

Planting higher order skills in the unconscious: a speculation on the role of the unconscious in education

In this essay I intend to follow up a general interest in what light some aspects of neuroscience can cast on learning, in particular how conscious and unconscious learning can be managed through teaching practices in higher education. It is a commonplace educational observation that once skills are practiced, their performance becomes not just less awkward, but less deliberate and more automatic. We know this as individuals from learning skills such as driving a car, swimming, riding a bicycle, learning to play a musical instrument, or learning a language. One sign that learning has taken place, we might say, is that the performance of the target skill, or the use made of knowledge acquired, has become 'second nature'. It has become relatively automatic or unconscious.

This is not a surprising or particularly challenging observation, until the suggestion is made that these unconscious or preconscious processes are not merely automatic sequences of learned behaviour, but are resilient, versatile, sophisticated and flexible learned thinking and decision-making processes.

There is a myriad of sophisticated tasks we perform automatically or unconsciously, from all those smoothly performed skills involved in verbal communication to the almost equally swiftly executed skills of literacy and numeracy that are a required basis for producing, for example, essays and reports. I am not suggesting that essays and reports are produced unconsciously, but that the foundational skills, including a number of thinking skills, are performed so swiftly and routinely that we are not conscious of them. It is not clear how the brain manages to process these tasks so quickly and efficiently in a variety of situations at the service of a variety of purposes. It is as if, given an instruction or a request, the (previously trained or educated) brain conducts a series complex steps closed off from our conscious participation in order to deliver to us the required decision, interpretation, solution or distinction.

The involuntary aspect of some complex learned behaviour can be demonstrated from the 'Stroop effect' (1935). Subjects in these studies were presented, for example, with the word 'red' printed in orange and could not easily restrict their analysis to the *colour* of the printed word because they could not prevent themselves reading the word 'red'. This type of effect suggests that the tasks that become 'second nature' to us are automatic in the sense of being fixed, rigid chains of action. At the same time, however, the flexibility and sophistication of processes outside conscious participation can be demonstrated by the speed with which many can read a sentence such as, 'The rangers will not permit you to enter the park without a permit.' Without conscious decision-making on our part the necessary adjustments come to us that enable recognition of the second 'permit' as not only a different lexical element but one which requires a different rhythmic production and particular breath control to perform.

This characteristic performance of apparently unconscious skills has led some theorists of neuroscience to conclude that consciousness has only a limited part to play in cognitive functioning and thus in education. It (consciousness or self-

awareness) merely ‘receives’ the results of memory, associations, analysis and decision-making conducted out of the reach of this conscious awareness. In 1991 Max Velmans of the Department of Psychology at the University of London, published a long survey of neuroscience research literature in the journal *Behavioral and Brain Sciences* which concluded that while consciousness—or conscious attention (sometimes called ‘focal attentive processing’)—*accompanies* learning, the associations, calculations and analyses necessary to learning take place beyond the perception and beyond the participation of conscious mental processes. The considerable sophistication and flexibility of unconscious processes seems to leave little real function for the conscious mind to perform. Velmans concludes his study by answering his question, ‘Is human information processing conscious?’ by proposing:

In reflective thought or problem solving we may have some awareness of internal processing in the form of thoughts, emotions, images, and so on. Whether consciousness is *necessary* for such processing, however, is a different matter ... awareness of ‘inner responses’ follows the processing required to produce them. For example, covert speech results from the antecedent processing involved in thinking, problem solving, remembering, silent reading, and so forth. This applies equally to the ‘intuitive insights’ that are the product of the creative process. As noted earlier, conscious contents that *follow* given forms of information processing cannot be thought of as *entering into* that processing. (666)

For Velmans and many other neuropsychologists and neuroscientists, we can be conscious *of* a mental process, or we can be conscious of the *results* of a mental process, but consciousness cannot enter into or causally influence a mental process.

This is a controversial position, but one that has been difficult to refute, or to definitively prove. I do not want to pursue the implications of this argument for a philosophy of mind, but I do want to take seriously the possible pedagogical implications of allowing for unconscious aspects of thinking as a central element in education.

Normally, teaching practices, particularly in higher education, are aimed at bringing knowledge, skills, processes and reasoning to conscious attention, and keeping them under conscious attention. Perhaps, though, the real measurement of learning is whether a skill or an aspect of knowledge, or a way of thinking, has become internalized enough to be not just automatic but to be no longer available to consciousness.

