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John M. Pearce, FRS

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NICHOLAS JOHN SEYMOUR MACKINTOSH
9 July 1935 — 8 February 2015
Nicholas John Seymour Mackintosh was an experimental psychologist whose principal goal was to understand the basic mechanisms of learning and cognition, largely through research with animals. The two textbooks that he wrote on this topic synthesized a vast body of research and set it within a theoretical context of association formation that has remained dominant for over 40 years. He developed a formal theory of the relationship between attention and learning that had an immediate impact and can be expected to be the foremost theory of its kind for many years to come. He was also a prolific experimenter, whose ingenious experiments were remarkable for the theoretical insights they offered into the mechanisms of learning in a wide range of species. Towards the end of his career, he developed an interest in the measurement of human intelligence. The textbook that followed from this interest is one of the most authoritative ever written on the topic.

**Life History**

At the funeral of Nicholas Mackintosh, in Bury St Edmunds cathedral on 12 March 2015, his brother-in-law, James Brunt, gave three speeches. The short version described Nick as: ‘A very clever man who liked a drink.’ The slightly longer version described him as: ‘One man. Two degrees. Three wives. Four names. Five children. Six visiting professorships.’ The full-length version provided a fascinating summary of his life outside academia.

**Education**

Nicholas John Seymour Munro Mackintosh was born in London in 1935 to Daphne, who was Anglo-Irish, and Ian, who was a Scottish GP. The family was based in Malaya, but Nick
and his elder sister Sally spent most of their time in the United Kingdom, where they were cared for by a wealthy grandmother. With the onset of World War II, and Nick only five years old, he and Sally were evacuated to Canada on the *Duchess of Richmond* along with 20 or so other children (see figure 1). Daphne remained behind in London and Ian remained in Malaya. Nick’s education at this point took place in a school that was purpose built for the evacuated children near St Saveur, 50 miles north of Montreal. The many opportunities for swimming and kayaking in the summer, and skiing and skating in the winter, went some way towards compensating for the complete lack of a family life. Nick and Sally embarked on their return journey to England by boat in 1943. They made it safely to Lisbon, only to be abandoned in a hotel by their chaperone, who took the last remaining seat on the only available flight to London. It was left to Sally, who was by now in her early teens, to persuade the waiters and staff of the hotel to care for them both. After several months in Lisbon, Nick and Sally were finally reunited with their mother in London, where they were joined some time later by Ian, who returned after being confined for over three years in a Japanese prisoner of war camp.

Nick’s education continued in a variety of prep schools in Surrey and Oxfordshire. His attendance at these schools as a day pupil was made possible by sharing a succession of rented houses with his mother. He won a scholarship to Winchester College when he was 13, where he is said to have thrived, despite disliking the school. He studied English Literature, Latin and Greek, which he regarded as being responsible for his ability to express himself clearly and easily in writing. The school report of which he was most proud stated that ‘Mackintosh has a fertile mind and a fluent pen and he uses both to avoid doing any work’. While the first two of these observations remained true for the rest of his life, he proved the third to be wholly inaccurate.
After leaving Winchester in 1953, he spent a year teaching at a prep school before spending six months at the Sorbonne in Paris and some time in Vienna and Amsterdam. Nick was always vague about what he was meant to be doing and, indeed, what he did, during this period. However, he did admit to writing half a novel, which no-one has ever seen. I also know that, because he missed the last ferry to Dover on one of his return trips home, poverty obliged him to spend a night in a disused pill box outside Calais after hitch-hiking all the way from Greece. The next two years were spent in National Service as a recruit in the 13th/18th Hussars in Germany, where he was a member of a tank crew guarding the border between East and West Germany. Quite how he would have mounted a defence against an attack from the East is not clear, as the tank was not fitted with ammunition.

Nick was offered a place as an undergraduate at Magdalen College, Oxford, in 1957 and graduated in 1960 with a degree in Philosophy and Psychology. He progressed immediately to study for his DPhil in experimental psychology under the supervision of Stuart Sutherland, with whom he worked closely for the next 10 years, and for whom he had a deep admiration. He chose to study psychology over philosophy because he believed that only one philosopher in a generation can make an impact, whereas he thought he might be able to do something useful in psychology.

