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Benefits of a Professional Training Year for Undergraduates on a Neuroscience Degree Scheme

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The benefits of undergraduate students taking a professional training year (PTY) as part of their neuroscience degree have been analyzed for fifteen cohorts of students between 1994 and 2008. Those students taking the PTY scored 4.4% more in their final year aggregated total than those who did not. In addition, these students were 2.58 times more likely to gain a first class degree and 4.8 times less likely to gain a second class (division two) degree than those who did not take the placement year. Analysis of final year marks, whether or not they had taken the PTY, indicated a significantly better performance by female students. Progression onwards to

postgraduate study for a PhD was almost four times higher for PTY students than for those not taking the PTY. No PTY students progressed on to a Masters scheme of postgraduate study whereas a small number of three year students did. The benefits of a PTY also extended to students' self-enhancement and maturity as judged by themselves, their peers and by academic staff. This study, the first for the relatively new undergraduate discipline of neuroscience, confirms earlier findings for other academic disciplines.

Key words: neuroscience; professional training year; industrial placement; biomedical degree; sandwich year

The aim of this study is to test the hypothesis that participation in a professional training year during a recently emerging undergraduate academic discipline – neuroscience – is beneficial to students taking the degree scheme. The desirability of introducing a degree course in neuroscience was in part stimulated in the late nineteen-eighties by colleagues in the biomedical (specifically pharmaceutical) industries who were experiencing shortcomings in the training of science graduates that they recruited for laboratory work. In their experience, graduates in such subjects as biochemistry, physiology or pharmacology had not gained sufficient knowledge for research in contemporary neuroscience. Investigative methodological advances in the early nineteen-eighties and nineties were so rapid and widespread that neuroscience research was able to approach problems using a multitude of disciplines. What the biomedical industry required were suitably qualified science graduates who had had some exposure to a wider range of biomedical disciplines in addition to the classical biomedical subjects. Specific shortcomings that were identified were the behavioral sciences, neuroanatomy of the mammalian central nervous system and neuropharmacology. At Cardiff University, these sought-after academic disciplines were all available in addition to biomedical subjects and the decision was made to establish a neuroscience degree course *de novo*. This approach contrasted with some other UK universities who added a final year project in neuroscience to existing biomedical degree schemes and classed it as a neuroscience degree.

In spite of considerable skepticism in certain quarters of the university, mainly due to the lack of awareness of neuroscience as a putative academic discipline and therefore for employment prospects for neuroscience graduates, the proposed course was presented to the university and received approval. The first cohort of undergraduates was admitted to the new neuroscience

degree scheme at Cardiff University in 1991 when the course included contributions from the Schools of Pharmacy and Psychology in addition to the more classical physiological, neuroanatomical and biochemical input from the School of Biosciences. In succeeding years, the course content has changed to include subject matter that reflects the increased importance of molecular biology and genetics as well as advances in neuroscience itself. From the outset, those planning the new course were convinced that the option of a placement year would be not only highly relevant to the course but also an attractive feature for this new undergraduate degree scheme due to the rapid expansion of neuroscience research by the pharmaceutical and other biomedical industries. Clearly, prospective students thought so too as enrollment into the four-year course commenced in the second year of the life of the scheme.

Since the inception of the degree scheme in neuroscience, including the 'professional training' year (PTY), many students have opted for a PTY in the United Kingdom or abroad. The Cardiff Neuroscience PTY, one of only two or three in the UK, provides students with the opportunity to spend a period of nine to twelve months experiencing neuroscience research in an industrial, academic or clinical laboratory in order to gain, at first hand, experience of how scientific information is acquired and analyzed. It also provides students with an insight in understanding the advantages and limitations of research techniques. During the PTY, students are part of a research group under close supervision of the research group leader but they are always able to contribute to the planning and execution of the group's research program. Their work is reported and discussed within the research organization and then written up in the form of a detailed 6000 word report and presented orally on their return to the university. Assessment of the PTY is derived from contributions from the on-site supervisor, two neuroscience-related academics and from academic staff

who judge the oral presentation, particularly regarding the students' ability to defend their work from questions asked by the audience. The mark awarded for the PTY contributes to the overall final year mark.