Why might this be the case, and why might it be important to recognize this aspect of learning? We know from the exercise of rote learning that acquiring certain basic and fixed mental and bodily shortcuts (multiplication tables, spelling of words, foreign language vocabulary, carving, writing or drawing skills, etc.) as automatic behaviour chains can free our minds and hands to attend to matters of more universal, philosophical or creative intent. This applies equally to the arts as to the sciences. It makes sense that this economy of effort, which has its obvious survival benefits for the human species from an evolutionary viewpoint, might also be at work with more sophisticated and even creative skills. From research findings I will refer to shortly, it

seems to require less energy to produce a result unconsciously than consciously, and conservation of energy has always been an evolutionary benefit to complex animals.

Some neurological studies of learning behaviour seem to confirm the view that a reduction in brain activity is an indicator that learning has indeed taken place, and perhaps that it has become inaccessible to conscious awareness. In 1992, Haier, Segal and others used PET scanning technology (see Posner and Raichle 1994, 62-3, for an excellent explanation of this technology) to measure brain activity among children learning to play the hand held computer game, Tetris. The researchers found that once children became skilled in this game (after four to eight weeks of practice) relevant cortical brain activity decreased despite sometimes a more than sevenfold increase in skill levels. Those whose skill increased the most showed the largest declines in cortical brain activity. In another, later study, subjects were shown an image of an object. Some were asked simply to name the object while others were asked to name a related verb (e.g. for the image of a hammer, the verb *pound*). Cortical brain activity measured via a PET scan was considerably higher and more various among those whose task it was to name a related verb — for about fifteen minutes. Once the skill was acquired, there was no discernible difference in brain activity between the two groups. (Petersen et al. 1998). In another related study reported in *Nature*, researchers found a reduction of cortical brain activity using MRI technology (see http://en.wikipedia.org/wiki/Magnetic_resonance_imaginghttp://en.wikipedia.org/wiki/Magnetic_resonance_imaging for an explanation of this technology) once a complex finger exercise was learned. Paradoxically, in subsequent weeks the localized cortical brain activity related to this skill increased beyond the levels measured during initial learning, suggesting that local brain areas can reorganize their cellular activity independently of awareness or intention, perhaps in the process of memory fixation (Karni et al.).

My guess is that this neurological pattern of activity reduction and localization is related to the degree of comfort and relaxed response a student develops as confidence in practising a skill increases. My hypothesis here is that there is fundamentally no difference between practicing an academic skill and a physical skill. An academic skill might require a more complex and flexible knowledge base, but it is clear that both skills require an ‘apprenticeship’, the one marked by acquiring creditation as a tradesperson, the other marked by acquiring a PhD or similar accreditation based on skills demonstrated. My suggestion is that it takes time to develop the important skills (thinking, judgment, response to the unexpected) to the point where they are, as it were, automatic. I have found no evidence that the neurological pattern identified in the research quoted above equates to a particular phenomenological ‘moment’ for students, but it provides me with an aim in teaching skills, and a possibility for measuring success.

As a digression, it is worth noting here the strange situation such a model of learning proposes for any teacher. The teacher is an expert in a field, and hence, according to this model the teacher’s knowledge has become automatic, that is relatively inaccessible. This is one of the problems faced by the famous Physics lecturer Eric Mazur (Biggs and Tang, 111-2) who realized his lectures were not teaching what he thought they were. His solution was to ask students to read the relevant material for a lecture beforehand and let him know what parts of it gave them trouble. This then would guide the content of his lectures. His difficulty had been in imagining himself

back into a position of ignorance in order to know what needed explaining if fundamental principles were to be conveyed to the students. This insight, it seems to me, underpins Biggs and Tang's model of education as 'conceptual change' (2007: 21); in their constructivist method they emphasise the importance of teaching and learning based upon clearly stated outcomes and assessment tasks that require 'engaging the task deeply' (21). They characterize 'deep' learning as the kind of learning that requires both an understanding of the big picture and familiarity with details, noting that pleasure accompanies such learning (24-5). One point I would make here is that such pleasure cannot arise as a conscious decision, but is likely produced when a learned task is bedding down into the automatic or unconscious levels of neurological behaviour—where there is confidence over the basic moves, apparently instinctive moves towards the best solutions, a 'feel' for a discipline.

My interest for the purpose of this discussion is in the teaching of a particular skilled perception—the understanding of regular accentual metrical effects in poetry—a skill best learned through the kind of practice that gives a student a 'feel' for it beyond 'mere' conscious awareness or conscious analysis. It is, in addition, an element of poetic technique open to many types of analysis and a range of subjective interpretations.

