THE REGRETS OF A CANTAB.

IT is a trite remark of moralists, Mr. Editor, that it is too often our
fate in this strange drama of life, to change our opinions and views of
the value of our pursuits—to look back with wonder at the energy
with which we have followed a mistaken road to happiness, and to
awaken, as unexpectedly as suddenly, to the conviction that we have
been wasting ourselves, wearing out our lives and destroying our time,
in a chace which we now find, too late, to have been the chace of dis-
appointment. Alas! I never thought that I was so soon to become
myself an example of this piece of morality—so suddenly to awaken
from a long dream, from a period which has indeed vanished like a
dream, leaving not a trace behind but the regret of lost hours; of
happiness, nay, of health, sacrificed to the attainment of a vision.
So sudden has been the shock, in such an instant did the light break
in on my senses, that I scarcely yet feel as if I were myself—can
scarcely collect my confused thoughts to tell you what it is that I do
feel.

But when my conviction tells me that I am now at length a man—
that I have obtained the important age of twenty-one—that almost the
last recollection of myself was as a boy of sixteen: then it is that
I ask myself, where are my five years, what have I been doing, what
have I gained, what happiness have I enjoyed, in what way have I
qualified myself for the duties which are now forced upon me? I
look backward, and still I look backward, and I attempt to recollect
what I have been doing—how those years passed—what pleasures
they brought—what ideas I have gained—what instructions secured.
I try my mind in all directions—I attempt to lay hold of the past
time—to measure its intervals by acquisitions of knowledge, by suc-
cessions of events, by successions of feelings, of opinions, by plea-
sures, by changes of my views—but my attempts are vain. I find no
record of time in it; for I find no successions of events or feelings—

no remembrance of pleasures gained or views changed—no accumu-
lation of successive knowledge, no stores of varied ideas—nothing to
tell me that those years consisted of months, weeks, days, hours—
that time has marched on for five years, and that the youth of six-
teen is now a man of twenty-one—that he who foresaw, as a boy, the
day when he was to act as a man, is now arrived at the period of
action. A single idea measures the whole of this long interval; and
for ever labouring in vain to expand it, the sad conviction is for ever
forced on me that its extremities meet, that I had fallen asleep at its
commencement, and awakened at its termination.

And that one idea consists in Mathematics. Mathematics! the very
word haunts me; I attempt to dilate it, to vary it, to specify, to analyze
in what it consists—of what ideas, what parts it is composed; to as-
certain what it is that I do know, what is the knowledge that I have
gained. And still the word mathematics, mathematics, recurs to me;
it whirls in my head, and when I attempt to investigate what it means,
a confused succession of angles, and curves, and equations, and fluxions,
chases itself up and down, as it seems, in my brain, and still it ends
in the conclusion that I am a Mathematician.

This is the dream of the last five years; but, even in this dream,
when I attempt to trace my own progress from the first proposition
in Euclid and the addition of algebraic quantities, to the very last
of our Senate-house problems, to the day which saw me at the summit
of honours, that day, which was the mark of my long ambition,
which was to reward me for all my privations and toils, I cannot
recall even the terms which called me back to renewed exertions, far
less the months and weeks which found me for ever a student over
my daily and nightly task. Thus have I sat now, for months,
plunged in a dark melancholy, sometimes buried in regrets, and now
and then rousing myself by recollections of my reputation and
honours; while, in brighter moments, I attempt to persuade myself
that I have laid in a stock of useful information, that I am grounded
in all the sciences, and that I am fitted to carry on, with more
brilliant success than my fellows, the profession which has fallen to
my lot.

But, alas! these delightful visions vanish as fast as they arise.
Wherever I go, whatever I attempt to do, my mathematics slip from
beneath me; and again I find that I am, among men and in the
world, the very boy that St. John's saw me five years ago. In society,
in conversation, it matters not what society, what conversation, I
must sit silent, having but just now discovered that men do not con-
verse about equations or curves. All the world except myself, seems
to abound in ideas; and I possess but one. If, by chance, I can
partake for a moment in some diversion, I am immediately left be-
hind, since it departs to subjects of which I know nothing, and to
arguments, the force of which I cannot feel. And it often happens

also that I lose my temper or become disheartened; finding that I
cannot demonstrate the propositions on ordinary matters which I may
chance to maintain, sometimes finding that men do not understand
demonstration, or will not listen to it, and sensible that, if I am for
a moment listened to, it is with silent and sad civility.   I can see too
that I am pitied for my ignorance; and you, Mr. Editor, if you have,
like myself, risen to Cambridge honours, can feel the mortification
which the senior wrangler of his day, the man to whom all Cambridge
looked with envy or veneration, must feel at enduring the pity of
those who could not solve a common problem de maximis et minimis,
who do not even know that an oval is an ellipse.

It is a trifle, in my present state of feelings, that female society is to
me a blank, and that I am even shunned by those to whose amusement
I can contribute nothing, and to whom my gravity and habits of
abstraction are repulsive; but I can easily see that it will not always
be a trifle, since I find myself beginning to envy the liveliness of man-
ners of the sex, and the mutual delight or cheerfulness of those around
me, where I sit meditating on some past problem, or rather, at-
tempting to drive from my mind ideas that will ever intrude.   But
it is not a trifle to find that, while I imagine myself possessed of the
power of separating the true from the false, of pursuing without
deviation a line of strict reasoning, of ensuring assent by demonstra-
tion, I have neither true nor false to distinguish, nothing about which
to reason, nothing to demonstrate, and no one to convince.   The
whole world seems to be in a conspiracy against me; determined to
occupy itself exclusively in every thing that I do not know, and, as
if determined not to believe that there is such a science as mathe-
matics in the world.   No one has yet had the incivility to tell me
that they think my knowledge of no use; but I grieve to say that I
am fast suspecting it myself.

I have still occasionally tried to console myself with the reflection, that
although the world was indifferent to this science, that it could not
perhaps in justice be expected to care for problems, of which I cannot
myself explain the use now that I am awakened from my dream, yet
that, from my habits of rigid investigation and close reasoning, I
should possess a decided superiority in discernment, in the observa-
tion of facts, in deducing their results, and consequently in explaining
myself with that precision which commands attention and enforces
assent.   But, alas! here also I have miscalculated.   Unacquainted
with physical facts, with nature in any of its forms, I am unable to
observe accurately, because I have no bottom on which I can found
distinctions.   If I see, I do not see what is seen by others, because I
cannot observe justly; nor can I remember what I do see, because
I do not distinguish with sufficient accuracy, and because I have no
basis of collected materials to which the things which I see can be
associated, no general knowledge or principles by which they can be

consolidated, and by whose aid they can be recalled and recollected, when I am desirous of turning them to use. I labour to learn what others know, but it is as yet in vain; and the little that I do acquire I can convert to no purpose, because I cannot recall and arrange it when it is wanted.

If the whole world of physical nature is thus to me little better than a blank, the moral world is all confusion and doubt. I can even scarcely comprehend what moral reasoning means, or how men can suffer themselves to be convinced by arguments which seem to me without solidity or accuracy. At every step, I am overwhelmed by reasons which I cannot answer, though they do not convince me; and when I attempt to discuss or reason, myself, I am silenced by some shallow opponent whom I should have despised at Cambridge, but who, I much fear, has in reality the advantage over me. I had been told that mathematics formed the only logic; and I believed it, because every body seemed to believe it, as they believed that one book of Euclid was worth the whole of Aristotle. I fear at last that we have all been in a mistake; for I find that this is a logic which has no concern with the conduct of life, with morals, law, politics, with any thing in short of all that which forms the great mass of human action and human reasoning. I have indeed lived to find that the logic of triangles is the logic of triangles and nothing more; that moral magnitudes cannot be measured or compared by mathematical rules, and that where nothing is definite, nothing rigidly proportional, nothing positive, and where a thousand jarring quantities are concerned in one question, it is in vain to expect aid from the rigidity of mathematical laws, or the accuracy of mathematical investigation. The human soul is assuredly not a triangle.

And if I have, too late, unwillingly admitted this conviction, it is not, I grieve much more to confess, without finding that my mind is not the powerful engine which I had imagined while triumphing in the victories gained over those refractory problems in the differential calculus, to which I owed all my fame and fancied I was to owe my happiness and my success in the world. I feel as if all my other powers had been extinguished by the cultivation and growth of this sole one; that, like Aaron's rod, it had swallowed up all its competitors. I cannot feel, appreciate, comprehend, what is going on around me. I strive to understand what seems understood by all but myself; to feel what others seem to feel; to infer as they infer; and to calculate on events as they calculate. But all seems a maze and a mystery; as if my mind was of a different constitution from that of mankind in general; as if I had not even the feelings of my species, far less its reasoning powers, its views of the nature and causes of events, its anticipations of their consequences, and, as a natural result of those, the power of determining on my own future conduct.

Thus do I find myself without even that worldly prudence, which,

in others, seems the result of a habit that costs no effort ; as if Nature had gifted them with some faculty which she had refused to me.   Incapable of discerning character through the mist of entangled actions, I am deceived or deceive myself in every hour of my narrow course ; more a boy, perhaps, in the world than at the day which saw me first entered at college ; and, as I fast find, not adding to my friendships, but rather daily losing those which I had at first imagined myself to have secured.   The world has nothing in common with me, or I have nothing in common with the world ; and I begin to fear that I shall shortly be left alone to my own ideas, or compelled to return to St. John's, and there wear out my days in the pursuits which have so long engrossed my whole attention.

  But it is not only in the collisions of society and the world that I thus find myself a castaway : and though I have said that I must return to end my days on a fellowship in the Combination Room, I am chained to it and must remain, since I must follow the profession that has been allotted to me.   And while that profession drives me to books, to reading, to study, it is among books, in libraries, that I also seek for the occupation and amusement which society has not afforded me.   But as yet I seek them almost in vain.   Every thing is new to me—all is unknown.   The world of science and of morals, the whole encyclopædia of knowledge, except mathematics, is to me as to the child just born.   If I open upon history, it is to find that I must retreat, and retreat again ; and terrified at the magnitude as at the novelty of the undertaking, I abandon it in despair.   In policy, legislation, ethics, all is darkness, for I have no principles to guide my search ; and here too I am alarmed at the obscurity, as well as at the extents of subject, of which I had never even suspected the magnitude, number, or importance, scarcely the existence.   Accidentally thrown for a few months into a circle engaged in discussing matters of commerce and public economy, I retreated from it with a sense of shameful ignorance, and with the hope of mastering those subjects in private.   But I labour and despair, and I see no light : I am confounded with new views, I am puzzled with reasons which seem unsatisfactory, and I am referred to facts which I know not where to seek.   The whole seems a turbulent ocean where there is no rest, a chaos where I cannot yet find those principles which I am now sensible I ought long ago to have mastered, and which I cannot now exert myself to search for and establish.   When I think that I have found some basis of an enquiry, it soon slips from me again ; for there seems to me nothing congenial in my own mind, with which it can be amalgamated and to which it can adhere.

  But to reflect on these graver matters is, at this moment, a source of vexation, almost of distraction to me, and I must quit it for things of less importance, though, like all else, sufficient sources of unhappiness, and, as you will shortly see, Mr. Editor, soon to prove, as I much

fear, no small addition to the evils which my mistaken pursuits have brought on me.

My profession, as I knew, would require a knowledge of the arts, a general one of the whole, and, of some branches, a very particular one. I did not therefore forget that there were such arts as painting and architecture; and, like others, I had amused myself with the Fitz- william collection, always putting off the day of acquiring that which seemed to me of so much less importance than the solid study of mathematics, and, at length, in the overwhelming absorption of those pursuits, even forgetting, at last, that there were such things daily in my eye as the buildings of Trinity, as Downing College, and Henry the Sixth's Chapel.

