

Anxiety and study methods in preclinical students: causal relation to examination performance

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Summary. Stress and anxiety are substantially raised in many preclinical students in their first year at medical school. Although correlated with poor end-of-year examination performance, anxiety levels did not cause poor performance, but were themselves caused by previous poor performance in sessional examinations. Study habits showed declining deep and strategic approaches, and increasing surface ('rote-learning') approaches. Surface learning correlated with poor end-of-year examination performance, and was a result of previous poor sessional examination performance. Deep learning did not correlate with performance, whereas strategic learning correlated positively with examination success, even when measured 2 years previously during application to medical school.

Key words: anxiety/*etiolo; *learning; students, medical/*psycholo; *educational measurement; stress, psychological/etiolo; arousal; education, medical, undergraduate; educational status; cohort studies

Introduction

Medical students are frequently described as 'stressed', in comparison with control populations (Firth 1986), and that stress continues on into the pre-registration year (Firth-Cozens 1987). Although examinations are a principal cause of stress (Kidson & Hornblow 1982), and *viva voce* examinations are peculiarly stressful (Arndt *et al.* 1986), few studies have looked at the

development of stress during the first academic year, at the development of study habits, and at their relationship to examination performance. Stress, which is a psychological process, indicating failure of coping, must be differentiated from arousal, which is a physiological state accompanied by a high level of sympathetic activity; anxiety is the vector sum of stress and arousal, containing components of both (Cox 1978).

Poor examination results in students in higher education are usually not due to low academic ability, particularly in medical students who have previously attained good A-level results (McManus & Richards 1986), but result instead from inappropriate study habits, methods and motivations (Entwistle 1981). Three approaches to study have been identified (Newble & Entwistle 1986): *surface learning* emphasizes rote-learning of facts, motivated principally by fear of failure; *deep learning* stresses understanding of underlying concepts, motivated by interest and a personal need for understanding; and *strategic learning* selectively applies surface and deep strategies, amongst others, to particular tasks, motivated by a desire for success.

In this paper we describe the changing levels of stress, arousal and anxiety within a cohort of first-year preclinical students, in relation to their work methods and academic achievement.

Methods

All members of the 1986 cohort of entrants to St Mary's Hospital Medical School were asked to take part in a longitudinal study of stress and arousal, and it was explained to them that they would be asked to complete questionnaires on six

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separate occasions throughout the year. At the time of distribution of the first set of questionnaires students were given the opportunity to withdraw from the entire study. Stress and arousal were assessed using the Multiple Adjective Check-List (MACL) (Mackay *et al.* 1978), and were measured at six separate times: in November 1986 (midway through the first term) (time 1); January 1987 (immediately before sessional examinations) (time 2); March 1987 (mid-way through rag week) (time 3); April 1987 (several weeks into the third term) (time 4); and twice in June 1987 (once on the evening before the first main written examination (time 5), and once on the evening before the first compulsory *viva voce* examination (time 6)).

Anxiety was measured using the State-Trait Anxiety Inventory (STAI) (Spielberger 1983), which gives separate measures of state and trait anxiety. State anxiety was measured at the same six occasions as the MACL was used, while trait anxiety was measured only in November 1986. Typical state anxiety norms derived from the test manual give scores of about 31 when students are relaxed, 37 in normal, unstressed conditions, 43 when taking a mildly stressful, timed IQ test, and 56 after watching a film of 'a stressful movie depicting several accidents in a woodworking shop' (Spielberger 1983).

Study habits were measured in November and April, using a shortened, modified form of the Biggs' Study Process Questionnaire (SPQ) (Biggs 1979, 1985) which gives separate measures of *surface*, *deep* and *strategic* learning strategies. The questionnaire contained 18 of the original items, six for each learning style.

The 1986 cohort of entrants had also been studied extensively during selection and measures from the STAI and SPQ had been made in the autumn of 1985, during selection (time 0); the SPQ was sent by post as part of a more extensive questionnaire within a week or so of receiving the application form, and the STAI was administered immediately before or after the selection interview (McManus *et al.* 1989).

Results were obtained for the four separate sections of the end-of-year (MB BS part IB) examination and for the sessional examinations; since all sections showed the same pattern, only total marks for sessional and final examinations will be reported here. The mean grade attained in

A-level examinations was also obtained for each student.

Statistical analysis was by one-way analysis of variance and Pearsonian correlation analysis as appropriate.

Results

Of 106 first-year preclinical students, none asked to be withdrawn from the study; between 77 and 103 (72.6–97.1%) students actually completed questionnaires on the various occasions. Eighty-two students (77.3%) had also taken part in the study of selection. Two students left before the examinations in June 1987.