An example might help make this clear. The famous lines of the final verse of Robert Frost's poem, 'Stopping by Woods on a Snowy Evening' (Frost in Ramazani, 2003: 214-5) go like this:

The woods are lovely, dark and deep,
But I have promises to keep,
And miles to go before I sleep,
And miles to go before I sleep.

By one analysis, this poem follows a strict iambic pattern of lightly and heavily stressed syllables in turn, with the accented syllables in bold as follows (though this is a background sound element, not strictly determining the way the lines might be spoken aloud for sense):

The **w**oods are **l**ovely, **d**ark and **d**eep,
But **I** have **p**romises to **k**ee**p**,
And **m**iles to **g**o before I **s**lee**p**,
And **m**iles to **g**o before I **s**lee**p**,

The effects of such a rhythm are orderly, comforting, recollecting childhood rhymes and the steady movement of traveling by foot (the term iambic is etymologically related to limb). There are hints or overtones of the spondee (two heavily accented syllables) in the final two lines as well, giving them slowness and gravity, suggesting the further journey we all must take into a permanent sleep. The 'feel' one can gather for the uses of this rhythmic effect in language is the point of drawing attention to it and to other rhythmic elements in language.

Such a skill requires, at first, a careful introduction to linguistic and phonetic elements of spoken English and a careful introduction to the purpose of regular accentual metrical effects in English verse. In creative writing subjects, the challenge for students is always to put their understanding to creative use in producing their own creative writing. I am not so concerned in this discussion with the outcome of students producing creative writing, but with the embedding of a knowledge-based skill that is more than a fixed, automatic performance of behaviour or rote learning.

I am in the process of developing more continuous assessment tools in the second-year undergraduate subject 'Poetry', using the LMS site provided by the University, on the understanding that with applied activity through the whole course of a semester, rather than the more usual burst of activity at the end of semester to complete assignments, students are more likely to begin the process of acquiring the confidence that will initiate a reduction of brain activity around the targeted skills and thus secure skills and applied knowledge in more permanent memory sites. This year, for instance, I have introduced an option for students to submit a weekly assignment (a poem), in place of submitting major assignments at the mid-semester and end-of-semester stages. They are also provided with weekly feedback through taking on this option. I have made the continuous assessment a voluntary option because it has the potential to cause stress for those who are not prepared for its demands; those for whom 'urgent assessment tasks' (Biggs 21) would become counterproductive. There is a body of literature on the diagnostic and corrective benefits well constructed continuous assessment can provide (see for instance le Grange and Reddy 1998).

This technique has some similarities to a study conducted by Sven Isaksson at Stockholm University, published in February 2008 in *Assessment and Evaluation in Higher Education*. In this study students of an intermediary archeology subject were given 'five minute essays' at the end of each lecture, with feedback before the following lecture. Isaksson found 'a quite steady increase' (statistically significant to $p=0.0021$) in the number of essays obtaining high grades as the semester went on. This seems to be evidence that the method does lead to a development of skills in preparing for and attending to lecture information and retrieving it soon afterwards.

While a third of the 26 students in this study found the five-minute essay system stressful, half of them were still positive about the experience. Interestingly though, the students still generally preferred the longer essay to the short weekly tasks. In this study students seemed to be reacting with some anxiety to the tight time pressure on them during the period they were given to produce their five-minute essays immediately after the lectures. There is of course an important distinction to be maintained between student enjoyment or comfort zone and their learning needs. I have given students a full week to produce each poem in the subject 'Poetry' this semester, hopefully relieving some of the aspects of stress related to tight deadlines. In addition, I have made participation in this system of practice and feedback voluntary. 10% of students in an enrolment of nearly 100, have chosen the weekly-poem option. This low number indicates perhaps how unusual such an assessment regime is in an Australian higher education setting. Students are generally not prepared for it and are wary of it, perhaps.

The provision of weekly feedback has made it possible for me to point out to students the rhythmic effects they have used 'instinctively', or the success with which they have employed more deliberate rhythmic effects in their poems. I am hoping that by drawing their (conscious) attention back to this aspect of their poetry (an aspect that is particularly opaque or 'difficult' to many students), a set of unconscious processes will develop to bring this aspect of language to their attention on a more regular basis.