This neglect has just broken on my recollection. On a sudden I have found myself in London, in the midst of paintings, and if not surrounded by numerous specimens of admirable architecture, yet surrounded by variety of good and evil, and, what is worse, by a sort of excited spirit on all subjects of art, which seems now to pervade all classes of society. And I must now also fall into the company of those who know my public views, and from whom it is in vain that I attempt to conceal my disgraceful ignorance. Of paintings, of masters, of schools, of any thing that relates to the art or its principles, I feel like a child, or a savage suddenly brought out into a new world; as ignorant as that child, and without any one feeling or idea in unison with the persons or things about me. I am sensible that I am daily deprived of a source of pleasure, the effects of which I can see on my friends; but that is a small evil in comparison with the unlucky fact, that I have lost my reputation, (if I can be said to have lost what I never possessed,) before I have acquired it. My character for taste, or for expected knowledge, is already blasted, and to recover it may prove impossible.

It is now scarcely a consolation to me that I am a better mathema- tician than my neighbours, that I am really, as I may fairly say, a profound and solid geometrician. I have just discovered that a very little geometry is sufficient for an architect or an engineer, and that mathematical knowledge forms one of the least useful parts of his practical acquirements. And I have found, too late, that all which I could ever have wanted might have been learned in six months, that my command over the differential calculus is as useless in engineering and architecture as it is in chemistry or law, and, in short, that I have wasted five years in acquiring what is useless; and, what is much worse, while I have wasted years that can never be recalled, I have acquired a state of mind which I cannot well define or describe, that seems absolutely to unfit me for this profession, or for any practical one, for any of all the things which are to constitute my particular duties. All my refined powers of reasoning, all my habits of close abstraction, all my knowledge in higher branches of mathematical science, I now

find to be equally inapplicable and useless: they are not capable of application in practice, and as to my reasoning, I find it of much less value than that of my unscientific neighbours and rivals.

And while I have wasted those years in this dazzling and seducing pursuit, I have forgotten to learn all that I really wanted, all that I should be hourly called on to apply: and now I know not how to acquire them. The whole mass of my wants has fallen on me at once, and I know not at which side to begin. While I pursue one thing, I am distracted with claims from another quarter; nothing is done right, and nothing of all that I attempt to acquire in this hurried and confused manner, adheres to me, because I have not bottomed myself in those matters when I might: I am a pupil when I ought to be teaching, a student when I ought to be acting, and an apprentice where I should have been a master. If, of my five years, I had but spent four on the proper objects of my education, I should now have been at my ease, I should, I flatter myself, have been far advanced in my profession in life, in the way, possibly, to wealth; but whether I shall ever now recover what I have neglected and lost, is much more than doubtful. In truth, a thousand times in this forced and aukward career, I sit down and despair, almost envying the duller men whom I see outstripping me in the race, but who, instead of following the silly and fruitless plan which my injudicious friends had laid down for me, have spent their youth in acquiring useful knowledge and useful powers of reasoning.

A thousand times too, in the day, do I now feel tempted to curse Cambridge, and all its useless and foolish studies; studies which have misled my youth, injured my health, robbed me of my money, and destroyed my precious time. As an engineer, I was to be well grounded in mathematics, forsooth; I could never prosper without mathematical knowledge; it was the basis, the whole, the entire, the "sine qua non" of my education. And so it has proved, God knows; and could I but forget it all again, and recall, were it but one quarter of my lost hours, I might now be comparatively a happy man.

I have neither the courage nor the temper at present to examine the system of that university: while still feeling the attachment of habit to it, to my college, to all the people and customs which have been almost entwined with my existence, I cannot allow myself to speak with the indignation which would, I am sure, follow such an attempt. I will not, therefore, ask by whom this system was established, why and how it is fostered, for what purpose, and with what views or hopes the exclusive study of mathematics is encouraged, and why it is held out as the sole object worthy of ambition, and its honours the only merit. But I may ask, with what views an education of this nature is given to him who is intended for the church, for the law, for commerce, for physic, or to him who may be destined to the higher offices of the state, or to any office of this nature? There is not one of all those to whom

mathematics can be of any use as an acquisition, unless I were to make a slender exception in favour of physic ; and, in no one, does the logic of mathematics, as it is called, produce or cultivate that species of reasoning or establish those mental powers which are to form the guide and rule of their conduct, and direct them in the just and correct management of the duties which they will have to perform. ·

And how can I forget also, that, in all this, the real objects of the studies of all these persons is neglected and forgotten, as my own have been ?   The churchman learns neither theology nor religion ; the lawyer neither law, history, ethics, nor that logic which must form his logic ; nor do either cultivate their own language, that which must form the basis of their rhetoric and oratory, far less that rhetoric and that oratory on which the professions, both of the church and of the law so naturally depend.   That the future physician learns neither physic, anatomy, botany, chemistry, nor pharmacy, nothing of all that constitutes his science and enables him to practise his art, is more than notorious ; since, having, with us, gone through the farce of his terms and his degrees, he must go elsewhere to learn every thing that is essential ; while, like myself, he must begin to study in reality, just when his studies are supposed to be finished, and when he ought to be practising his profession.   In what way the mathematical science is to qualify a man for being a statesman, or a legislator, or an officer of government under any form, I am really unable to conjecture ; being perfectly convinced that, with all of that knowledge which I possess, and which, writing anonymously, I may boast of, without egotism, as equal to that of Woodhouse or Ivory, I am very sure that I am not fit to be made a commissioner of customs, or even a treasury clerk.   :

If the university itself will not consider these things, if it will not reflect that its duty and business, the very purpose, I suppose, for which it was founded, was, and is, to educate young men so that they may be fit for their several professions, and not to make every man indiscriminately a mathematician, and nothing else, though he may never, in the whole of his future life, have again occasion to look at a triangle or think of an equation, our parents at least might ask themselves this question before they send us to waste our time and money on so fruitless a pursuit.   But they follow the stream without reflection ; dazzled, I suppose, by the imposing terms, *mathematics* and *science*, and by the fame of Newton, and by all those unexamined opinions by which the mass of mankind is governed.   Thus also the very name Cambridge seems to deprive them of their senses, as does the word university, and the much more sonorous honour of an university education ; to which all aspire for their darling children, as if there was a virtue in the very name, as if to have breathed the air of Cambridge for four or five years, was to convert an ignorant being into a philosopher.

I have become a mathematician, it is true ; and, thus far, the object of my own parents, mistaken and misplaced as it has been, has not

been defeated. And if I had been destined for a professorship of mathematics, or to the place of astronomer royal, the end would have been attained. But my end has not been attained, as that is not my fate; and, so far, therefore, my own time has been as much wasted as that of those, the far greater number, who have neither acquired mathematics nor any thing else.

That there are many such, who leave Cambridge as little informed, on even this subject, as they entered it, I presume I need scarcely say, when we find so few mathematicians in the world; so few in society, even in professions which seem to require this kind of knowledge, who know any thing whatever about the matter. If parents expect that every boy who goes to Cambridge is to issue a mathematician, they are most grossly, grievously mistaken; and so far from this, I can venture to say that, in my own year, there was not one mathematician left the university; and that ninety-nine in a hundred could not, in two months after leaving it, have solved a common problem in plane trigonometry. By what means the appearance of this acquisition is carried through the university, by what means young men contrive even to rise to honours without real mathematical knowledge, it would be tedious to say here; and perhaps it would not be right in me thus far to betray the secrets and expose the vices of my own Alma Mater.

But if parents will not be convinced by my assertion, it is not difficult to bring the matter to the test of calculation. There are not a great many real mathematicians in Britain altogether; and, of that small number, which it would be invidious to the less informed to select and name, there is not one-third that has been educated at Cambridge. Speaking as a mathematician ought, I will only assume that a thousand young men annually arrive at Cambridge and quit it, or that there are a thousand residents, a thousand persons educated in the mathematical science. If any one can produce fifteen mathematicians formed by Cambridge within the last thirty years, I should be very well pleased if any of your correspondents would name them, for it is more than I could do; and this, it is plain, gives a ratio of one to two thousand. That is, out of two thousand young men, spending, on an average, three years, or four, and, I ought to add, a thousand pounds each, in acquiring mathematics, one succeeds; while, I am very sure, that of the remaining one thousand nine hundred and ninety-nine, there are not fifty that have become even moderately skilled in this science, while there are at least a thousand who know not more about it than an infant. And even of those who may have gained some knowledge of this nature, there is not one in two or three hundred to whom it becomes, in after life, of the remotest degree of use, or even of satisfaction or ornament. There may be a few whose misfortune it will be to become teachers in academies, to whom it may become a profession; while, unluckily, it proves a worse one than that of a carpenter or a tailor. A few also may possibly become architects or

engineers, or soldiers; but it is a singular fact nevertheless, that since the days of Sir Christopher Wren, we have not had one architect nor an engineer who was a mathematician.

With this chance of success before them, parents may now calculate, each for himself, whether his son is to be the fortunate exception, the sole youth of two thousand, or even of one thousand, who is to be the mathematician, to acquire that miraculous rank and wonderful knowledge, for which all those sacrifices have been made. And when they thus calculate, let them also add to the calculation, that if their child be destined to a profession, they are impeding his studies instead of forwarding them; impeding those, whether he acquires the mathematics or not, and wasting that time which is generally all the time he possesses towards acquiring the knowledge which he really requires. Let them here calculate too, that probably when he leaves the university, he must immediately enter on his profession, be he destined for a statesman, a clergyman, a lawyer, a doctor, a merchant, a manufacturer, a chemist, an engineer, an architect, what not; or that if, as is probable, he is utterly unacquainted with all that which must be the foundation and knowledge of his peculiar profession, he must spend three or four more years, and another thousand pounds, in acquiring what he ought now to have known, or set to work and take his chance of contempt, ignorance, incapacity, and perhaps ruin.

And there is another consideration yet, which must not be kept out of this calculation; while I am sorry that I cannot overlook it, reflecting, as it does, on the establishment to which, in spite of all its errors, and my misfortunes, I still feel an unaccountable attachment. It is very probable that young men arrive at Cambridge from the public schools, with very doubtful morals, to use no harsher phraseology; yet though my own studious and retired habits kept me from mixing much with the idle society of my own or any other college, it is but too notorious and lamentable that the university is an extensive school of vice and profligacy under all their forms. It is absolutely fearful to reflect on what even I have witnessed; and I do not indeed well see how it is possible for any youth to stem the universal torrent of corruption; while it is most certain, that there is an extremely small proportion of young men who ever think seriously of any study or learning while they are at the university, or consider it as any other than a place in which they may amuse themselves with every species of fashionable vice.

Thus it happens, that, not merely neglect of all useful learning is the character of the university, but that there are acquired in it, habits of idleness, immorality, laxity, or absolute vice, scarcely ever again to be eradicated, and not seldom attended with ruined health as with ruined minds, to become the bane or curse of after life.

And while I must confess that I was myself shocked and astonished at the general conduct of my fellow students, in spite of all the

appearance of discipline, which I presume, of the efforts of the heads of colleges, and of rules and sciences; so was I still more surprised at finding that the necessity of learning seemed not to form a feeling with any but the solitary few of studious habits, or narrow means, or with those who knew and felt that their success in life must depend on their own unsupported exertions. I had expected to find that every one was in pursuit of science and of nothing else; that all conversation was scientific, or at least literary, and that, to learn, was a pleasure as well as a duty. Knowing that there were professorships of botany, anatomy, chemistry, law, and so on, I had flattered myself with finding not only professors, but students, skilled in all these sciences, and pursuing them with avidity; and I expected that, with little effort of my own, living in the midst of scientific conversation, I should have acquired an insight into those sciences which were especially to be of use to myself; that my doubts could be resolved in a moment by merely asking questions; that I should be directed in the choice of books, and that libraries, lectures, persons, every thing around me would be open to me; that I was to live in and breathe an atmosphere of science.

· Alas! I found myself an Undergraduate, looked down on by all above me; nobody, not one man, seemed to care about himself or about me; except my tutor, who could only listen to my Euclid and my Algebra, and who, when I questioned him, was unable to answer me; and discouraged all other studies but his own. Many of the professorships were sinecures, and there were no lectures; where there were lectures I found I could not learn from them, as I could ask no questions, make no experiments, get access to no books, and found nobody to communicate with, nobody to direct me, to tell me what I ought to learn or how I could contrive to learn it. In short, I found that nothing but mathematics were honoured or cared for; and those who did not pursue them, spent their days and nights in idleness and drinking. By degrees, therefore, I forgot what it was that I wished to learn and ought to have learned; and, naturally studious and retired, sunk into the abyss of mathematics, gained honours, and, at length, I was awakened from my dream.