Students opting for a PTY are required to have performed satisfactorily in their first two years of study, ideally having reached an upper second class (>60%) average mark at the very least. It is the student's responsibility to locate a placement but they are given considerable assistance and advice from the PTY tutor in making the necessary arrangements to secure the placement and in putting together their curriculum vitae. PTY candidates are usually given a searching interview by prospective hosts in the biomedical industries but for academic-related placements, references from academic staff usually suffice. Neuroscience students from Cardiff have secured PTY placements in a wide range of university departments, research institutes and hospitals in the United Kingdom, Europe and the USA as well as in research laboratories in the pharmaceutical industry in the United Kingdom. During their time on placement, they are kept in touch with the PTY tutor in Cardiff by telephone and Email as well as receiving a visit from the PTY tutor. During this visit, the tutor has in-depth discussions with the project supervisor to discuss the student's progress as well as discussing all aspects of the placement with the student. This feedback, from both students and supervisors has been used to assess the success of the placement and the suitability or otherwise of the host institution, particularly in relation to future placements.

Analyses of the benefits of a PTY have previously been undertaken for other bioscience (Gomez et al., 2004), psychology (Reddy and Moores, 2006; Auburn et al., 1993), economics (Mandilaras, 2004), engineering (Thomas, 1977), business studies (Duignan, 2003) and physics (Smith 1985) degree schemes; they generally report an enhanced performance on return to university for the final year. Enhanced academic performance following a PTY is not generally considered to be the rationale for undertaking a placement year (Duignan, 2003) but appears to be a very welcome consequence. The present analysis of the academic performance of those taking a PTY is the first such analysis of undergraduate performance in a neuroscience degree scheme in the United Kingdom. It clearly demonstrates that the advantages of so doing are not only in academic achievement but also in the area of personal and professional development and in progression to postgraduate study.

MATERIALS AND METHODS

The final degree percentage marks of fifteen cohorts of neuroscience degree undergraduates (217 students) have been analyzed during the period of 1994-2008 in the School of Biosciences at Cardiff University. The evaluation compared the performance by those students who undertook a PTY with those on the standard three year degree course. The proportion of the final degree percentages attributed to the PTY mark is included for those students as the PTY mark contributed to the degree classification. The marks of two final year core modules,

consistently present since modularization in 1997, have also been included in the analysis, as an indicator of actual final year performance. The available data also permitted analysis of performance by gender but not by entry qualification to university. In addition, available information on first destination following graduation has made possible an evaluation of the progression to higher degrees of the two student groups. Significance of the data was tested by a two sample T-test assuming unequal variance.

RESULTS

Student numbers

The total number of students on the Neuroscience degree scheme during the period was 217, of whom 30.9% were male and 69.1% were female. The overall proportion of students taking a PTY was 30.4%, of whom 22.7% were male and 77.3% female compared to 33.8% male and 66.2% female on the three year course.

Final Year marks

The average mark obtained in the final year was $66.01 \pm 5.9\%$ (S.D.) for the PTY group and $61.63 \pm 4.7\%$ for the three year group. The difference in the means was statistically significant ($p < 0.001$).

By gender

For the three year course the mean mark for male students was $59.1 \pm 6.6\%$ and for females $62.9 \pm 4.9\%$. The difference in the means was statistically significant ($p < 0.001$).

For the four year (PTY) course the mean mark for male students was $63.1 \pm 7.4\%$ and for females $66.6 \pm 3.8\%$. The difference in the means was statistically significant ($p < 0.01$).

For the four year (PTY) course the mean mark awarded for the PTY itself to male students was $66.1 \pm 8.3\%$ and for females $69.1 \pm 4.4\%$. The difference in the means was statistically significant ($p < 0.01$).