Family life

Nick’s family life was influenced by his childhood in two ways. An obvious influence was the lack of a permanent home in his childhood, which led him to seek a stable base throughout his later life. Paradoxically, whenever he achieved this goal he admitted he would become terrified and want to flee. The other influence was a permanent feeling of guilt that resulted from his upbringing as a Catholic. He reasoned that since he already felt guilty he might as well do whatever he wanted, as the guilt could not be made worse. As his brother-in-law remarked, in putting this principle into practice he sometimes hurt those close to him.

Nick met his first wife, Janet Ann Scott, when, as Oxford undergraduates, they were both working in Stuart Sutherland’s laboratory in Naples during the summer of 1959. They married a year later in Naples and had two children, Alasdair John, who was born in Oxford, and Lucy Dorothea, who was born in Canada. The marriage was dissolved in 1978. He met his second wife, Bundy Wilson, while he was Professor of Experimental Psychology at the University of Sussex and she was a researcher in the animal laboratory. They married in 1978 and had two sons, Duncan Ian James and Douglas Lachlan. The marriage was dissolved in 1989. Nick met his third wife, Leonora (Lee) Caroline Brosan, a clinical psychologist, when she was interviewed for a part-time teaching position in his department at the University of Cambridge. They were married in 1992 and had one child, Angus James Brosan.

Nick is remembered by his children for his patience and his relaxed approach to life. He taught them that the world was an interesting place, and he encouraged them to make their own decisions in their own time. Nick’s relaxed approach to life extended to driving. His children remember being allowed to drive cars around fields from a very early age. They also remember being driven by Nick on family holidays across Europe at great speed and with scant regard for the fines that were accumulated. Such recklessness also extended to North America, where Nick was banned from driving in the state of Georgia.

Much of Nick’s adult life was spent living in the countryside, first in Sussex, and then in Suffolk. He greatly enjoyed looking after the land he owned, and engaging in projects such as creating ponds and swimming pools. A prominent feature of the garden was the barbecue,
which was brought into action whenever there was the slightest excuse to entertain staff and students from his department. True to the above short description of his life, these occasions were helped by generous supplies of wine and beer.

After retiring in 2002, he gained considerable pleasure from caring for a diverse collection of animals, including alpacas (see figure 2), a small flock of Hebridean sheep—some of which ended up on the dining table—and Lee’s overweight pony. This does not mean Nick lost touch with his academic interests. Retirement was also spent as a journal editor for six years, preparing the second edition of a text book, writing research articles with a wide range of collaborators and presenting papers at conferences around the world. In 2011, Nick chaired the Royal Society Working Group on Neuroscience and the Law. The clear and far-reaching report produced by the committee highlighted the benefits that those engaged in the legal process might gain from a greater understanding of new developments in neuroscience.

**ACADEMIC CAREER**

*Academic posts*

The peripatetic lifestyle of Nick’s early years also characterized much of his academic career. After gaining his DPhil, he spent the next three years in the Institute of Experimental Psychology at Oxford, where he was a research associate (1963–1964), a university lecturer (1964–1967) and a Nuffield Research Fellow, Lincoln College (1966–1967). His wanderlust during this period was satisfied by trips to Sutherland’s laboratory in Naples to study
discrimination learning in the octopus, and by a visiting assistant professorship at the University of Pennsylvania, where he presented a series of lectures on learning to an undergraduate class (1965–1966). This year was important as it enabled him to influence, and be influenced by, an outstanding group that had a profound impact on experimental psychology in North America for nearly half a century: Vin LoLordo (who was Nick’s teaching assistant), Steven Maier, Bob Rescorla, Martin Seligman and Sara Shettleworth. It was during this year that Nick came to appreciate the full significance of Pavlovian conditioning for the study of associative learning. To the amusement of his North American colleagues, he also had the opportunity to show his stoicism by eschewing an overcoat in favour of a sports jacket as his only protection against a freezing Pennsylvanian winter. Further travel involved visiting professorships at the University of California, Berkeley (1965–1966), and the University of Hawaii (1966).