Yet once or twice I seemed to awake during my career, and thought of asking myself what I was doing; whether I was making myself acquainted with my future profession; whether I was studying che-mistry, geology, mineralogy, sciences with which it was probable I was hereafter to deal; whether I was learning to draw, to survey land, to understand materials as a builder and an engineer, whether even my geometry and my algebra were teaching me how to build a bridge or a dock, how to lay out a canal, work a mine, or construct a crane or a mill. But again, the charm of my mathematics, the ambition of honours, hurried me away and drowned those thoughts; and then also I reflected that I should now assuredly attain a fellowship, and who

then gain access to all the men of science around me, be admitted to the instructive conversation of the Combination Room, and soon make up my time. I did succeed; I became all that I had wished, and, must I say it, Mr. Editor? in all that period which I spent in this Elysium, I never once heard a single question of science discussed, or even named; and I learned, rather too late, that as was the bottom so was the top; and that I must now seek for what I wanted elsewhere. I sought it all in London, where I now see, when it is too late, that I ought to have sought it all originally; for, even in the apathy of my regret and despair—almost despair—I here find that I have acquired more knowledge in three months than in the whole five years of my residence at Cambridge. London is the university, after all. It is here alone that real knowledge is to be acquired. I have shut up my Newton and La Place for ever; and even while I write, a gleam of hope breaks on me, and seems to assure me that I may yet be something, though I feel that I must again begin to labour, when I had flattered myself that my labours were ended.

I have blamed my parents; and yet they were not so far wrong as most others; since the connection of mathematics with my future views might have misled better judges. They knew not, and I had to discover, that a very limited portion of mathematical acquirements was amply sufficient for all my purposes—for all useful purposes; and that my duties were to be practical, not speculative. They did not know, and I did not consider, that fluxions would neither explain nor construct what it would fall on me to understand and direct; and they forgot, as I did, how many other sciences would be called on in my career, and that my success must depend on the universality of my knowledge, and of my practical and useful knowledge. They forgot, and so did I, that if I spent all my time in mathematics, I should have none left for my necessary studies; but they expected to make a mathematician of me; and a mathematician indeed they have made. But the mathematician will starve; and he must now learn to forget what he has been, and grieve over the honours to which he once looked as the supreme attainment in human felicity.

It is a year now, Mr. Editor, since I committed to paper, the lamentations (for so I must call them) with which I have troubled you. Whether, Cantabrigian as I understand you to be, you will condescend to publish them as a warning against the rock on which I have been wrecked, I cannot foresee; and it was from a doubt on this subject that they have so long lain in my portfolio; so often tumbled over that it will be fortunate if you can decypher them. On viewing them, however, I have determined that they shall take their chance; and written, as they were, during various moments of sad reflection, I will not even alter the form, though I must not boast of a correct composition where I did not intend to make one. I have now begun to

see daylight in the career before me; I have even undertaken to direct one of my former companions, equally industrious and equally misled, if less successful; and whose object also was somewhat different from mine, inasmuch as he was destined to the superintendence of two important manufactories, requiring profound and extensive chemical knowledge, among other things. Thus I am become a sort of teacher and a learner at once; and have scarcely yet discovered by which of the two operations I have made the greatest progress.

My pupil, however, if such I can call him, is at no loss in deciding between his present line of study and that which he pursued so long, with even more industry, though to no useful purpose. If I have derived some slender advantage from my mathematics, it has been his evil fate to gain none; and the whole of his previous labour, if not the whole of mine, has thus been absolutely lost. He has been once or twice inclined to trouble you, like myself, with the history of his own peculiar grievances; but will now, I believe, be satisfied to leave the pen to me; though I cannot, as he might, explain precisely what are the operations which he will have to conduct, or to what extent he must yet labour in acquiring the knowledge which a just view of his profession has pointed out as necessary for him. But, like myself, he feels that London is his university; and that, under a guidance, here easily obtained, and with the active demonstrations going on all around him, in real, not fictitious lectures, in manufactories, models, machinery, operations of all kinds, and with the opportunity of cultivating practical men, consulting books, asking questions where doubts arise, and the power of working for himself, he is rapidly restoring to himself the time he had lost, and bidding fair to be the useful and intelligent professional man of which he had at first despaired.

And if I have thus set up as a teacher, a very partial one and a very imperfect one I must admit, I have also discovered, in the conduct of those kind-hearted persons who have assisted him in his pursuits, some facts in the business of teaching, which have rather confounded all my former university theories on this subject; which have as much confounded me as I have been disappointed by the new views respecting the high and vast utility of extensive mathematical knowledge, which have lately been forced on me.

I said that my friend and neighbour at St. John's was no less industrious than myself; gaining the applause of his tutor, and taking ultimately what we call a very fair degree. Thinking, myself, of nothing beyond the solution of our problems, and seeing his success, I had considered that his tutor was doing well the duty he had undertaken, and was often inclined to compassionate as well as to applaud his laborious exertions. I have had, Mr. Editor, to change my mind about this matter; and not less to change my mind about the labours and judgment of a teacher, than about the success of his pupils. Never was such a routine of mechanism, as that which is called

teaching; and I really doubt now whether there is any practised teacher, whether in mathematics or anything else, who makes the slightest mental exertion, or does more than might be done by an engine, if we could make an engine speak. My friend was a mathematician, I have said it; but his mathematics were a mere effect of memory, an affair of rote; and when I began to examine him as to principles, when I tried to make him apply them to practice, I found him as much at a loss as if he had never looked beyond the first book of his Euclid. I see now the reason, though I did not see it then, and I see that it cannot be otherwise. Neither public teacher, the teacher of a class, nor private tutor, ever attempts to ascertain what is the pupil's state or strength of mind; whether he really understands what he is doing, still less whether he sees the object, purpose, or connexions of it. To all minds, all conditions of intellect, and almost all of progress, in the public class at least, and too commonly in the private ones, the same instructions are given, the same mechanical explanations; and while the process seems to be advancing in the general mass, the teacher never considers what the individuals are doing, but is satisfied. And instead of really labouring, even in this slovenly way, of doing his duty, I am now convinced that there is not the least mental exertion; and that, as is reported of Sir Walter Scott, the teacher might be composing a novel while he is appearing to listen and to teach.

I am not going to lay down a better method; I could not if I were inclined, since I am but a new and an inexperienced teacher myself, as the teacher of one pupil must needs be. But I have discovered two things; that, in six weeks, I have taught my friend more mathematics, that is, more real, solid, useful mathematical knowledge than he had acquired during his whole university residence; and that, in one hour he has done more under my direction, or been put in the way of understanding and doing more, than he would have acquired, or did acquire, in the ordinary instruction, during a whole term. I know his mind, and I know his progress; I see his doubts and can solve them. I can show him his road and make it easy; and I can also show him where and how his mathematics will be of use, and how he is to use them; what is useless, and what he may neglect.

But I have also discovered that in this, which is my especial science, it requires more exertion of mind, more care, more discernment, to direct and educate one pupil well than to teach a whole class; and that perhaps the labours of one hour, to me, are thus greater than the whole exertions of a day to the teacher who carries on the routine of a dozen pupils. This has taught me a sort of respect for private tutors which I was little inclined to yield formerly; but I must add, that this respect can only be commanded where the tutor really does his duty to his especial pupil, whose mind he must study, to whose slowness or aberrations he must adapt his instruction, whom he will fairly examine,

and whose doubts he will clear up, as he directs him in that particular manner which suits the complexion of his mind. Such a tutor is, I am sure, invaluable; and if (as I may, anonymously, say it without a blush) I feel that I am myself such in mathematics, I must equally conclude that the same rule applies to all the sciences; as indeed I am partially convinced already, by the effects which a very few conversations only, with professional men, have produced on the mind such progress of my friend.

I must own, that during my severe labours and intense application at college, I was unwilling to believe what I had often read and heard, that learning of any kind was to be attained without such application; and far less was I inclined to admit what was asserted of the Jesuits' method of instruction, which consisted chiefly in conversation, and in very occasional conversations also. I now acknowledge my error. I now see that when I have been spending ten hours a day in intense labour, I have not reaped the fruits of one hour; though what became of the rest, I cannot now divine. And I now also see that had I possessed a sensible and intelligent tutor, instead of a mechanical one, (though mine was among the best,) I should have made in one hour the progress I made in a week; and that, above all things, if I had had the good luck of possessing one that was a man of real science, instead of a mere mathematician, I should with facility have attained, at the same time, a solid insight into the different sciences which I was then studying, and have, partially, at length begun to understand.

Such is a sort of sketch of the present history of my own labours and those of my friend; and every day I am more and more surprised at the progress we are both making in our several studies, and in no other direction than that which I have named, and our own exertions. Above all things, I am thankful for the events which have fixed me for a time in London, and for the circumstances which have given me access to men of real and various knowledge, as to all those works, drawings, collections, and so on, which surround me at present; to that habit, in every thing solid and useful, which forms such a contrast with the useless, dead, unprofitable gloom and sleep of a college life and of college studies. I am now no longer ashamed to find myself in society; and, every day, I am sensible that I learn something useful in conversation, as every day I see and observe something from which I derive valuable and solid instruction. I am even astonished at the rapidity of my progress, now that I have once found the real avenue to learning. Five months, nay almost five weeks, have done more for me lately than the whole five of my college years; and the despair which had aided, with my former uniform gloomy labours, in paralysing my faculties, has fled, never more, I trust, to return.

But I must cease to speak of myself, though I cannot help thinking that my history may be of use to things who may be situated as I have been, and am, however doubtful it may be of influencing those

whether pupil or parents, who still look up to Cambridge and to mathematics with wonder and awe; and who, unable to form opinions of their own, will continue to follow the muddy stream which their predecessors have floundered in before them. But now that I can argue this question in another way than I should have done when my eyes were darkened with the fogs of St. John's, I shall trouble you with one or two thoughts that have recently occurred to me on the subject of mathematical learning.

I am not going to doubt or deny the profundity, the splendour, the difficulty, of that study which forms the sole or main object of a Cambridge education, you may well suppose; nor, though I have named my own regrets and indignation, am I even insensible to the captivating nature of those pursuits, to the high interest which they excite, or the gratification which they afford. I know not indeed that life contains any pleasure greater than that of watching the development of mathematical truth—than that of pursuing a train of accurate reasoning, or seeing our labours terminate in a satisfactory result. Neither am I insensible to the just fame which our university has derived from the great men which it has produced in this department, nor to that which Britain itself has inherited from the great names that are found in the annals of its mathematical science. Far from it. Mathematics have been my mistress, and they are still the objects of fond recollections; and of an interest which I am but too-sensible I must not now indulge as I have done. For, that they possess those seducing qualities, is perhaps even one of their faults; since we must not too far yield utility to pleasure; even though that pleasure be the laudable pleasures of the intellect, the exertion of our highest reasoning faculties.

As members of an active community, it is our business and duty to qualify ourselves for the services which it demands from us; and hence: mathematics must, and can only be, justly estimated, like all other knowledge, by their utility; except in those rare cases where those who have no absolute duties to perform, may, if they please, use them as the occupation or amusement of their leisure.

I know full well that they form the indispensable preliminary, the grammar, I might almost say, of many of the sciences; of some at least. I know this from my own experience, because the sciences in question are those which fall especially to my lot. But let us see that we do not over-rate their use and application. They are required in some of the arts that belong to war and to navigation; they are required in those arts where mechanism and machinery are concerned; and thus they form a basis of instruction for the engineer, the architect, the miner, and the surveyor, if we may distinguish this last profession. But here we may almost draw the limit; for they are not the grammar of the theologian, the lawyer, the statesman, the economist, the merchant, the agriculturist, the chemist, or the physician, nor of many

offices, branching out of those, which I need not detail; as they are equally useless to most artists, artists in the fine arts, and to a large division of artisans and manufacturers.

Such a statement must demonstrate to how small a portion of society the uses of mathematics are limited; while it is the custom to bestow this education indiscriminately on all; on all, at least, who frequent the nursing mother whose milk I sucked.