Li-Ju Chen and other researchers from the National Taiwan Normal University have conducted a study that might offer me a chance to gain some understanding of

students' development of 'feel' as questions of rhythmic effects in poetry are explored. In their study, 'Marking Strategies in Metacognition-Evaluated Computer-Based Testing', published in 2010, they used a system of computer based continuous assessment with a difference. Students (in this case ninth-graders) were invited to rate their confidence that an answer was correct. This allowed teachers to gauge students' 'metacognition monitoring ability'. For instance, when an answer was right and the student rated their confidence high that the answer was right, teachers were confident that this students' metacognition monitoring was high. In contrast, when a wrong answer was rated with confidence as a right answer, teachers could see that there were fundamental problems of understanding with that student, and provide more adaptive feedback. With this system students were also motivated to check the reasons for wrong answers.

What is called 'metacognition monitoring ability' in the above study might equate to what I am identifying as 'feel' for particular qualities in poetry.

This study suggest to me that I could incorporate another series of tasks through the LMS system which would allow students to identify rhythmic effects in poetry samples, speculate on their purposes, and then rate their own confidence in their judgment. The self-rating will give me or other teachers a chance to identify those whose understanding is not yet secure, those whose understanding is misguided, those who do have a strong grasp with well placed confidence regarding these aspects of poetry, and those who are capable of recognizing instances where subjective judgment means that confidence can never be secure.

While a number of assignments completed regularly on the LMS site would give students practice in identifying iambic, trochaic, anapaestic, spondaic and other effects in poetry, this practice would not be the point of the tasks (i.e. it would not be a mechanical or automated skill one learns through repetition), but rather the point would be in the process of accessing (or selecting for notice) an underlying sensitivity to the English language's always-present rhythmic effects. For this reason, the samples chosen would not be clear teaching examples of unequivocal patterns, but rather more subtle, less easily identified or classified samples.

Though such a skill is particular to the learning of poetry-writing in a creative-writing class, I would argue that it is a skill fairly typical of the skills acquired in higher education. It is a skill based on particular fields of knowledge with their own terminology (in this case linguistics, phonetics and poetics), which are put to professional use. This means that the student is expected to internalize this knowledge and express it as a set of higher order skills — subtle, responsive to context, and always flexible, but not entirely conscious.

References

- Biggs, John and Catherine Tang. 2007. *Teaching for Quality Learning at University*. Third edn. Berkshire, England: McGraw Hill, Society for Research into Higher Education & Open University.
- Chen, L.-J., Ho, R.-G., & Yen, Y.-C. (2010). Marking Strategies in Metacognition-Evaluated Computer-Based Testing. *Educational Technology & Society*, 13 (1), 246–259.
- Haier, R. J., B. Siegel Jr., A. MacLachlan, E. Soderling, S. Lottenberg & M. S. Buchsbaum (1992) 'Regional glucose metabolic changes after learning a complex visuospatial/motor task: a positron emission tomographic study' *Brain Research*, 570, 134-43.
- Hampton, Scott and Robert Reiser (2004) 'Effects of a theory-based feedback and consultation process on instruction and learning in college classrooms' *Research in Higher Education*, Vol. 45, No. 5, August, 497-527.
- Isaksson, Sven (2008) 'Assess as you go: the effect of continuous assessment on student learning during a short course in archaeology' *Assessment & Evaluation in Higher Education* Vol. 33, No. 1, February, 1–7.
- Petersen, S. E., H. van Mier, J. Fiez and M. Raichle (1998) 'The effects of practice on the functional anatomy of task performance' *Proceedings of the National Academy of Sciences of the United States of America*, 95, 853-60.
- Posner, Michael and Marcus Raichle (1997) *Images of Mind*, New York: Scientific American Library.
- Ramazani, Jahan, Richard Ellmann & Robert O'Clair (eds). 2003. *The Norton Anthology of Modern and Contemporary Poetry*, vol. 1. Robert Frost, 'Stopping by Woods on a Snowy Evening' pp 214-5. New York: Norton.
- Stroop, J. R. (1935) 'Studies of interference in serial verbal reactions' *Journal of Experimental Psychology*, 18, 643-62.
- Karni, Arvi, Gundela Meyer, Peter Jezard, Michelle Adams, Robert Turner and Leslie Ungerfielder, (1995) 'Functional MRI evidence for adult motor cortex plasticity during motor skill learning' *Nature* 377, 155-8.
- Le Grange, Lesley and Chris Reddy. 1998. *Continuous Assessment: an introduction and guidelines to implementation*. Capetown, South Africa: Juta & Co.
- Velmans, Max (1991) 'Is human information processing conscious?' *Behavioral and Brain Sciences*, 14, 651-726.