Another year in Oxford was then followed by a return to Canada, where he was the Isaac Walton Killam Research Professor at Dalhousie University, Halifax, Nova Scotia (1967–1973). While at Dalhousie, Nick, together with Vern Honig, organized a symposium entitled ‘Fundamental issues in associative learning’, at which the seven best researchers and thinkers in the field presented papers. The relatively small book based on these papers, which was
Biographical Memoirs

edited by Mackintosh & Honig (1)*, marked a turning point in both the theoretical and empirical analysis of associative learning. The final chapter was written by Nick and it is remarkable for its foresight concerning future developments in the field.

In 1973 Nick was awarded a Professorial Fellowship by the Science Research Council (now BBSRC), which reunited him with his Oxford supervisor, Stuart Sutherland, at the Laboratory of Experimental Psychology, University of Sussex (see figure 3). He quickly established his laboratory as being among the best in the world and, with his postdoctoral assistant Anthony Dickinson (FRS 2003), was soon publishing experiments that transformed our understanding of the role played by attention in associative learning (6, 8). Nick became Professor of Psychology in Sussex in 1977, and was departmental chairman from 1978 to 1980. Of course, this does not mean he spent this entire period in Sussex. In 1977, he was the McBride Visiting Professor at Bryn Mawr College, Pennsylvania.

A more permanent move took place in 1981 when Nick was appointed Professor and Head of the Department of Experimental Psychology at the University of Cambridge—a position that he held until his retirement in 2002. The Department of Experimental Psychology thrived under Nick’s headship. It was consistently ranked among the top psychology departments in the United Kingdom for its research, but the achievement that gave Nick most satisfaction was its being the first department in the University of Cambridge to be awarded a perfect score for the Teaching Quality Assessment exercise. Upon learning of this success, Nick dived straight into a wine shop and emerged with an armful of champagne in order to celebrate with the academic and support staff whose hard work had led to this outcome. Throughout his stewardship, the Department of Experimental Psychology was a happy place to work.

Nick was a Fellow of King’s College, Cambridge from 1981 to 2005. He served as Chair of the School of Biology and was a member of the University’s General Board of the Faculties from 1988 to 1990 and from 1996 to 2000. He used these positions to change a system of allocating resources that he regarded as archaic and unbalanced, to one that ensured fairness and transparency throughout the School of Biology. Together with Gabriel Horn (FRS 1986), he was also able to achieve the impossible within the Natural Science Tripos in Cambridge, by introducing a new first-year course, Evolution and Behaviour, which meant that for the first time at least some psychology was taught at this level.

While at Cambridge, Nick’s itchy feet led him to visiting professorships in Australia (1990, University of New South Wales), France (1993–94, Université de Paris-Sud) and the USA (2002, Yale University). A 40-minute video of an interview in which Nick discusses his career can be found at: https://www.youtube.com/watch?v=q-amHjZB8TM&feature=youtu.be.

Books

Nick said that his most important contribution to research was the books that he wrote. The first of these, Mechanisms of animal discrimination learning (2), was co-authored with Stuart Sutherland and published in 1971. It summarized the fruits of their 10-year collaboration, and the authors each took primary responsibility for half of the chapters. The book is remarkable for the originality of its theoretical ideas and for its outstanding scholarship. At the heart of the book is the claim that learning in animals is guided by a process of selective attention. This was a bold statement to make in 1971, when the suggestion that animals have mental processes such as attention was regarded as tantamount to heresy by many researchers. At the time of its

* Numbers in this form refer to the bibliography at the end of the text.
Nicholas John Seymour Mackintosh

publication, the book was among the few to demonstrate that experimental psychology of the highest standard was being conducted on the European side of the Atlantic.

