NO=1660 ma=km
[Insert instructions here to read the correlation matrix]
la
NEUR EXTRA OPEN AGREE CONSC SURF STRT DEEP STRESS EE DP PA AWQDeep AWQSR
AWQSD WCQCI WCQWL WCQSR
se
NEUR EXTRA OPEN AGREE CONSC SURF STRT DEEP STRESS AWQDeep AWQSR AWQSD
WCQCI WCQWL WCQSR /
MO NY=15 ps=sy,fr te=ze be=fu,fr
awdeep awsrat awsdisc cind wload supprec /
MO NY=15 ps=sy,fr te=ze be=fu,fr
pa ps
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0 0 0 1 0 0 0 0 1 1 1 0 0 0 0
OU me=m1 MI RS EF MR SS SC nd=3
```

The table of *beta* coefficients below shows *all* paths which were significant with $p < .05$. However for simplicity, the path diagram shown in the main paper includes only those paths which have $|t| > 3.6$ (equivalent to $p \approx .0005$). Those interested in other non-drawn paths may find them in the table below. For parameters included in the model, LISREL displays firstly the parameter estimate, then the standard error in parentheses, and finally the t-statistic (which for all intents and purposes is equivalent to a z statistic, given the large sample size).

PSI		NEUR	EXTRA	OPEN	AGREE	CONSC	SURF
	-----	-----	-----	-----	-----	-----	-----
NEUR	1.000 (0.035) 28.801						
EXTRA	-0.267 (0.025) -10.507	1.000 (0.035) 28.801					
OPEN	-0.029 (0.025) -1.181	0.214 (0.025) 8.523	1.000 (0.035) 28.801				
AGREE	-0.101 (0.025) -4.093	0.123 (0.025) 4.972	0.096 (0.025) 3.892	1.000 (0.035) 28.801			
CONSC	-0.120 (0.025) -4.853	0.177 (0.025) 7.099	0.020 (0.025) 0.814	0.193 (0.025) 7.719	1.000 (0.035) 28.801		
SURF	- -	- -	- -	- -	- -	0.973 (0.034) 28.801	
STRT	- -	- -	- -	- -	- -	0.085 (0.023) 3.651	
DEEP	- -	- -	- -	- -	- -	-0.181 (0.024) -7.513	
STRESS	- -	- -	- -	- -	- -	- -	
AWQDeep	- -	- -	- -	- -	- -	- -	
AWQSR	- -	- -	- -	- -	- -	- -	
AWQSD	- -	- -	- -	- -	- -	- -	
WCQCI	- -	- -	- -	- -	- -	- -	
WCQWL	- -	- -	- -	- -	- -	- -	
WCQSR	- -	- -	- -	- -	- -	- -	

PSI		STRT	DEEP	STRESS	AWQDeep	AWQSR	AWQSD
	-----	-----	-----	-----	-----	-----	-----
STRT	0.927 (0.032) 28.801						
DEEP	0.398 (0.025) 15.885	0.955 (0.033) 28.801					
STRESS	- -	- -	0.730 (0.025) 28.801				
AWQDeep	- -	- -	- -	0.818 (0.028) 28.801			
AWQSR	- -	- -	- -	0.099 (0.022) 4.587	0.928 (0.032) 28.801		
AWQSD	- -	- -	- -	0.019 (0.019) 0.983	0.054 (0.020) 2.684	0.718 (0.025) 28.801	
WCQCI	- -	- -	- -	- -	- -	- -	
WCQWL	- -	- -	- -	- -	- -	- -	
WCQSR	- -	- -	- -	- -	- -	- -	

PSI	WCQCI	WCQWL	WCQSR
WCQCI	0.913 (0.032) 28.801		
WCQWL	-0.139 (0.022) -6.376	0.844 (0.029) 28.801	
WCQSR	0.280 (0.024) 11.919	-0.082 (0.022) -3.795	0.920 (0.032) 28.801