And I may now also safely ask, to what extent mathematical knowledge is useful to the profession and pursuits which I have just named? or, rather, what extent, what progress in mathematics is required to gain, for those purposes, all that is wanted for success?

I must make that enquiry brief, which might easily be prolonged, by details that would occupy too much of your valuable room.

Let us even suppose that the practical man ought to be acquainted with the mathematical principles of the arts which he exercises, it is not difficult to see how very narrow a basis of mathematical knowledge is necessary for all those purposes. In mechanics, it is sufficient to know the most obvious demonstrations in the theory; and to what a narrow branch of geometry those are limited, I need not say. That a mechanician should be acquainted with dynamics, nobody will maintain; and it is most certain that he would derive no use from them. The same kind of reasoning applies to carpentry and architecture, as it does to ordinary and military engineering, and to gunnery and navigation; as it does also to surveying, since a knowledge of plane and spherical trigonometry will give even the theory of that which may quite as well be conducted by mere practical rules. And if there are practical problems, such as in mensuration for example, the principles of which cannot be understood without fluxions, I know not that it is necessary for every gauger and surveyor to be a mathematician, or that he would gain much in utility by knowing the theory of rules which cannot fail to succeed in his hands.

But, writing to your general readers, I must not enter on details here which would not be generally understood; though it is easy to ask, whether it is necessary that every practical lawyer should be also a jurist, like Bentham, every merchant a Smith or a Malthus, more than every navigator a Newton. The cases are parallel; and the inventors, the great theorists in science, must, in all cases, be distinguished from those who are to apply the discoveries which those have made.

And it is a remarkable truth, that those inventors, those great theorists and mathematicians, have not been the discoverers of the useful applications of mathematics. Nearly every one of our valuable discoveries in the mechanical arts, have been the produce of men not mathematicians; often, absolutely ignorant of almost the name of mathematics, and very frequently utterly uneducated. The very worst Minister of Marine which France ever possessed, was the ma-

thematician Monge ; and excelling us, surely, as the French have for a
long time done in mathematical science, we have almost invariably
outstripped them in ship-building. We have very lately outstripped
them, conspicuously, in the person of Sir Robert Seppings ;—himself,
if I have rightly understood, so ignorant at first of the commonest
principles, that he did not even understand what was meant by the re-
solution of forces, and could not comprehend the principle of his own
invention, even when it was explained to him. Thus also have we,
most notedly, outdone the rival nation in our endless machines and
inventions, notwithstanding their superior and boasted science ; and
in no one case of this nature, I believe, have we been indebted to a
mathematician, even for a hint.

I excepted Wren before ; but, in no other instance, have our great
engineers and architects been mathematicians : while he, who was the
very father of modern engineering, of the trade of civil engineer,
Smeaton, did not make even a pretence to that mathematical know-
ledge of which he possessed none. It would be easy to apply this
much more widely, but it is not necessary—while it would be no less
easy to give the history of individuals, sufficiently well known to the
public as men of the highest eminence in their professions, and not
less known to mathematicians as utterly ignorant, or most slenderly
informed in mathematical knowledge.

I might here show, if I chose, the exact point at which mathema-
tical knowledge ceases to be practically useful, whether in mere
geometry, or in algebra and in the more abstruse methods of calcu-
lation which depend on the adoption of symbols; but to do this,
would be to write what general readers would not understand, and
what mathematical ones will comprehend without explanation.

This is as far as I can here venture to go on the question of the
practical and absolute application and utility of mathematical learning ;
but it is proper to examine that assertion also, which maintains that
mathematics form the only true logic, and that they are the most
valuable engine for cultivating the faculties. Though I noticed this
subject formerly, it deserves a little further examination.

Were I to judge solely from my own experience, I should, without
hesitation, deny the assertion—feeling that I have gained nothing but
the faculty of patience and abstraction ; while I am not less sensible
that this patience is such only, as it is applied to the very objects for
which, and by which, it was formed. I do not perceive that I have one
jot more patience than my non-mathematical friends, in the ordinary
pursuits and studies of life—nor in moral matters ; nor do I perceive
that my habits of abstraction to a series of signs and symbols, have
any thing whatever to do with that moral quality, as required for the
general concerns of life. On the contrary, I suspect very much, that
it is quite the reverse ; and that from long habit and practice of
having my attention exclusively excited and secured by one class of

operations, I can scarcely fix it to matters which possess a less apparent interest, or a different kind of interest. I am not even sure that I am not the worst chess player in the whole circle of my acquaintance; though often assured that an algebraist and a mathematician must inevitably be the conqueror of the world and the rival of Philidor.

Now, of the utility of mathematical science as an engine of reasoning, I am even more doubtful, or, rather, I am quite certain, that it is of no use whatever, beyond those particular objects of which it forms a basis or a portion. I can feel its value in conferring precision of views and ideas in my mechanical pursuits, undoubtedly; and I feel too, that it renders my language, on all physical subjects, I believe, certainly on many, more precise than that of most of my friends. But there it ends ; and I cannot really see how it should possibly do more.

In fact, the whole matter has been miscalculated, or over-rated, from ignorance of mathematical science chiefly; but partly from confounding different things under the general and vague term—reasoning; from not accurately inquiring into the process called reasoning, as it is applied to different objects and pursuits.

A man must indeed be absolutely ignorant of mathematics, to imagine that all the branches of it consist in trains of reasoning, even though we were to use this word in the most lax sense. A student does reason himself through Euclid's elements, I admit, as far as that can be called reasoning, which is never for a moment engaged about any thing but the comparison of quantities, about the contemplation of equal or dissimilar magnitudes, about angles and lines, surfaces, solids, and proportions. Here, under some sense or other, geometry is an object of reasoning; and the geometer, he who pursues this branch of mathematics, may cultivate his reasoning faculty by this method—if he can,—as far at least as it admits of being thus cultivated.

But I must inform your common readers, that geometry is not the fashion, at present, in mathematics; since it seems that there must be such variations of humour and views, fashions, even on subjects of such a nature as this. It is the usage now to do the work in a far other way, by algebra, or by symbols; and though it is not all done thus, a deep incision has been made into the geometry which was the pursuit of our ancestors, and the pursuit of Cambridge also.

And whether this were the case or not, our college pursuits, or the mathematics on which we pride ourselves, are not founded in geometry but on algebra : they are the calculi, (to use a hard word,) the calculations, which depend on symbols, and in which I never could discover that any atom of reasoning, if I rightly apprehend that term, ever enters, at least after the first step is fixed. The whole is a system of conjuration, if I may use such a word for want of a better. Not only is there no one step that can be called reasoning, but the man who works this engine, does not even know, from one minute to

another, what he is doing; nor does he see one inch beyond the un-
meaning symbol which he substitutes or transposes, multiplies or
divides, squares or cubes.   There is not a point of the whole opera-
tion where he knows what he is performing, till the work is finished
and the solution comes out; and need I say, that if an x has been
misplaced, or a dot forgotten, it may turn out, as it often does, that
nothing is more than something, or that the same body weighs one
pound and ten thousand.   It is the man who puts a quantity of dice
into a box, and who exhibits his ingenuity and patience, by shaking
them so artificially, as to make them all turn up aces.

In this way, therefore, is the reasoning faculty cultivated by modern
mathematics; and your mathematical readers will vouch for me, that
I have not exceeded the truth; while there is not one who, if he be
honest, will not confess what I am now confessing.   If he do confess,
he will acknowledge, that, so far from his reasoning faculty having
been cultivated, it has much more probably been injured, and that he
is far behind in general mental powers to those who have undergone a
discursive, even a mere literary education; who have been engaged
on things, or even the names of things, or on ideas, instead of in conju-
rations, and abstractions, and the exercise of a peculiar kind of in-
genuity.

If it is answered, that there are, and have been, great mathema-
ticians who are also able lawyers, or men of general science and
extensive knowledge, it is easy to perceive that these are things running
parallel, not that the one is the produce of the other.   The same
ability and industry, otherwise directed, which have made this man
the lawyer, or man of general science, were also those which made
him the mathematician; but the latter study or effect has not been
the cause of the former.

If I have here spoken hitherto from my own experience, I can also
back myself by authority; by that of Dugald Stewart, himself a
mathematician as well as a moral philosopher; and by a far greater
name than his, that of Bacon.   So can I also, by the name of a
mathematician, whose knowledge in this science will as little be
questioned as his general ability, I mean S'Gravesande.   I need
not quote from the first work, which is in the hands of most persons ;
but when Bacon remarks, that the " logical part of some men's minds
is bad, while the mathematical part is good," he pronounces at once
his judgment on the logical value of mathematics.   The expressions
of this last named author, are far more full and strong: but as I
cannot well abridge a passage which it is not very convenient to
quote, I may refer your readers to his well-known work.

But I may remark in general, that there is an utter distinction
between mathematical and moral reasoning, depending on circum-
stances that must be apparent almost as soon as they are named.

Let us examine in what mathematical reasoning consists; what is

the nature of mathematical truth: and, in this examination, it is of geometry that I must speak; since it is to this branch of mathematics, to be correct, that the operation of reasoning is limited.

I shall but use the language of much better mathematicians than myself, when I say that the whole science is founded on the very simple fact contained in one of the earliest propositions of Euclid; namely, and in vulgar language, that two magnitudes, triangles, which coincide in every part when brought into approximation, are equal. And, not to enter on the doctrines of proportion, as not suited to general readers, while all mathematical truths are based on the simple fact of equality, all mathematical reasonings are analogous processes, by which that equality is finally inferred.

Consent, or conclusion, is therefore an inevitable consequence; or it is compulsory on us to believe in what is called demonstration; while, in every step of the whole process, there is an equally necessary conviction of the truth or falsehood of the different relations by which we finally ascertain the ultimate truth in view. There is here no conflicting evidence to distract us, no probabilities to mislead us, no opposed weights to balance, no fair falsehoods to influence our reasoning, nor any prejudices to contend with. The truth or the falsehood are always clear and decided; and we believe, not because we desire it, but because we cannot avoid believing.

And let us also observe here, that if we have no prejudices to contend with, it is because we have no interest in the result; no other interest at least, than that of convincing ourselves that it is fairly and truly drawn. Our affections are in no way engaged in the conclusion; it is indifferent to us what that is, so that it be but a just conclusion. We might not have known that the angle in a semicircle was a right angle; it is even possible that we might have expected, we might possibly have wished, to find it otherwise; but the moment that we are convinced it is so, we are satisfied. If, at present, we are anxious, interested, in finding the ratio of the hypothenuse, or the area of the circle, it is because we think them capable of being ascertained: let the impossibility be demonstrated, and we are as well satisfied as if we had assigned the ratio of the one and squared the other.

As an engine of reasoning, therefore, or rather as a method of logic, a means of cultivating the general reasoning or logical faculties, the mathematics possess the fundamental defect of considering truth merely as it relates to itself; not in its connexion with us, with our passions, prejudices, desires, or feelings. And, similarly, its truths bear no relation to the state, nature, or feelings of mankind at large; or to human actions and human events. The truth of mathematics relates simply to quantity, and to abstracted quantity; and their circle of reasoning is but one, ending as it begins; unyielding, incapable of bias or perversion, unacquainted with probabilities, and rejecting all that is not certain; tangible, it may almost be called.

But the mass of human knowledge, human events, human actions, consists not in quantities, not even in certainties ; life is a series and an entanglement of probabilities, or of things not tangible, and not to be measured or weighed. Thus also do the great operations of reasoning consist in the examination of probabilities, in the balancing of contending evidences, evidences of different force and weight. They consist in discovering and eliciting absolute truth, by a series of operations utterly distinct from those by which the truths which belong to quantity are discovered ; and failing to elicit absolute truth, they learn to act upon that which is probable, which is supported by the predominance of evidence.