Many regard Nick’s 1974 book, *The psychology of animal learning* (3), as being his greatest academic achievement, which one commentator described as ‘an enormous effort that set a standard for scholarship and intelligent discussion that few other books on the subject can even approach’ (Williams 1987). The field of animal learning in 1974 was mired in heated debates about a wide range of theoretical issues. Is reward necessary for learning? Why does unlearning progress more slowly when reward has been presented intermittently rather than consistently during prior training? How can the absence of an aversive event support avoidance behaviour? What knowledge do animals acquire during a learning experience? Nick rose above all these controversies by offering a coherent theoretical position based on the assumption that association formation forms the bedrock of learning. That is, when two events are repeatedly paired together, be they two stimuli, or a response and either a reward or punishment, animals learn about this relationship and behave accordingly. As Hall (2016) noted, although this idea was not new—it was consistent with the empiricist tradition of British philosophy, and with the views of many North American learning theorists—what was original was the attempt to explain all of animal learning with this single, unifying idea.

From his associative perspective, Nick was able to provide satisfying answers to the questions raised above, and many others. He was also able to provide a theoretical framework that guided research for the next 40 years. If that is not enough, the book provides a scholarly review of more than 2000 experimental articles that represented all the major research topics under investigation at the time. Nick’s stated aim was not to shy away from the controversies surrounding these topics, but to review the evidence from all points of view, and to draw the appropriate conclusions. Not surprisingly, these conclusions often, but not always, were in keeping with his associative perspective. The result was a book whose summary of research findings, and the empirical conclusions drawn from them, set a standard that remains unmatched to this day. Despite his determination to get to the heart of every problem he encountered, the book is clear, concise and beautifully written throughout its 630 pages. It also conveys a sense of intellectual excitement by showing how well an associative analysis is able to explain so many of the phenomena discovered through laboratory investigations of learning in animals. Nick said that he wrote the entire book in fewer than five months, which is quite remarkable, especially given that all he had at his disposal was a pen, paper and a card index. It is an outstanding achievement, and it resulted in one of the best books that have ever been written in experimental psychology.

*Conditioning and associative learning* (9), Nick’s next book, was published in 1983. Despite a considerable degree of overlap, this book diverged from the *Psychology of animal learning* in two important respects. On the one hand, it offered a more detailed and more wide-ranging theoretical analysis of the empirical findings revealed by studies of associative learning than its predecessor. On the other hand, rather than review exhaustively these studies, only those findings that were relevant to the theoretical analyses under consideration were discussed. The result was a book that was half the length of the previous one, but which was packed with an abundance of theoretical insights. In his review of *Conditioning and associative learning*, Williams (1987) listed 10 conclusions that he regarded as important, but a consideration of just a few of these should provide a flavour of the book. Nick argued that the associations formed during Pavlovian conditioning, when a tone might signal food, are different from those formed during operant conditioning, when pressing a lever might
produce food. He argued that the ease with which associations are formed during conditioning depends not just upon contiguity, but also upon relative predictiveness, spatial contiguity, similarity, relevance and past experience. He argued that a theory developed by Spence (1936) still forms a satisfactory basis for our understanding of discrimination learning. And he argued that association formation is guided by molecular rather than molar relationships. Today, many of these conclusions are taken for granted, but they were not in 1983, and this move to general acceptance can be attributed largely to the arguments presented in the book. Even now, more than 30 years after it was published, the case made by the book for regarding learning in animals as being based on association formation remains convincing.

In 1974 a prominent animal learning researcher, Leon Kamin, published a book on human intelligence, in which he attacked fiercely the notion that IQ is largely inherited (Leon Kamin 1974). Given what he had learned as an undergraduate, Nick was surprised by this claim and was thus goaded into heading in an entirely new direction—the study of intelligence testing. His first publication on this topic was, in fact, a review of Kamin’s book that appeared in the *Quarterly Journal of Experimental Psychology* (4). This was far from a typical book review. It extended to 14 pages and provided a detailed critique of Kamin’s arguments, based on a careful reading of many of Kamin’s sources.