Final Year core module marks (20 credits per module; Final year total of 120 credits)

PL3003 (Neuronal Excitability and Transmitters)

For the three year course the mean mark was $64.4 \pm 6.6\%$ and for four year (PTY) students the mean mark was $69.9 \pm 7.7\%$. The difference in the means was statistically significant ($p < 0.0005$).

PL3004 (Molecular Neuroscience)

For the three year course the mean mark was $64.4 \pm 6.1\%$ and for four year (PTY) students the mean mark was $67.0 \pm 5.2\%$. The difference in the means was statistically significant ($p < 0.005$).

Degree Classifications

The degree classifications awarded were as follows (% student numbers):

3 Year

1	2-1	2-2	3
10.9	51.1	29.0	9.0

PTY

28.0	66.0	6.0	0
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By gender – first class degrees only

3 year		PTY	
Male	Female	Male	Female
9.8%	14.0%	30.0%	23.5%

Analysis of progression to higher degrees**Total student numbers**

3 Year: 1 PhD per 11.6 graduates

1 MSc per 30.0 graduates

PTY: 1 PhD per 3.14 graduates

0 MSc uptake

By gender

3 year			
Male		Female	
MSc	PhD	MSc	PhD
3	5	1	8
PTY			
Male		Female	
0	10	0	11

DISCUSSION

The numerical data clearly indicate that those students taking a PTY average a final year percentage 4.4% above that of those on the 3 Year course which is comparable, but slightly greater, than previous analyses of PTY performance in other bioscience (Gomez et al., 2004) or psychology (Reddy and Moores, 2006) degree schemes. Marks obtained in the two core final year modules analyzed also demonstrate improved performance by PTY students compared to those on the 3 Year course during the final year itself. This mark differential is reflected by degree classification as it demonstrates that PTY students, as opposed to 3 Year course students are more likely to gain a first class degree by 2.58 times, an upper second class degree by 1.3 times and the probability of being awarded a lower second or third class degree is almost negligible. During the period over which the fifteen cohorts have been analyzed, Cardiff University has changed to modular schemes of study (in 1997) but the marks from the PTY that contribute to the final year mark have consistently ranged between 20 – 25% of the total final year mark, based either on raw marks or percentage contributions from credit-based modules. It is not altogether surprising that those students who take the PTY are a self-selected group who has performed well in Year 2. Although there is no lower mark limit for Year 2 students hoping to take a PTY, those that apply and those that are accepted are usually performing at least at an average of 60% as judged by in-course assessments and autumn semester module marks in Year 2. As arrangements for the PTY are normally completed by March-April of Year 2, the final year 2 marks are not available to the PTY host organization. In view of the fact that many Year 1 university students take a while to adapt to new methods of study in higher education and do not perform to their true potential, Year 1 marks are not formally taken into consideration by the PTY tutor; it is evidence of an upwards trajectory in Year 2 performance that is sought before the PTY tutor agrees to an individual student's request to seek a PTY placement. Unfortunately

a complete set of Year 2 marks were unavailable to determine any improvement of academic performance by those taking the PTY compared to the 3 Year group.

The significantly better PTY and final year performance by female students in neuroscience is noteworthy and is consistent with the findings of Mandilaras (2004) and McNabb et al. (2002). It is also consistent with McNabb et al.'s (2002) report that, in spite of a better overall performance, female students are less likely to obtain a first class degree. However, the percentages of females gaining a first class degree in neuroscience at Cardiff is higher than the 7.6% level compiled from data on all subjects 'allied to medicine' or the 7.2% in Biological Sciences in UK universities (McNabb et al, 2002). The reasons underlying differences in gender performance at university are considered to be complex, mystifying and incompletely understood, in spite of a thorough analysis of this phenomenon in United Kingdom universities (McNabb et al., 2002). It is possible that there are alternative factors influencing these gender differences in academic performance, alluded to by McNabb et al., (2002) that are psychological and biological in nature. Such factors which have not been analyzed could be referred to as differences in personality traits and attitudes to academic performance, particularly in relation to assessment.