The logic, therefore, of all that is not mathematics, is a logic apart from the logic of quantities, of abstract and absolute truth ; and this is the logic in which human knowledge, all other human knowledge than mathematical, is concerned. And it is a distinct logic ; which never was, and never will be, formed out of the logic of mathematics. And while this latter species of reasoning is thus inapplicable to the great mass of human knowledge and human action, it possesses no power in counteracting those great obstacles to the discovery of truth—passion, feeling, prejudice ; qualities with which we are in daily contention, which are the leading causes of error and falsehood, as of wrong action. It is the logic of morals, of metaphysics, if I may use a term often abused, which is the logic that we require ; that logic which proceeds by analogies, which exerts itself in weighing probabilities, in counteracting passion, in clearing away the endless entanglement by which truth is perverted or obscured.

If this reasoning applies most fully and especially to moral investigation and moral truth, to that which forms the endlessly implicated and main business of life, so is it true, if in a less marked degree, that the logic of mathematics, that precise, dry, and secure method of investigating truth which is derived from geometry, is not an engine of general power and application, even with respect to physical nature as it now surrounds us. Were our knowledge of nature complete, had we elicited all the facts, ascertained all the truths that belong to matter in its endless forms, our reasoning respecting physical analogies, events, or facts, would be as precise as our reasoning respecting abstract quantities ; and we might then indeed apply to them a rigid logic resembling the logic of mathematics. There would be one logic for matter, whether real, or in its abstract relations ; as there would be, and must always be, for morals, while we are the imperfect creatures that we have been formed.

But we are yet far removed from this degree of knowledge. We know the forms and relations of matter, the bodies or substances which constitute physical nature,—Nature,—and their mutual relations and actions, but in parts ; we see them imperfectly, even where we do see ; and what we do not see we attempt to infer or

conjecture by analogies, by probabilities, by the balance of evidence. Thus it is that the logic of physics partakes of the logic of morals, as yet, even more than it does of the positive logic of mathematics. And this might easily be illustrated in a thousand ways ; it might easily be illustrated by the mathematics themselves, when the very first step, the foundation of a mathematical investigation, is laid on moral reasoning, or fixed by the logic of superior probabilities.

I cannot here afford space to illustrate this as it might easily be illustrated, nor attempt to specify the exact nature of that logic which must be our guide in physical investigations, since it would require an essay in itself. But I may remark, that it must be founded, and can only be founded, on an extensive acquaintance with nature, with the forms and relations of matter ; and I may therefore leave it to the conclusion of your readers, how far the bare habits of mathematical reasoning will tend to form the logic of physics; or what probability there is, that we shall find a sound logician of this class, in him who has neglected the study of the things on which he is to reason, or whose whole logic has been confined to the comparison of the abstract truths that relate to mere quantity.

Such is a very slender sketch of the question, as it relates to the utility and nature of the logic to be derived from mathematics, as compared to that which is required for the investigation, whether of moral or physical truth ; and here, for want of sufficient space, I must allow the question to rest.   And, practically, it is a truth but too well known, as many more than Bacon have agreed, that while mathematicians have generally shown themselves no better reasoners than other persons in questions of morals, in all the great questions that belong to human life, they have very often, and very conspicuously, proved themselves to be much more deficient.   Such censure has even, and not unfrequently, been passed in the form of ridicule and satire, and, most assuredly, not unjustly.   How slenderly the great study of physics, of material nature, has profited by their reasoning powers, it would be equally easy to show ; and when there have been exceptions, it is rather because two pursuits have been combined in one powerful mind, and that the philosopher and the mathematician have existed together in the same man.

I think I may fairly add to the preceding remarks, that while human knowledge does not consist in demonstrable and abstract truths, the exercise on those, which constitutes mathematical powers and forms mathematical reasoning, is deeply injurious, in a negative manner, by causing the neglect of the other mental powers, by leaving other, not less necessary faculties, uncultivated.   It not only induces the neglect of the sciences and objects themselves, for the understanding of which it is held out as the indispensable basis and preliminary, it not only causes a similar neglect of moral relations and moral probabilities, thus

leaving the mind unfurnished with those facts, the knowledge of which is indispensable, and which must be the basis of all reasoning, without which there can indeed be no reasoning, but it impedes the very cultivation of those faculties which it is held forth as especially calculated to form.

And I believe too it will be found, that these pursuits (I speak, of course, of their excess) have an injurious general moral influence, that they affect perniciously the very texture of the mind, by inducing a habit, a permanent feeling of dissatisfaction, or doubt, respecting all truths which are not capable of strict demonstration. He who has long been used to receive exclusive satisfaction from the proofs that relate to magnitude, figure, and proportion, rarely feels easy under any proofs of inferior value. In the ordinary conduct of life, it is unquestionable that this state of mind has produced the effect of causing indecision of character; an unwillingness to act, or a slowness in action, or positive misdirection and wrong conduct, where persons of other habits, of minds commonly esteemed much inferior, have found no difficulty in choosing, and have also taken the right path.

Such appears to be the chief of the evils resulting from an extensive or an excessive attention to mathematical studies; while such also appear to be the answers which ought to be made to those who maintain their useful influence on the mind, and the explanations by which those answers may be defended. I know not if, after this, it is worth our while to consider some minor inconveniences arising from the same cause, but they may be named before terminating this slender essay, if essay it may be called.

It appears to be a fault in mathematical studies that they too often deprive science of its attractions, whatever seduction they may exert over some minds, thus repelling many more than they attract. This is an evil of no small weight; and I think that its effects may easily be witnessed in our own university. There is a happy medium, it is certain; but I fear it is not very often obtained; and that while, to most, science itself is thus rendered disgusting and repulsive, producing the same general dislike to study which is also the result of an exclusive attention to the dead languages in our schools, to a few others the consequence is that already stated, of exercising a seduction which directs them from all the really useful or necessary pursuits of youth.

Nor must I forget one other consequence, which, if not extremely frequent, is important in its results, defeating the very end and purpose of all that on which so much labour has been bestowed. It is most certain that the mass of mankind is incapable of following a train of close reasoning, or of comprehending the nature of demonstration; nor can it be expected from those who have not been accustomed to define their ideas or exert their own reasoning powers; while it is equally

certain that this great mass is especially under the influence of its prejudices and feelings.

Here, therefore, not only are the efforts of the mathematical reasoner wasted, his demonstrations thrown away, but, deprived, from want of habit, of all those modes of influencing mankind which depend on more vulgar or other modes of persuasion, he is vanquished by an inferior intellect, or sees produced, by means which he knows not, or has been taught to despise, the very effects at which he has laboured in vain. It is not in the nature of a rigid and mathematical reasoner, as it does not belong to his especial mode of reasoning, to vary, to extend, to repeat his arguments, to apply to feeble ones, to use analogies, to deal in illustration, to indulge in metaphor, to condescend to ornament, to appeal to the passions.   He reasons with others as he would reason with himself; forgetting that all are not like himself, undiscerning in character, and unable to lower his faculties to the ignorant, to adapt himself to the prejudiced, or to suit and vary his methods of proof to the infinitely varying characters of the human mind.   If, to apprehend clearly and to reason rigidly, must be the basis of persuasion, must confer the powers of demonstration, it must be recollected that all this is yet but the basis, and that those properties alone will not produce conviction, unless he who hears be capable of apprehending with equal velocity and precision, and of reasoning, himself, with equal accuracy.

But I must end, with some fear lest I should have wearied out your patience.   I would not, however, be mistaken.   I do not undervalue mathematics, far less despise them; I do not wish to see them abolished as a study for youth, because I am sensible that, to some of the sciences at least, a certain portion of them is necessary.   But I wish to assign them their due value, and particularly for the end towards which they have been held out as indispensable—the general cultivation of the mind.   And I wish that parents, and students also, would consider, precisely and accurately, not vaguely, not under the influence of habit and words, but with a view to the future, what it is that they propose to themselves in cultivating this branch of knowledge, what time it deserves, and whether there is not much more that is far more necessary. Mathematics are not the " one thing needful;" far from it; and, most assuredly, will those repent, as I have done, who, in looking backwards, find, in their retrospect, that every thing which they are now called upon to do, has been sacrificed to an useless pursuit or an empty fame.

I ought not, perhaps, to blame my teachers—to turn traitor to my own Alma Mater—but there is a fault somewhere; and the fault must be in those, who, having themselves been educated in false views, having received a wrong education, go on perpetuating it; as it must continue to be perpetuated while mathematician shall succeed to mathematician, and while all honours shall be reserved for mathematical attainments. It is to this cause that we must equally trace the persistence, in the

rival university, in classical education, almost exclusively; and to the
same cause must we refer all the imperfect systems of education which
have been promulgated, though few of them have been brought into
action.

At my early age, and with my own imperfect experience, I do not
pretend to correct the present systems, nor to offer a substitute. But
I have acquired some experience, because I have now discovered my
wants, and am labouring to amend. It must remain for him of longer
and wider experience to lay down the exact road by which he has
succeeded, and to warn the student against the erroneous paths into
which he has been misled. It will be for such a philosopher, for him
who has actually laboured up the hill of instruction, and who, in
watching his own progress, has also kept his eye on that of others, to
point out the mode in which the different branches of knowledge bear
on each other, by what means it is most safe and easy to commence,
and by what to proceed. He will know, since it will be the knowledge
of experience, how to abreviate, by the mutual illustration which the
several parts of science afford to each other; how to exclude what is
superfluous while he takes the shortest and the most secure track; and
it is he who will best know how to gain what is wanted for each, how to
teach to every one what he requires, and no more, since human life will
not admit of everything, and how to gain for each and all, what is wanted,
with the least retrogradation or superfluity, the least labour, the least
loss of time.   I am, &c.
                                        CANTABRIGIENSIS.

————

POSTSCRIPT.—It strikes me, on reperusing what I have said, that I
have not explained myself so clearly on one point as the case required,
and as I have not now time to review and alter what I have written,
I have taken the liberty with you of making the addition in a postscript.

If I have shown that the reasoning faculty is not, in reality, culti-
vated by mathematics, and more particularly by the higher branches,
or the algebraic system, (to use that term for the whole tribe of Calculi,)
you must also remark that this is the department exclusively honour-
able, to which the attention is really paid, and to which premiums and
reputation are allotted. It is not the object of Cambridge to cultivate
useful mathematics, and still less to teach its pupils how they are to
be rendered useful. Many of the trial problems, the great objects of
ambition and emulation, are truly visionary, as far as any real utility
is in question; and many more involve solutions which concern very
few persons, and are little likely ever to be wanted in practice, even
in scientific inquiries and operations.

I may here support myself on the authority of La Place, when he
remarks, that the higher branches of mathematical investigation have
arrived at such an extent and such a state, that they are no longer
within the power of one mind, but require a division of labour and

attention; and by a remark which concerns the present criticism
much more materially, namely—that whatever proofs of the powers
of the human mind they may give, they are barren studies and useless
labours, holding out no uses or benefits to man or society, but rather
wandering through the airy and visionary regions of the imagination.
It is long since they have transcended all the real wants of physical
science; and it is in pursuit of such useless exercises of ingenuity that
Cambridge is now sinning, and ambitious of sinning still further.

And were it otherwise, they are all solutions of questions solved
long ago; demonstrated to satisfaction, admitted, and in a state of
perpetual application. It is a very natural question, whether a man
is to spend three or four years of his time and labour, for the purpose
of going through all the steps which are required for the redemonstra-
tion of a problem or a theorem long since settled; when all that he
can require from it in the course of his life, admitting that life to be
a scientific one, is its use and application. The truth is, that life is
not long enough for all this work; and were the principle to be com-
pletely applied, it is evident that the united lives of Euler, Newton,
La Grange, De L'Hopital, La Place, D'Alembert, and twenty more,
would be insufficient to render a man of this kind fit for the common
duties of life, if he is never to act till he is master of the principles or
demonstrations under which he is to labour.

The absurdity of this system does not readily strike us without thus
stating the extreme case. The truth is, that there is a foolish and
ultra refinement about the Cambridge studies, as there is, more or less,
about what is called a mathematical education, in most instances. An
engineer or an artillery officer is occupied for three or four months on
conic sections, or fluxions, or both, that he may be able to demonstrate
the flight of a cannon ball in a parabolic curve; and when he has
occasion to put this projectile itself into actual motion, the first thing
he discovers is that he does not know how to go about it, how to reach
his mark; while he discovers at the same time, that his projectile does
not describe a parabola.