When he arrived at Cambridge, Nick did not want to take over the course on associative learning, which was already in the safe hands of Anthony Dickinson. Instead, given that his interest in human intelligence testing had already been roused, he volunteered a course on this topic. The background reading that he undertook when preparing this course formed the basis of his next textbook, *IQ and human intelligence*, which was published in 1998 (11). Nick acknowledged that the history of IQ testing had been controversial, and that a good deal of nonsense had been written about this topic. His aim in the book was thus, in the manner of his earlier books, to review the relevant evidence and to use it to judge the various positions that had been expressed concerning the measurement of intelligence. It is evident that he was highly successful in achieving this goal as the book, which is a joy to read, was very well received by the intelligence testing community. It was widely praised not only for providing a comprehensive and objective introduction to the topic, but also because of the influence it exerted at a practical level. According to the Psychometrics Centre at Cambridge, in their obituary to Nick, his book ‘represented the turning of the tide in attitudes in the UK, both academic and public, towards the need to remedy underachievement in inner-city multiethnic schools as well as a recognition of the important role that psychology had played and would continue to play in addressing these social issues’. A second edition of the book was published in 2011 (15).

### Research

Nick did not just write books. He was a dedicated researcher who was committed to understanding the basic mechanisms of associative learning, largely through experiments with animals. Driving much of his research was the belief that attention plays a critical role in guiding the course of associative learning. This view was presented in his book with Stuart Sutherland (2), the main purpose of which was to put forward a new theory of attention and learning. According to their analyser theory, when an animal receives two events paired together, such as a tone signalling the delivery of food, the ease with which it learns about this relationship is affected by how much attention is paid to the tone. Moreover, attention can vary with experience. Attention to the tone will be high if it has repeatedly been followed
by an important event, such as the presence or absence of food, whereas attention to the tone will be low if it has been followed unreliably by such events. Even though they showed how the theory could explain a wide range of findings, the theory of Sutherland and Mackintosh did not receive the recognition it deserved. One reason for its relative neglect is that shortly before the book was published, Rescorla and Wagner put forward an alternative theory that could explain in an elegant manner many of the phenomena accounted for by the Sutherland and Mackintosh model (e.g. Rescorla & Wagner 1972). Moreover, this success was achieved without the need to invoke changes in attention.

Nick reacted to this assault by publishing a new theory of attention in 1975 (5). In keeping with his earlier theory, changes in attention continued to be important for determining how rapidly learning about a stimulus will take place, but the rules that govern changes in attention were different from those advocated in the earlier model. In the earlier model, stimuli were in competition for the attention they received. The more attention paid to one stimulus, the less could be paid to others presented at the same time. This constraint was lifted for the 1975 theory.

In this new theory, pairing a given stimulus, A, with food on a particular trial was assumed to result in the growth of an association between internal representations of the two events. The strength of this association reflected how well the stimulus was regarded as a predictor of food, and was assumed to determine the strength of the response to A. Equation 1 describes the change in associative strength of A, $\Delta V_A$, that will take place on any trial. In this equation, $V_A$ represents the current associative strength of A, and the value of $\lambda$ determines the maximum associative strength that can be acquired for a given magnitude of food.

$$\Delta V_A = \alpha (\lambda - V_A)$$

[1]

The role played by $\alpha$ in this equation is crucial, as its value, which can vary between 0 and 1, was said to reflect the amount of attention paid to the stimulus, A. It follows from the equation that learning about a stimulus will be more rapid when attention to it is high than when attention to it is low. Nick proposed that the value of $\alpha$ will increase if A is a better predictor of the outcome with which it is paired than any other simultaneously presented stimulus. On the other hand, if the stimulus in question is a poorer predictor of the outcome than any stimulus that accompanies it, then the value of $\alpha$ will decrease.

This simple set of proposals resulted in a highly influential theory that had an immediate impact. Not only was it able to offer an alternative explanation for many of the effects that can be accounted for by the Rescorla–Wagner (1972) theory, it also pointed the way to experimental designs that would reveal findings that posed a serious challenge to this theory. One such finding was referred to by Nick as learned irrelevance. He argued that if a stimulus, such as a buzzer, is presented randomly with respect to the occasional presentation of an outcome, such as water, then, by virtue of being a poor predictor of water, attention to the buzzer will decline to a very low level. In confirmation of this prediction, and in keeping with equation 1, Nick and Andrew Baker were able to show that learning about the buzzer was severely disrupted when it was subsequently used as a signal for water (7).