LISREL provides a wide range of Goodness of Fit statistics for models, which are shown below. Although the chi-square statistic itself just reaches significance (64.85, 43 df, $p=0.0172$), that is hardly surprising given the large sample size. Probably the most useful measures of the success of the model are that the Goodness of Fit Index (GFI) = 0.995 and the Adjusted Goodness of Fit Index (AGFI) = 0.986. Other measures of fit are shown below:

Degrees of Freedom = 43
 Minimum Fit Function Chi-Square = 64.855 (P = 0.0172)
 Normal Theory Weighted Least Squares Chi-Square = 64.450 (P = 0.0187)
 Estimated Non-centrality Parameter (NCP) = 21.450
 90 Percent Confidence Interval for NCP = (3.780 ; 47.082)

Minimum Fit Function Value = 0.0391
 Population Discrepancy Function Value (F0) = 0.0129
 90 Percent Confidence Interval for F0 = (0.00228 ; 0.0284)
 Root Mean Square Error of Approximation (RMSEA) = 0.0173
 90 Percent Confidence Interval for RMSEA = (0.00728 ; 0.0257)
 P-Value for Test of Close Fit (RMSEA < 0.05) = 1.00

Expected Cross-Validation Index (ECVI) = 0.132
 90 Percent Confidence Interval for ECVI = (0.121 ; 0.147)
 ECVI for Saturated Model = 0.145
 ECVI for Independence Model = 2.654
 Chi-Square for Independence Model with 105 Degrees of Freedom = 4373.235
 Independence AIC = 4403.235
 Model AIC = 218.450
 Saturated AIC = 240.000
 Independence CAIC = 4499.454
 Model CAIC = 712.372
 Saturated CAIC = 1009.749
 Normed Fit Index (NFI) = 0.985
 Non-Normed Fit Index (NNFI) = 0.987
 Parsimony Normed Fit Index (PNFI) = 0.403
 Comparative Fit Index (CFI) = 0.995
 Incremental Fit Index (IFI) = 0.995
 Relative Fit Index (RFI) = 0.964

Critical N (CN) = 1726.640
 Root Mean Square Residual (RMR) = 0.0169
 Standardized RMR = 0.0169
 Goodness of Fit Index (GFI) = 0.995
 Adjusted Goodness of Fit Index (AGFI) = 0.986
 Parsimony Goodness of Fit Index (PGFI) = 0.356

R² values. The *R²* values for the variables in the structural model are shown below, and correspond to the proportion of the variance in each measure which is explained by the model.

Squared Multiple Correlations for Structural Equations					
NEUR	EXTRA	OPEN	AGREE	CONSC	SURF
---	---	---	---	---	0.027
STRT	DEEP	STRESS	AWQDeep	AWQSR	AWQSD
---	---	---	---	---	---
0.075	0.044	0.269	0.184	0.073	0.280
WCQCI	WCQWL	WCQSR			
---	---	---			
0.088	0.154	0.081			

Correlation matrix. The complete correlation matrix used for the LISREL analyses is shown below. It includes the three measures of burnout which were excluded from the simplified model presented in the main paper. Abbreviations are shown at the end of the Supplementary Information.