The mathematical studies are directed upon a principle pretty well
corresponding with the classical ones of the same university. There,
all the labour is bestowed, and the time spent, not on making a student
acquainted with Greek and Latin authors, not in acquiring facility in
writing or speaking Latin prose, which is the only one of the two likely
ever to be spoken or written, but in acquiring a critical knowledge of
quantities, and in making bad verses; or, if more is attempted, the
ambitious student employs himself in the ultra refinement of Greek
criticism, while the very purpose or end of learning the language is
overlooked. Surely if there be a purpose in learning a language, it is
that we may read its authors; or, at least, thus common sense would
think: but the language and the authors are both forgotten, in pursuit
of that which is but the accessary as it is the refinement, and which, if

the language itself is not to be used, will, of course, be itself useless.

Just so it is with our mathematics: we entirely neglect all their uses and applications, to pursue their unnecessary refinements; and the end of all is practically and truly this, that the best and highest mathematician will commonly turn out to be the man who is the most utterly at a loss when any question of practical utility comes before him. Most assuredly will he be so, if it is a new case; if he cannot immediately refer it to some known demonstration which is fixed in his memory.

The truth is, though it may seem harsh to say it, that what we gain in these studies is little better than a matter of rote. I know very well that I should not have believed this, had any practical mathematician or natural philosopher told me so when I was tormenting myself at St. John's with the differential calculus; and I have no doubt that I should have been very much enraged; and still less do I doubt that I should have despised him as an ignorant fellow; at the very best, a paltry geometer.

But I have lived some time now out of the atmosphere of St. John's; I have had ample time to review what it was that I learned, and I know pretty well also what sort of knowledge it was. I have learned to know it perfectly, since I have had occasion to apply myself to useful and practical investigations; and I say it without fear, that it was a rote learning. I do not mean by *rote* what is commonly implied in that term, the getting of a single problem by heart and then repeating it; but that the whole study, from the beginning to the end, was a rote with us, and that it is, almost invariably, little else. It was all concentrated in one series of acts of memory: and I beg of you to mark this distinction, for it is not likely that I shall convince a living and acting Cantab; though you who, like myself, are now in a capacity to review your studies, will not find it very difficult to understand me.   And, to make this more obvious, I will say that a pupil (I take an easy case) shall go regularly through the six books of Euclid, learn to demonstrate every proposition, so that he shall never be baffled, even by a cross question, yet that, when it is all done, he shall be as totally guiltless of the acquisition of mathematical reasoning or powers, as when he began.   He knows Euclid, I have assumed, and therefore I grant it; but, from the first problem of the first book, to the last of the sixth, the whole is one connected chain of things *remembered*, not *known;* a concatenated series of acts of memory, or a long *rote*.

And I will extend this reasoning to the whole of the ordinary acquisitions, even in much higher stages, which are made with us, or at any other mathematical academy, by ninety-nine of a hundred students; nay, I might take a much larger ratio. I know that there are exceptions, but they are rare; and equally rare is a real mathematician; such a mathematician as Dr. Young, for example.

These are hard truths; but they are truths.   And one proof, not

so inaccessible but what every man may find examples every day, is this: that after a few months' absence from college, or within a short time after the books have been closed and the study abandoned, Euclid, or whatever else, is as much forgotten as if it had never been read, and the ex-pupil becomes very shortly incapable of demonstrating the simplest proposition.   I will take a thousand men, and they shall even have been Cambridge mathematicians, men of honours, and not one shall demonstrate to me even the proposition which is the basis of the rule-of-three.   The reason is plain: the whole was an act of rote and memory ; the particular memory is no longer called into use ; the chain of the rote is broken ; and the whole, the parts, all, are forgotten.

And if this proof will not satisfy you, mathematician as you are, I will try another, of another nature.

I will produce to you a hundred teachers of mathematics, men perfectly versant in what they are teaching, teaching well, teaching every day, respectable mathematicians, good mathematicians if you please.   I will allow you then to put a question to such an individual, which he has not formerly considered, which has not lain in his line of teaching or his usual train of reflection.   Or it shall be a mere variation of some case familiar to him, a practical application, we will say, or perhaps an application in which there are some petty contesting considerations. He shall not solve it without labour, perhaps great labour ; or he shall commit a gross error, or error after error, or he shall not solve it at all.

You may try this experiment whenever you please: and if you ask me the reason, I will say that his mathematical knowledge is good as far as it is in use, that it is good as far as it goes.   And my similar corollary from this is, that all his knowledge is a rote: it is only the first case more extensively viewed, and placed in another light.

I will not illustrate further what I know will be repelled with indignation, true as it is.   But this is the reason of that utter chasm which is found between the study of mathematics and the use of mathematics : and that chasm gives us the same proofs in another way.   It is the cause of the chasm also which occurs between the period of leaving our mathematical studies and entering upon the practical uses which we meant to derive from them.   It is the very chasm from which I myself suffered so long : if I have at last surmounted it.   But if I have surmounted it, how has this been effected ?   By entering on an entire new course of study, for which I made time, to my excessive inconvenience: for, unluckily, I cannot say—for which, fortunately, I had time.

And what had I here to do, but first to throw aside all that I had so long laboured at ?   Yet I *was* a mathematician ; and need I ask what would have happened in such a case, to a student who had learned his mathematics by that act of memory which I have described ? to a rote mathematician, to a paltry geometer, perhaps, who had laboured up to spherics, or even to conic sections ?   or to a wretched algebraist

who had imagined himself a great man and a wonderful mathema-
tician, because he had worked from the beginning to the end of
Wood or Bridge?

No, Sir, what I say is a truth, because I see it every day; and
because I am in that class of society and way of life in which I can see
it.   I have taken a hundred, I will take a thousand of such mathema-
ticians, and they shall not be able to apply one atom of their imaginary
knowledge to any one necessary or useful thing.   And when they begin
really to work, they must learn to work: and to work as if they had
never heard of Euclid or Simpson.   The whole thing is new to them:
they are raw: raw in every thing: lumbered, if they are lumbered,
with useless mathematics; or, as is more likely, utterly empty, and to
seek for every thing,   If the student is an architect, he thinks no more
of his geometry; for he does not know how to use it.   He takes some
good books of carpentry, and follows the rules that wiser men—mathe-
maticians, certainly—have laid down; but into whose reasons he never
thinks of enquiring, while he would not understand them if he did
enquire.

Sir, mathematics, Cambridge mathematics, or any mathematics that
you please, and use—utility, their application, science, be it what it
may, natural philosophy, are two distinct things.   One man in ten
thousand writes them: the rest must follow and believe.   They have
no time to seek for reasons: and if they had, they could not find
them.   The mathematician architect believes the carpenters' book,
because Nicholson or Emerson says it is true; and the journeyman
carpenter does the same: and the one does his work as well as the
other.

By this time the mathematician discovers that he might have been
better employed for three or four years: but he will generally discover
it when it is too late.

And it is owing to this, which I have been endeavouring to explain
more distinctly than I had done, that, in reality, in use, our men of
practical science have not been mathematicians, and that mathemati-
cians, in scarcely any instance, have been practically useful men, or
have known any thing whatever about the uses of their learning.
Accidentally, the two may have been united; but that is all.   They
are distinct studies, and distinct pursuits: and, judging from expe-
rience, the general probability is, that a practical man could not easily
make a worse choice than in spending his time on mathematics;
particularly, since he must certainly neglect what is essential, and,
what is also very likely and very common, render himself unfit for an
active and useful profession.

<div align="right">Once more, I am yours, &c.</div>

<div align="right">A. H.</div>

Mathematics and mental health in early nineteenth-century England

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‘Nothing is less applicable to the conduct of life than mathematical reasoning’, wrote Mme de Staël (1813, I, 177). In her view, a person whose education has been primarily mathematical is accustomed to clarity and lucidity, and so cannot cope with the murky choices of everyday life. ‘That which is most important for our conduct in life is to understand our fellow creatures’, she insists, but the mathematician cannot do this: his training has made him deficient in sympathy and intolerant of difference. He seeks the certainty of mathematical demonstration in all aspects of life, but ‘primitive truths, those which are seized by feeling and genius, are not susceptible of demonstration’ (De Staël 1813, I, 178). Mme de Staël’s pessimistic assessment of the effects on the character of an education in which mathematics is dominant was to be echoed many times during the nineteenth century by British writers impatient with the traditional and patrician respect for mathematics in the curriculum and in wider culture. But in the context of emerging Romantic models of the proper relationship of feeling to thinking, critiques of mathematics’ unbalancing effect on the mental faculties became especially powerful.

In contrast to classicizing eighteenth-century psychological models, which typically advocated subordinating feeling to reason, Romantic-era writers often argued that emotion and rationality should be seen as two equally important parts of a single process. In aesthetics, in criticism of all kinds of art, and in psychological writing, the complete union of thought and emotion was increasingly represented as a mark of genius; but even for non-geniuses, the natural state of the healthy mind was thought to be characterized by thinking and feeling interacting as equals. As the highly influential German Romantic philosopher Friedrich Schlegel put it in his lectures on the *Philosophy of life*: ‘thought and feeling stand reciprocally in need of each other. As thought gains new life and animation from the rich feeling, [...] even so the feelings are not unfrequently first awakened, and very often strengthened and elevated, by the lofty flight of thought’ (Schlegel 1847, 374).

It is hardly too much to say that a new ideal of selfhood was generated by this model in which thinking and feeling invigorated and intensified one another. Along with this new ideal, new models of outstanding humanity were generated to celebrate those whose balance seemed much more finely tuned than normal, and equally, new pathologies were produced to classify individuals in whom the thinking and feeling faculties failed to balance or to unite. In a cultural climate that admired emotional thought and thoughtful emotion, branches of knowledge which appeared to emphasize reason almost to the exclusion of feeling provoked considerable anxiety.

In particular, as the quotation from Mme de Staël illustrates, concern was growing about the unbalancing effects that mathematical work could have on the vulnerable mind. One arena in which this concern made itself felt was in education, as demands for a more varied curriculum and more balanced exercise of the mental faculties threatened to dethrone mathematics from its traditional central place in the studies of the elite. It was not only in school and university syllabi that mathematics began to be differently emphasized, though. Little attention has yet been given by historians to the role of mathematics in the emerging psychiatric literature of the period, but mathematical study came to be widely discussed in this branch of medicine during the early nineteenth century. Like schoolchildren and university students, the mentally ill or those in danger of such illness were considered to be especially vulnerable to the potentially harmful effects of too much mathematics; but the subject also came to have a place in therapeutic regimens.

Mathematics and the causes of madness

'I know positively [...] that mathematicians are not exempt from insanity. I possess the skull of an individual who excelled in mathematics, and was insane by pride and vanity' (Spurzheim 1817, 111).

Establishing a proper balance of thought and feeling was not an abstract piece of the Zeitgeist for highly educated people in the first decades of the nineteenth century, but an urgent aspect of self-care. It became almost an axiom of mainstream medical writing during the 1820s and 1830s that contemporary life, particularly in the cities, over-stimulated the intellect at the expense of moral and physical welfare. 'In these times,' warned James Cowles Prichard, 'mental exertion is stimulated to the utmost; and too great sacrifices are often made to the cultivation of intellect, or even to the mere acquisition of knowledge' (Prichard 1835, 172). In particular, the level of education demanded by modern life was widely considered a major cause of mental illness. The medical reformer Edwin Lee, for example, noted that nervous illness was now more prevalent in Britain than ever before, because of the excessive contemporary development of susceptibility, itself largely a result of 'the modern system of education, which tends to the cultivation of the cerebral faculties in a degree disproportioned to the exercise of the bodily powers' (Lee 1833, 23).