Stress and anxiety scores showed highly significant ($P < 0.001$) variation throughout the year (Fig. 1), being lowest during rag week and rising to their highest levels just before the first written examination. It is clear that although high levels occur immediately before sessional and final examinations, levels were also high in April, several weeks before the examinations themselves (although students had just experienced Part 1A of their main examinations). Arousal levels showed no significant change through the year, confirming that changes in anxiety were due to the stress component rather than the arousal component.

Learning styles showed significant changes during the year; surface learning increased both between selection and November ($P < 0.001$), and between November and April ($P < 0.001$), and deep and strategic learning decreased during the same periods ($P < 0.001$; $P < 0.001$).

Correlation analysis showed that poor final examination performance correlated with high anxiety during March, April and June 1987 (Table 1), but not with anxiety in Autumn 1985, November 1986 or January 1987. A similar pattern of correlations was found with sessional examination results.

Strategic learning habits correlated with good examination performance, whereas deep learning showed no relation at all to good performance (Table 1). Surface learning strategies in Autumn 1985 and November 1986 were not predictive of examination performance, but surface learning in April 1987 correlated with both poor sessional and final examination performance.

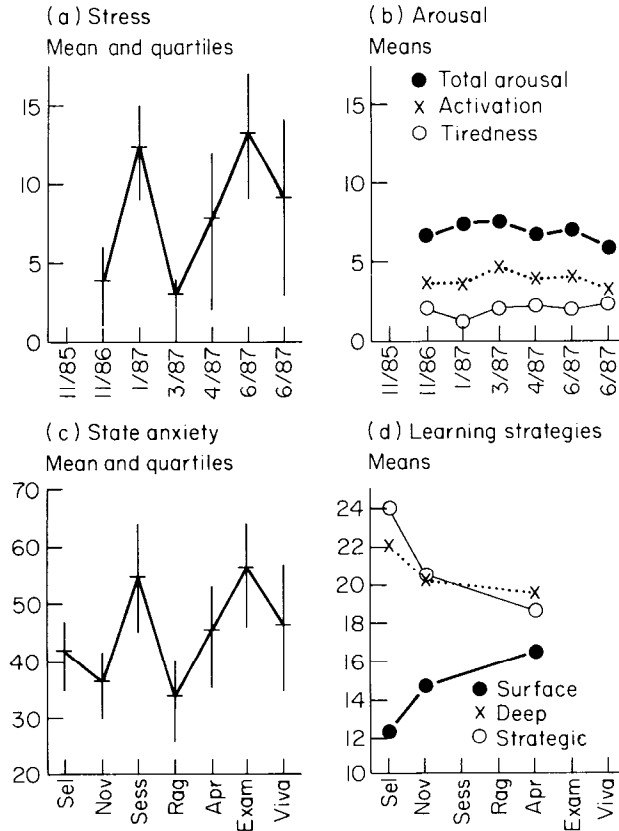


Figure 1. Shows the mean levels and quartiles of (a) stress, (b) arousal, (c) anxiety and (d) learning strategies shown by students at selection and at different times during their first year at medical school. Key: Sel: Selection, autumn 1985; Nov: November 1986; Sess: Sessional examinations, January 1987; Rag: Rag week, March 1987; Apr: April 1987; Exam: end-of-year (final) examination, June 1987; Viva: *viva voce* examination, June 1987.

Examination results, stress, arousal and anxiety scores, and learning strategies were also correlated with a number of other variables, including sex and domicile (hall of residence or private lodgings); no significant correlations were found. Mean grade at A-level showed a significant correlation with final examination result ($r = 0.282$, $P < 0.025$), but not with sessional examination results ($r = 0.192$, NS). A-level grade showed no significant correlation with stress, arousal or anxiety levels, or study habits.

Non-linear regression analysis found no evi-

dence of significant quadratic relationships between anxiety or stress measures and examination performance.

Correlations between state and trait anxiety measures and learning strategies showed that students with high *trait* anxiety were less likely to have deep learning strategies at the time of selection ($r = -0.423$, $P < 0.001$), and were more likely to adopt surface learning strategies by April ($r = 0.454$, $P < 0.001$). No correlations between state anxiety and learning strategies were significant after correction for multiple significance testing.