	NEUR	EXTRA	OPEN	AGREE	CONSC	SURF	STRT	DEEP	STRESS	EE	DP	PA	AWQDeep	AWQSR	AWQSD	WCQCI	WCQWL	WCQSR	
NEUR	1.000	-0.267	-0.029	-0.101	-0.120	0.048	-0.013	-0.001	0.489	0.404	0.230	0.038	-0.110	0.017	0.314	-0.135	0.271	-0.150	
EXTRA	-0.267	1.000	0.214	0.123	0.177	-0.120	0.068	0.161	-0.268	-0.278	-0.216	0.212	0.269	0.052	-0.167	0.099	-0.157	0.137	
OPEN	-0.029	0.214	1.000	0.096	0.020	-0.121	-0.127	0.147	-0.009	0.040	0.035	0.171	0.325	-0.115	-0.052	0.065	-0.069	0.031	
AGREE	-0.101	0.123	0.096	1.000	0.193	-0.075	-0.005	0.049	-0.028	-0.082	-0.284	0.148	0.022	0.068	-0.078	0.017	-0.034	0.159	
CONSC	-0.120	0.177	0.020	0.193	1.000	-0.062	0.226	0.103	-0.158	-0.113	-0.130	0.111	0.104	0.106	-0.434	0.087	-0.055	0.078	
SURF	0.048	-0.120	-0.121	-0.075	-0.062	1.000	0.084	-0.215	0.019	0.097	0.096	-	-0.102	0.117	0.131	0.017	0.031	0.033	
												0.011							
STRT	-0.013	0.068	-0.127	-0.005	0.226	0.084	1.000	0.409	-0.042	-0.035	-0.108	-	0.099	0.209	-0.124	0.069	0.031	0.018	
												0.006							
DEEP	-0.001	0.161	0.147	0.049	0.103	-0.215	0.409	1.000	0.015	-0.035	-0.103	0.133	0.232	0.101	-0.103	0.056	-0.007	0.043	
STRESS	0.489	-0.268	-0.009	-0.028	-0.158	0.019	-0.042	0.015	1.000	0.445	0.273	0.006	-0.126	0.006	0.292	-0.235	0.331	-0.223	
EE	0.404	-0.278	0.040	-0.082	-0.113	0.097	-0.035	-0.035	0.445	1.000	0.452	0.235	-0.134	-0.004	0.206	-0.190	0.378	-0.147	
DP	0.230	-0.216	0.035	-0.284	-0.130	0.096	-0.108	-0.103	0.273	0.452	1.000	0.061	-0.140	-0.066	0.199	-0.119	0.179	-0.209	
PA	0.038	0.212	0.171	0.148	0.111	-0.011	-0.006	0.133	0.006	0.235	0.061	1.000	0.118	-0.011	-0.012	0.054	0.130	0.151	
AWQDeep	-0.110	0.269	0.325	0.022	0.104	-0.102	0.099	0.232	-0.126	-0.134	-0.140	0.118	1.000	0.101	-0.085	0.207	-0.067	0.101	
AWQSR	0.017	0.052	-0.115	0.068	0.106	0.117	0.209	0.101	0.006	-0.004	-0.066	-	0.101	1.000	0.023	-0.001	0.045	0.063	
												0.011							
AWQSD	0.314	-0.167	-0.052	-0.078	-0.434	0.131	-0.124	-0.103	0.292	0.206	0.199	-	-0.085	0.023	1.000	-0.125	0.258	-0.111	
												0.012							
WCQCI	-0.135	0.099	0.065	0.017	0.087	0.017	0.069	0.056	-0.235	-0.190	-0.119	0.054	0.207	-0.001	-0.125	1.000	-0.227	0.346	
WCQWL	0.271	-0.157	-0.069	-0.034	-0.055	0.031	0.031	-0.007	0.331	0.378	0.179	0.130	-0.067	0.045	0.258	-0.227	1.000	-0.168	
WCQSR	-0.150	0.137	0.031	0.159	0.078	0.033	0.018	0.043	-0.223	-0.147	-0.209	0.151	0.101	0.063	-0.111	0.346	-0.168	1.000	

Stress, burnout and satisfaction with medicine

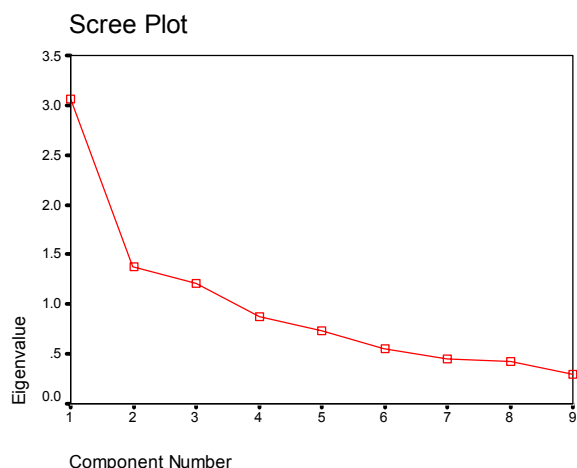
We have chosen in the structural equation modelling to look only at a single outcome measure, 'stress', represented by the score on the GHQ-12, scored on a 0-1-2-3 basis. We did however also have measures of the three sub-scales (EE: Emotional exhaustion; DP: depersonalisation; PA: Personal accomplishment) of the abbreviated Maslach Burnout Inventory (aMBI). In the 2002 follow-up we also had a measure of 'satisfaction with medicine', which had three separate items [7]. The GHQ-12 and aMBI were administered to the doctors both as PRHOs (PRHO) and in 2002, while the Satisfaction measure (SAT) was only administered in 2002. Here we assess the inter-relationships between the measures and demonstrate that GHQ-12 provides a good surrogate for the other measures.