Those whose education was most specialized or most focused on a single discipline were widely considered to be most at risk of becoming mentally unbalanced. A very well-known case is that of the twenty-year-old John Stuart Mill, who suffered an emotional collapse towards the end of 1826. Although Mill's education, which he received at home from his father, had been at least as broad in terms of disciplines as those of many of his school-educated contemporaries, it had been intensely narrow in the sense that it was tailored to produce not a rounded individual, but the perfect tool of utilitarianism. In recent biography and criticism, the breakdown that Mill suffered has been read primarily as a consequence of these singular and extraordinary circumstances (for instance Collini 1999, 124 Capaldi 2004, 57; Snyder 2006, 11). Mill himself, indeed, reported feeling at the time that his unhappiness was 'the natural effect' of his education; but reflection over several decades led him as an older man to suspect that the breakdown was 'in all probability [...] by no means so peculiar as I fancied it, and I doubt not that many

others have passed through a similar state' (Mill 1989, 116). Though he expressed himself with caveats, he was quite right in this: his crisis was part of a wider emotional phenomenon. His may be, as George Levine has called it, 'the most famous nervous breakdown in (at least intellectual) history' (Levine 2002, 95), but it was by no means unique. Rather, it was a single case of a kind of psychic damage being done on a larger scale, which was frequently and intimately associated with the excessive study of mathematics.

The damage was characterized primarily by an apparent disruption to a radical degree of the connections between thinking and feeling. In Mill's case, his education had focused almost wholly on training his habits of thought, ignoring habits of feeling; but as Mill reflected in his *Autobiography*, it was thought of a particular kind that caused the problem. Recalling the months of 'dry, heavy dejection' he experienced in 1826–27, he wrote:

> I now saw, or thought I saw, what I had always before received with incredulity –
> that the habit of analysis has a tendency to wear away the feelings: as indeed
> it has, when no other mental habit is cultivated, and the analysing spirit remains
> without its natural complements and correctives (Mill 1989, 114).

Though Mill's account of the harm done by 'analysis' does not refer to mathematical analysis, there are connections to be drawn between the Romantic reaction against consciously unemotional analytical thought and contemporary conservative reaction against the incursion of Continental 'analytical' mathematical methods into British university syllabi and professional mathematics. Here, though, Mill emphasizes primarily the harm caused by the one-sidedness of his education and habits: he had been brought up without a synthesizing force to counter-balance his carefully-trained reliance on analysis. I have suggested that the first decades of the nineteenth century saw widespread concern about the damage done to mental health by the demands of modern life, and more specifically by a failure to balance thought and emotion, particularly in the context of education. Within this broad context, particular anxieties about the effects of analysis indicate the context in which discussions of the effects of mathematical study on mental health should be interpreted.

Other young men of Mill's time were suffering similar sensations of drastically reduced affect, and attributing them, like him, to unbalanced mental training, including overactive habits of analysis. Contemporaries who had not undergone Mill's extraordinary upbringing nonetheless reported, and lamented, receiving an education which profoundly unfitted them not only for professional life, but also for personal interactions. Unlike Mill, they had suffered this maladjustment via a most conventional kind of education: the one delivered by the Bachelor of Arts degree at Cambridge University, of which mathematics was by far the most important part.

During the first couple of decades of the nineteenth century, the Mathematics Tripos was the only BA Honours degree open to Cambridge students. Even the institution of the Classics Tripos in 1822 produced little substantial change in the essentially mathematical nature of the curriculum traditional at Cambridge, because in order to appease conservatives within the institution, the University insisted that students wishing to sit the Classics Honours exams must pass in Mathematics, a demand which many students found 'exceedingly oppressive', as one laconically put it (Bristed 1873, 120). Thus it was impossible even for classicists to avoid spending an enormous amount of time mastering the mathematics syllabus; and for mathematics students, there was room for virtually no other kind of work. Counting his final

years at school or with a tutor as well as his time in Cambridge, a young man might well spend five or six years working on nothing but mathematics. The Cambridge BA Honours curriculum had always been narrow; but as the contents of the Mathematics Tripos expanded and competitiveness among students was carefully fostered, it became extremely demanding too.

Not surprisingly, the system produced casualties. William Paley, who had himself been Senior Wrangler at Cambridge in 1763, and whose moral philosophy became such a pillar of natural theology, is said to have commented of the Honours system that 'the stimulus is too strong; two or three are cracked by it every year [...] some of them go mad; others are reduced to such a state of debility, both of mind and body, that they are unfit for any thing during the rest of their lives' (Best 1827, 6). Andrew Warwick argues in his study of nineteenth-century high achievers in Cambridge mathematics that by the 1830s and 1840s, a system had developed which encouraged students to work 'to the point of emotional and intellectual breakdown' (Warwick 2003, 179). We might usefully make a simple division of instances of mental illness among mathematical students (leaving aside illness thought to be caused by factors unrelated to their studies), according to whether the cause was attributed to quantity, or to quality or type, of study; among the latter type, interestingly, breakdowns frequently came not during the years of study themselves, but during the first months after graduation, as the contrast between intensive mathematical work and ordinary life made itself felt.

Sheer excess of study was a well-recognized problem among hard workers, or 'reading men'. Some cases were sufficiently simple that they could be dealt with by self-diagnosis and a change of habits: one American student reported disciplining himself to such hard study during his first year that his 'nerves' were badly affected, but limiting his work thereafter to eight hours a day solved the problem (Wright 1827, I, 199). Others, however, underwent much more severe, prolonged and damaging experiences. Andrew Warwick argues that academic ambition in Victorian Cambridge required students to risk mental illness: success depended 'upon a man's ability to judge how much sustained hard work he could tolerate without suffering a debilitating mental breakdown' (Warwick 2003, 190). For many, 'success' included not only passing creditably in Finals exams, but also the further work and examination necessary to win a College fellowship. The case of James Maurice Wilson gives a striking example: Wilson, an excellent student, graduated as senior wrangler in 1859, but before he could sit the exams for a fellowship at St John's College, he suffered a severe breakdown. Recuperating on the Isle of Wight, he found that he had lost all memory of the mathematics he had known so well only weeks earlier. Wilson's case had a comparatively happy outcome: dauntlessly he set to work once again, re-learnt his advanced mathematics from scratch, won his fellowship, took up a post teaching at Rugby School, and went on to become a very distinguished educational reformer (Wilson 1932, 48–49). Some unluckier men suffered breakdowns which forced them to leave the University, or obliged them like Francis Galton to abandon Honours work for the far less demanding 'pass' degree.

In addition to the dangers of over-work, dedicated students were also apt to suffer acutely as they became aware that their mathematical education had not prepared them for life beyond mathematics, as the patrician ideology that promoted the subject as an all-purpose gymnasium for young minds promised. In young men coming down from university, symptoms such as disillusionment, depression, and inability to make decisions gave fuel to the belief that the effects of a predominantly

mathematical education were unwholesome and even disabling. Despite the differences in their personal circumstances, the breakdown that John Stuart Mill suffered has strong similarities to accounts of the acute and debilitating unhappiness experienced by some of his male contemporaries shortly after completing their formal studies. These breakdowns were signs of emerging cultural unease about abstract thought, and they were sometimes used as evidence of the urgent need to re-connect thinking with feeling and with the material world.

In 1825, a pseudonymous article appeared in the *London Magazine*, titled 'Regrets of a Cantab'. The author was probably John Cowling, who had been senior wrangler in 1824, and had come first in the more advanced Smith's Prize examination ([Anon], 1856a, b).[1] At the time of writing the article, he was studying for the bar, and, according to 'Regrets', suffering severely from mental and emotional problems which he traced directly to his Cambridge mathematical training.

The article painstakingly describes a lonely condition of social incapacitation, low self-esteem, disillusionment and emotional numbness. Similarities are readily apparent with Mme de Staël's critique of mathematics as producing a failure in empathy and an aversion to problems involving uncertain data. The author's education had inculcated 'a habit, a permanent feeling of dissatisfaction, or doubt, respecting all truths which are not capable of strict demonstration' ([Cowling] 1825, 460). This habit now runs very deep; he finds that even in post-University life, he can only think like a mathematician: and he interprets this as meaning that he has lost the ability to think like other people. Consequently, he can no longer enter into other people's feelings. It would be fascinating to know what relationship this writer perceived between thinking and feeling, but perhaps because he experiences extreme isolation in both, his discussion jumps freely between the two almost as if they were the same thing. Miserably he attempts to mimic in his own emotions what he imagines to be the emotions of others, but fails:

> I strive to understand what seems understood by all but myself; to feel what others seem to feel; to infer as they infer; and to calculate on events as they calculate. But all seems a maze and a mystery; as if my mind was of a different constitution from that of mankind in general; as if I had not even the feelings of my species. ([Cowling] 1825, 440)

The careful self-analysis offered here is both a symptom and an expression of the loneliness resulting from loss of empathy. In each of the neatly paralleled clauses of these sentences, such as 'to infer as they infer', the writer groups himself with others, and at the same time separates himself from them. The phrase 'a maze and a mystery' suggests in its alliteration and rhythm a widely-used formula, but it is almost untraceable in writing before this date, although it is used very occasionally in later texts. The phrase enacts in miniature the writer's solitary condition, appearing to be part of a shared culture, but in fact an isolated anomaly.

Above all, the writer is bitterly disillusioned by the contrast between the cultural prestige of mathematics and the real effects that his work has produced in him.

[1] Alex D D Craik disagrees, considering the article to have been 'probably' by Solomon Atkinson, another Senior Wrangler of the period (Craik 2009, 13). But a handwritten note on the first page of a copy of the article held in Cambridge University Library attributes authorship to 'J. Cowling (St. John's)'. Garland (1980, 185) concurs with this attribution.

The prestige of the discipline is so great as to be almost hegemonic: 'I had been told,' he writes, 'that mathematics formed the only logic, and I believed it, because every body seemed to believe it' ([Cowling] 1825, 440). But on leaving the University he has found, rapidly and sickeningly, that 'we have all been in a mistake': mathematics has *not* taught him to reason effectively. It cannot do so, since it is a self-referential system based on perfect knowledge of perfect data ([Cowling] 1825, 440, 457). It is impossible to apply mathematical approaches to the messy, incomplete uncertainties of real life. As a consequence, the writer has great difficulty making ordinary decisions, afraid of doing wrong because he cannot fully predict the consequences of his actions ([Cowling] 1825, 460).

Comparable cases of university students' inability to make decisions were reported in the medical literature of the 1810s and 1820s. A similar case, for example, was discussed by the prominent London physician John Reid. An Oxford student, fuelled by academic ambition, had applied himself 'most intensely' to his work, but had been precipitated towards breakdown by fear of failure. A distressing symptom was his inability to make decisions, even simple ones affecting only himself: 'he deliberated a long time before he could determine on the most indifferent proceeding,' Reid recalled, 'and he had scarcely acted upon, before he invariably repented of, his decisions' (Reid 1823, 100). By the time Reid was called in, the student's condition was so bad that he was unable to get out of bed, because he could not decide what clothes to put on (Reid 1823, 100). In this case, the patient had presumably been studying classics, rather than mathematics (though Reid does attribute his breakdown to anxiety about a change in 'the mode or the subject of the examinations', conceivably referring to changes to degree regulations affecting the role of mathematics in Honours between 1800 and 1807 (Hannabuss 2000, 444)). But as with mental illness in mathematics students, this undergraduate's problem was considered the almost inevitable result of an unbalanced course of study, lacking in diversity and variety: 'if we have been reading, or thinking upon any subject until the attention be exhausted, we almost uniformly find the mind to be again roused and invigorated by directing it to a subject of a different nature' (Reid 1823, 101–102).

Reid's patient was eventually cured, achieved his academic goals and left the University (Reid 1823, 100–101). Cowling, too, recovered from his crisis of affect; he became a respected barrister on the Northern circuit, and evidently got over his dissatisfaction with Cambridge, since he formed close professional links with the University, accepting the post of Deputy High Steward in 1839, and six years later becoming University Counsel ([Anon] 1856a, 93). Indeed Cowling would, ironically, have been very much the sort of figure whom that indefatigable defender of Cambridge mathematics, William Whewell, had in mind when he boasted of the Mathematics Tripos's ability to train the mind for success in professional life: an 'extraordinary number of persons, [. . .] after giving more than the common attention to mathematical studies at the University, have afterwards become eminent as English lawyers' (Whewell 1838, 14). In turn, slightly later in the century, Whewell became an even more zealous and determined defender of mathematics's centrality in the curriculum than those authority figures who had assured Cowling and his contemporaries that theirs was the best kind of education for a young man of their class. It would be interesting and perhaps revealing to know how many of Whewell's 'eminent lawyers' had to pass through a period of breakdown between completing their mathematical studies and emerging as exemplary figures.