It has not been possible to relate final year marks for neuroscience undergraduates to university entry qualifications as these have not been standard over the 15 years analyzed. In the early 1990s, neuroscience was not well known as an undergraduate degree scheme by potential applicants, school teachers and the general public. Many of those who entered the degree scheme in the early years – and they were a small number - did so without totally understanding the subject but thought that it looked interesting on account of the contributions from several biomedical disciplines. A sizeable proportion of the entrants were students that had failed to meet the entry requirement for medicine by one or two A level grades and entered through the University and Colleges Admissions Service (UCAS) post A level 'clearing' process with higher grades for entry to neuroscience that were officially demanded through UCAS. Again, many of these students chose neuroscience as it 'looked interesting'. Also, the neuroscience degree course at Cardiff has enrolled students with non-standard qualifications such as the International Baccalaureat, Irish Highers and other higher education Access courses. Another factor making any comparison of entry qualifications to final degree performance unrealistic is that the standard 'A' level requirement for entry to neuroscience in Cardiff has risen from BCC in 1991 to its current level of AAB. Irrespective of whether prospective students applied for the three or four year degree on entry, it has always been possible to switch degree schemes at the end of Year 1 but no separate information is available regarding the performance of those students who opted for the four year course at this time.

The performance in the PTY contributes positively to the degree classification obtained by the PTY students. This, in turn, has had a positive effect on the numbers

going on to postgraduate study as a first destination after graduation, particularly for a PhD. It is not just the higher marks and degree classifications obtained by the PTY students but it is their laboratory experience on placement that is likely to influence their interest and commitment to postgraduate study. On the other hand, one or two PTY students have not enjoyed the laboratory experience while on placement and have been grateful and relieved that the PTY has made them realize that laboratory work is not what they want to do after graduation. Nevertheless some such graduates have indeed entered the biomedical industry but have specialized non-scientific aspects of the industry such as marketing, management or personnel relations.

A non-quantifiable consequence of the PTY appears to be the very noticeable self-enhancement of these students on their return to the Final Year. This sentiment has frequently been expressed verbally both by student peers and by academic staff and also commented upon by External Examiners who had spent time with them in *viva-voce* examinations over the fifteen year period. The first evidence of this is provided by the individual performance that the PTY students give in their oral presentation of their results. They present their work not just with confidence and clarity but clearly understand their topic in depth as judged by their ability to tackle rigorous questioning by an audience of academic neuroscientists and postdoctoral staff. Many PTY students who have had placements in research laboratories of pharmaceutical companies received training in presentational skills whilst on placement which is very beneficial in itself but it certainly does not obscure their own deep knowledge of their subject. On occasion, PTY presentations have been outstanding in their quality and maturity. Many students on PTY had not fully appreciated the importance of communication skills until they received training during the year. Another indicator of self-enhancement following the PTY is that many of the returning students deliberately choose final year laboratory projects that involve different experimental techniques to those that they used during the PTY. This strategy has paid considerable dividends in successfully gaining PhD places in renowned biomedical departments in UK universities. Another benefit of placement in an industrial setting has been that students who have impressed their supervisors sufficiently have been offered jobs following graduation, some positions including a doctoral degree scheme in collaboration with another university. It is clear that for a 20 – 21 year old undergraduate, moving sideways from the university environment into a professional, commercial environment for a year is a challenge that has been met by a step up in the individual's development and maturity.

In conclusion, the data presented supports the hypothesis of the academic and personal benefits of a PTY in a neuroscience degree scheme, comparable to analyses of PTY benefits in a variety of academic subjects in other United Kingdom universities. It further highlights the improved prospects for progression to postgraduate study. The intriguing subject of the gender differences in performance, now documented for neuroscience students,

is clearly a complex issue which remains unresolved in spite of the detailed investigation of this subject by McNabb et al. (2002). Lastly, it is evident that the current economic climate has clearly affected the uptake of PTY placements in the past two years on account of the financial implications of an extra year in a degree scheme but hopefully the demonstrable benefits of a PTY placement will limit the duration of this downturn.

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