There was complete data on all nine measures for 464 respondents. The correlation matrix is shown below. All of the measures load positively with the GHQ measures (except for PA and SAT, which are scored in the reverse direction, so that high stress correlates with low personal accomplishment and satisfaction).

	GHQPRHO	GHQ2002	EEPRHO	EE2002	DPPRHO	DP2002	PAPRHO	PA2002	SAT2002
GHQPRHO	1.000	.356	.500	.280	.273	.185	-.255	-.125	-.268
GHQ2002	.356	1.000	.224	.504	.093	.315	-.048	-.173	-.420
EEPRHO	.500	.224	1.000	.376	.482	.172	-.004	-.026	-.258
EE2002	.280	.504	.376	1.000	.222	.542	-.059	-.033	-.506
DPPRHO	.273	.093	.482	.222	1.000	.288	-.017	-.105	-.201
DP2002	.185	.315	.172	.542	.288	1.000	-.041	-.060	-.365
PAPRHO	-.255	-.048	-.004	-.059	-.017	-.041	1.000	.345	.180
PA2002	-.125	-.173	-.026	-.033	-.105	-.060	.345	1.000	.312
SAT2002	-.268	-.420	-.258	-.506	-.201	-.365	.180	.312	1.000

Principle Component Analysis showed that the first component accounted for 34.1% of the total variance. The scree-slope analysis (below) showed a clear 'dog-leg' after the first factor, suggesting that all of the measures were loading on a single common factor, and indeed all the loadings were in the expected direction.

	Component 1
EE2002	.758
SAT2002	-.703
GHQ2002	.652
GHQPRHO	.628
EEPRHO	.623
DP2002	.615
DPPRHO	.510
PA2002	-.303
PAPRHO	-.244



Although the correlation matrix does reveal some subtleties about the relationship between the nine measures, it is clear that the GHQ measure is a good proxy for the majority of the common variance within the measures.

Abbreviations

NEUR	Neuroticism (Big Five personality measure)
EXTRA	Extraversion (Big Five personality measure)
OPEN	Openness to experience (Big Five personality measure)
AGREE	Agreeableness (Big Five personality measure)
CONSC	Conscientiousness (Big Five personality measure)
SURF	Surface learning (Study Process Questionnaire)
STRT	Strategic learning (Study Process Questionnaire)
DEEP	Deep learning (Study Process Questionnaire)
STRESS	Stress (General Health Questionnaire, 0-1-2-3 scoring)
EE	Emotional Exhaustion (Maslach Burnout Inventory)
DP	Depersonalisation (Maslach Burnout Inventory)
PA	Personal Accomplishment (Maslach Burnout Inventory)
AWQDeep	Deep approach to work (Approaches to Work Questionnaire)
AWQSR	Surface-Rational approach to work (Approaches to Work Questionnaire)
AWQSD	Surface-Disorganised approach to work (Approaches to Work Questionnaire)
WCQCI	Choice-independence in work environment (Workplace Climate Questionnaire)
WCQWL	High workload (Workplace Climate Questionnaire)
WCQCI	Supportive-Receptive work environment (Workplace Climate Questionnaire)

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