Re-adjustment to non-mathematical society and its modes of thinking and feeling was clearly possible; despite Paley's chilly warning that 'two or three are cracked by it every year', the majority evidently overcame what was in many cases a temporary state. But as 'Regrets of a Cantab' movingly illustrates, the suffering undergone by someone trained to believe himself the possessor of the most acute and most multi-purpose education possible, and yet finding himself quite unable to cope with the everyday exigencies of life, was doubly severe because it seemed a baffling betrayal by the sources of authority, tradition and prestige.

Mathematics as a therapy for madness

> If a man's wits be wandering, let him study the mathematics; for in demonstrations, if his wit be called away never so little, he must begin again. (Bacon 1999, 115).

It seems paradoxical that at the same time as young men highly trained in mathematics were complaining of the harm that the subject has done their mental and emotional wellbeing, others should be advocating mathematical study as a therapy for mental illness. As I emphasized at the beginning of this article, though, early nineteenth-century anxiety about the effects of mathematics on the vulnerable mind chiefly focused on mathematics' dominance over, and sometimes exclusion of, all other kinds of mental exercise. The concern was with an unbalanced education; any subject studied exclusively could produce similar problems, but of the two major disciplines that made up contemporary curricula, mathematics was much more likely to be studied in this harmful way than classics. Classics could encompass linguistic, historical, literary, and philosophical work; mathematics, on the other hand, appeared to develop only one 'faculty' or mental ability, and could thus produce lop-sided minds, whose other faculties were in danger of withering away for lack of care. But where an individual's mental state was jeopardized by imbalances arising from other causes—where it was precisely the ability to think connectedly that was withering—then limited or temporary study of mathematics could help to redress the imbalance and return the patient to health. Exactly the qualities that made mathematics good mental discipline for schoolboys and university students gave it therapeutic value for the mentally ill: above all, it demanded complete absorption in a careful, controlled chain of thought, and thus strengthened the connectedness of ideas and prevented the mind from wandering into agitating or exciting fantasies.

The treatment of insanity seemed a considerable (though by no means complete) success story for the early nineteenth century. Writers and commentators of most political and religious hues were united in praise of the reforms that had been made since the eighteenth century, when asylums were places of horror, and 'treatment' was conducted by methods that now seemed more like torture than therapy. Above all, the prevalence of the so-called 'moral treatment' of insanity was noted as one of the great medical achievements of the modern epoch. Modern accounts of these reformed therapies have often been much less favourable. Michel Foucault, in his highly influential but now somewhat dated *Madness and civilization*, condemned moral treatment as bringing 'madness and its cure into the domain of guilt' (Foucault 1971, 182): advocates of the moral treatment believed that patients were capable of exerting their will to fight their illness; thus, Foucault argues,

patients were thought of as in some sense culpable if their condition did not improve. For most Victorian commentators, however, the difference between eighteenth-century and contemporary methods of treatment were a sign of the much increased insight and humanity of the modern age. 'Let us render our hearts' thanks to those noble men who have removed one of the darkest blots from our common human nature,' wrote the social reformer Jane Ellice Hopkins in an article on the history of asylum treatment (Hopkins 1877, 459).

Central to the 'moral treatment' was the belief that, as Samuel Tuke, one of its foremost early theorists put it, 'most insane persons [...] have a considerable degree of self-command' (Tuke 1813, 139). The corollary, he argued, was that rather than using external means such as physical restraints to control patients, those caring for the mentally ill must encourage them to control the manifestations of their madness themselves. A key element in helping patients re-establish self-control was to keep their minds off the subjects of their delusions: they should be kept busy. 'Of all the modes by which patients may be induced to restrain themselves,' Tuke wrote, 'regular employment is perhaps the most generally efficacious' (Tuke 1813, 156). He stressed that patients should be occupied in pursuits that were suited to their individual taste; at the Retreat, the institution he ran near York, intellectual and self-expressive activities were permitted as part of therapy, though of course there was a risk that given completely free choice, patients would revert to subjects likely to exacerbate their symptoms. To help his staff steer this difficult course, he made a series of suggestions about the kind of reading that could best be used with the insane. His views on this subject played a part in developing nineteenth-century beliefs about the place of mathematics in wider culture.

Above all, Tuke's staff had to find ways of engaging patients' attention without exciting their imaginations.[2] His clearest recommendation was that 'works of the imagination are [...] to be avoided' (Tuke 1813, 183). The reasons for this prohibition were unexplained; Tuke thought them 'obvious'. In the context of early nineteenth-century anxieties about the harmful effects of novels and sentimental poetry even on healthy readers, it is clear that Tuke was drawing on some fundamental and very widespread prejudices about the value of different kinds of intellectual work. Again, he did not explain his reasoning about which kinds of reading successfully avoided imaginative response, but he did specify that mathematics and natural science were 'the most useful class of subjects on which to employ the minds of the insane' (Tuke 1813, 183), so he must have thought these disciplines non-imaginative. He illustrates the efficacy of mathematical study in an anecdote (to call Tuke's narratives case studies would be to invest them with far too much formality) about a man 'of great respectability' who suffered very badly from depression, stopped eating properly, neglected his business and family, and lost the ability to concentrate (Tuke 1813, 184–186). In accordance with Tuke's belief that mentally ill people retained a degree of self-control, this gentleman decided to exert himself and 'regain the habit of attention', and chose mathematics as his

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[2] Thirty years after Tuke's book appeared, the reading-room was still very much part of the regime at the Retreat, and for better-educated patients, books were also available from York's two circulating libraries. Of the 112 patients undergoing treatment at the Retreat in 1842–43, however, only eight men and two women were recorded as having been employed in 'reading, &c' (Thurnam 1845, 47–48).

therapeutic tool. He set himself to relearning the mathematical techniques he had known quite well as a young man. Tuke narrated the result of his efforts:

> The first attempt to go through the easiest problem, cost him indescribable labour and pain. But he persisted in the endeavour; the difficulty of fixing his attention gradually lessened; he overcame his tendency to abstinence; and very shortly recovered the use of his faculties and his former temper of mind (Tuke 1813, 185–186).

Tuke characteristically does not explain why working mathematical problems helped this gentleman so much. But his advocacy of mathematics in therapy was followed up, in rather more systematic fashion, by later proponents of moral treatment, including, perhaps most influentially, the progressive and reformist English physician John Conolly.

Conolly rejected his conservative colleagues' pessimistic account of the damage done to the mind by modern life, and particularly by education. He sought to distinguish medical from merely political interest in education, and was suspicious about the motives of those who represented education as a danger to the health of the lower classes (Conolly 1830, 191).[3] Madness, he argued, does not result from over-, but under-exercise of the mind. In his view, the systematic and methodical qualities developed by a thorough education were rather a protection against madness. 'Those men who really most exercise the faculties of their minds, meaning thereby all their faculties, their attention, reflection, or comparison, as well as their imagination and memory, are least liable to insanity' (Conolly 1830, 346). But he agreed with those commentators discussed above, who argued that an unbalanced education could provoke insanity. Like Tuke, he felt that imagination was highly dangerous, if not balanced with more rigorous mental exercise. Creative artists were in his view especially prone to mental illness ('an irregular and injudicious cultivation of poetry and of painting has often concurred to produce madness' (Conolly 1830, 346)), but, he claimed, the famous Parisian institution at Bicêtre was said to have housed not a single naturalist, physician or chemist, since these professions all required a balanced and systematic education and thus strengthened the mind (Conolly 1830, 192–193).[4]

Another group especially protected against madness, Conolly noted, were 'geometricians' (Conolly 1830, 193). It is unlikely that he meant that there was something particularly healthy about geometry itself; like many in this period, he was using geometry partly as a metonymy for all kinds of mathematics. The subjects of geometry, he writes, are 'figure and number': 'figure' certainly pertains to geometry, but the inclusion of 'number' suggests that he also means to include algebra and even arithmetic (Conolly 1830, 72). Mathematics, he argues, makes an effective protection against insanity because both of its positive and negative qualities. The positive is that it exercises what he called the faculty of comparison, the failure of which is a necessary condition for insanity (Conolly 1830, 72). Mathematicians, again along with chemists and naturalists, are obliged by their occupation to exercise this

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[3] Conolly's *Inquiry* has become an important text for literary and historical studies of early psychiatry: important instances include Bourne Taylor 1988, 29–51, Small 1996, 48–57, and Shuttleworth 1996, 34–54.

[4] Interestingly, the Anglo-Irish Conolly included priests among the creative artists who suffered through being too much given to imagination (Conolly 1830, 192).

important faculty very thoroughly: as a result, 'nothing is rarer than to find a mad mathematician' (Conolly 1830, 346).

Conolly spends rather longer on the negative qualities which make mathematics so helpful in preventing insanity. First, it occupies more of one's attention than any other subject (Conolly 1830, 346), and second, it 'represses the wanderings of imagination, and secures the student, during a great part of his time, from the recurrence of feelings which are always the most imperious in those who are the least occupied' (Conolly 1830, 347). This passage clarifies what Conolly means when he recommends a balanced education, and it is a kind of balance unfamiliar to modern eyes: he all but excludes creativity and imagination from the healthy kinds of mental exercise. He seems to see no opportunity for either in mathematics, and devotes considerably more attention to mathematics' usefulness as a sopper-up of otherwise dangerous attention than to its power of actively strengthening reason. Complicated arithmetical problems will 'limit the movements of [...] fancy, and shut out the intrusion of restless feelings'; the tedium of such work will do no harm, since the 'drudgery of figures may weary, but has, I venture to say, seldom discomposed the faculties' (Conolly 1830, 347). The major therapeutic goal of mathematics in Conolly's view is to dull emotion; so the problems selected must be ones on which no emotional outcome hangs. When mathematics is applied to immediate problems, for instance, its wholesome effects can break down. Merchants and speculators, Conolly notes, who routinely engage in arithmetic, if nothing more mathematically advanced, have indeed become insane, being overcome by too strong feelings of desire or anxiety about the result of their calculations.

Conolly's work had considerable influence on many contemporary and later physicians working with mentally ill patients. His advocacy of the therapeutic and preventative benefits of mathematics was taken up and repeated by others, until it became a fairly standard, if comparatively minor, part of many practitioners' work. Only a decade and a half after his *Inquiry* was published, for instance, a writer in the *Medical Times* remarked, as if it were a well-known fact, that 'the study of mathematics has been known to cure insanity – and is in some cases worthy of trial, even where there has been no previous instruction in this branch of science' (Williams, 1846–47, 401). Williams's article confidently claims that the efficacy of mathematical study in treating insanity is so great that it can be prescribed whether or not the patient knows any mathematics at all, and even though it is particularly rebarbative to 'persons of weak mind, and especially by those predisposed to insanity' (Williams, 1846–47, 401).

The work of Tuke, Conolly and later followers such as Williams serves in part to solve the problem of how mathematics could be seen as simultaneously a cause and a treatment of mental illness. In both producing and causing insanity, it was the absence of imagination, emotional investment and human relations that were thought to be mathematics' key characteristics. Taken to extremes, as in the education of a Cambridge wrangler, this lack of feeling was sometimes enough to produce a malady which could be thrown off only by completely abandoning mathematical study, even to the point of amnesia. But at the same time, for minds unbalanced by too much imagination, judicious (even if unwilling) study of mathematics could give a respite from emotional turmoil and create a space into which sanity could return. Other accounts could be cited from writers who were much more positive, and indeed more personally knowledgeable, about the beneficial emotional work of mathematics. The famous example of William Wordsworth,

who found in the study of Euclid a solace and a 'charm' for a mind 'beset / With images, and haunted by herself' (Wordsworth 1850, 195), is only one of many instances of nineteenth-century people self-medicating, as it were, with mathematics. This article has sketched out a framework for a study of mathematics and mental health in early nineteenth century England: there is scope for a great deal more work to be done on Victorian life-writing and medical literature to extend the argument I have presented here. But I suggest that the conjunction of mathematics and mental health gives us a lens through which to view developing popular understanding of mathematics' place in a wider culture which both revered, and feared, the power of the imagination.

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