Table 1. Correlation of anxiety scores and study methods with performance in sessional and final examinations. (*: $P < 0.05$; **: $P < 0.01$; ***: $P < 0.001$)

	Sessional examination (January 1987)	Final examination (June 1987)
<i>State anxiety</i>		
0: Autumn 1985	0.064	-0.021
1: November 1986	0.012	-0.030
2: January 1987	-0.130	-0.069
3: March 1987	-0.284**	-0.246*
4: April 1987	-0.384***	-0.357**
5: June 1987 — written	-0.121	-0.108
6: June 1987 — oral	-0.184	-0.391***
<i>Surface learning:</i>		
0: Autumn 1985	-0.193	-0.107
1: November 1986	-0.161	-0.150
4: April 1987	-0.311**	-0.281**
<i>Strategic learning:</i>		
0: Autumn 1985	0.279**	0.326**
1: November 1986	0.308**	0.272**
4: November 1987	0.311**	0.362**
<i>Deep learning:</i>		
0: Autumn 1985	0.189	0.232
1: November 1986	-0.068	-0.031
4: April 1987	0.014	-0.116

Discussion

These results confirm the findings of previous studies that preclinical medical students are under considerable stress, not only during end-of-year examinations but also at other times throughout the year. These levels may well be sufficiently high as to cause serious concern about the mental well-being of some students.

The Yerkes-Dodson Law (Levitt 1980) suggests moderate stress may be beneficial to performance whereas too much is detrimental. However, the absence of linear or curvilinear relations between stress and examination performance, as in a previous study (Arndt *et al.* 1986), again suggests the inapplicability of the Yerkes-Dodson Law to anxiety and examination performance. Hence student stress cannot be justified by its potentially beneficial effects.

This study has found correlations between examination performance and both anxiety levels and learning strategies. The question arises therefore of the causal relationship between these measures.

The determination of the direction of causality when correlations have been demonstrated is never easy, particularly in the social sciences.

Thus if A and B are correlated, it may be because A causes B, B causes A, or A and B are both caused by some third factor, C. The third case can be assessed by examining the partial correlation of A and B after removing the effects of C; a null partial correlation implies that C causes both A and B. A causing B and B causing A can be distinguished in certain circumstances, and inferences then drawn about causality (Kenny 1979). If A or B are measured on two or more occasions, then differences in the patterns of correlation can allow one to exclude one direction of causality, and therefore render the other more likely.

Poor performance in sessional examinations did not correlate with prior anxiety in November or January, but did predict subsequent anxiety during March and April. In the present case we therefore have a correlation between sessional examination performance and anxiety levels. The alternative hypotheses for a direct causal relationship (excluding the possibility of other extraneous variables) are either that anxiety causes poor examination performance, or that poor examination performance itself causes anxiety. However, since the anxiety-perfor-

mance correlation is only present for anxiety measured after the examination, and not for anxiety measured before the examination, it is unlikely that anxiety causes poor examination performance, since then the causal relation should also be present prior to the examination. One of the two directions of causality is therefore excluded, and hence only one possible direct causal relation between the variables remains. We therefore conclude that anxiety during March and April is probably caused by poor performance in sessional examinations. It is of course possible that some third variable accounts for the relationship; since in principle there is an infinite number of such possible variables, the hypothesis is not open to direct refutation. However, for any specific variable measured in future studies the hypothesis may readily be testable by examining the partial correlation between examination performance and subsequent anxiety.

Anxiety during March, April and June correlated with poor final examination performance. Although anxiety during April correlates with poor final examination performance ($r = -0.357$), this result is not necessarily causal, since high anxiety is also correlated with poor sessional examination performance (which is highly correlated with final examination performance, $r = 0.652$). The partial correlation of April anxiety and final examination performance after taking sessional examination performance into account is -0.152 (not significant). We conclude that the correlation between prior anxiety and final examination performance is not itself a causal relation, but rather is the result of previous poor performance in sessional examinations, which both causes increased anxiety levels and poorer final examination performance.

As in other studies (Coles 1985) students showed increasing reliance on surface learning strategies during their first year, thereby adopting a strategy associated with poorer examination performance. Since surface learning strategies in Autumn 1985 and November 1986 were not predictive of sessional examination performance, but poor sessional examination performance did predict surface learning strategies in April 1987 we conclude, by a similar logic to that used earlier, that poor sessional

performance probably caused the adoption of maladaptive surface strategies.

Studies of university students in general typically find that examination performance correlates with using deep learning approaches (Ramsden & Entwistle 1981; Thomas & Bair 1982; Entwistle 1988), whereas our data find examination performance is predicted by strategic learning (a correlation which anecdotally is supported by our students' emphasis upon 'question spotting'). This difference may reflect our students' probably accurate perceptions of the excessive emphasis upon recall of factual knowledge at the expense of conceptual understanding in conventional, but not problem-based (Coles 1985), medical school curricula and examinations; certainly experimental studies show that testing solely by recall can rapidly induce surface learning (Marton & Saljo 1976).

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