During his days at Sussex, and his early years at Cambridge, much of Nick’s research was directed at exploring the implications of his theory. The findings from these studies, as well as from laboratories around the world (e.g. Holland & Maddux 2010; Le Pelley & McLaren 2003), lent considerable support to his views, with the consequence that his work (5) is among the most highly cited, and influential, theories of animal learning that have been put forward. It
should be added, however, that the theory is not without its shortcomings. One problem is that not only can animals learn that a stimulus signals the occurrence of an event, but, given the appropriate training, they can also learn that it signals the absence of an event. The theory is unable to predict this second type of learning. Another problem is that in some circumstances, attention appears to be high to a stimulus while it is being learned about and low when learning is complete (Pearce & Hall 1980), which is the opposite of the rules proposed in (5). He was aware of these problems and, together with Pearce (14), proposed that learning is governed by equation 2 rather than equation 1.

\[ \Delta V_A = \alpha.\sigma.(\lambda - V_X) \]  

In contrast to equation 1, there are now two learning rate parameters, \( \alpha \) and \( \sigma \). The value of the first of these is set according to the rules proposed in the original theory (5), while the value of the latter is set according to rules proposed by Pearce & Hall (1980). A further difference between equations 1 and 2 is that changes in associative strength of a given stimulus, \( A \), are no longer determined by a local error term—that is, by how well \( A \) predicts the outcome \((\lambda - V_A)\). Rather, these changes are determined by a global error term—that is, by how well the outcome is predicted by all the stimuli present on a trial, \((\lambda - V_X)\). Shortly before he died, Nick admitted to being unhappy with the idea that changes in associative strength are governed by a local error term, and he looked forward to pursuing further the possibility that such changes were governed by a local error term. What a pity that it must be left to others to take up this challenge.

Whatever the role of global and local error terms in associative learning, Nick’s enduring legacy, as far as his work on the role of attention is concerned, will be his advocacy of the principle that learning will progress more readily with stimuli that have previously served as reliable rather than unreliable predictors of an outcome. Following its formal presentation (5), this principle has repeatedly resurfaced, in one form or another, in a succession of theoretical accounts of associative learning (e.g. Le Pelley 2004), and there is every reason to suppose this trend will continue.

Another strand of Nick’s theoretical contribution concerned a phenomenon known as perceptual learning. This term refers to the ability of animals, and humans, to become more adept at distinguishing between two similar stimuli through repeated exposure to each of them. Nick’s interest in this effect was piqued by the observation of William James (1890) that the more one drinks claret and Burgundy, the easier it is to tell which one is which. To explain this effect, McLaren, Kaye and Mackintosh (10) argued that the repeated experience of two stimuli necessarily results in more exposure to the features that are common to both of them, than to the features that are unique to either one or the other. A process of habituation was then assumed to result in a loss of salience by the common features, and thereby enable the unique features to gain prominence and facilitate the ease of distinguishing between the cues. These ideas were presented with Ian McLaren in the form of a connectionist network (12), which was subsequently elaborated in order to encompass a wider range of phenomena (13).

Nick was a dedicated and skilled experimenter. It is not easy to design an experiment with animals that yields a result that is both reliable and original, and it is very much harder to design an experiment that also has important theoretical implications. But Nick excelled in all these respects. His experiments are important because they tell us something fundamental about the mechanisms of learning, memory and attention. At the outset of his career, his experiments were run by hand and required many hours of sitting in a dark chamber waiting
for a rat to jump from a platform to one of two stimuli. His later experiments took place in automated chambers that were controlled by racks of relays connected by complex wiring. Judging from his language, Nick did not always enjoy the process of connecting the relays together at the start of a new experiment. Ultimately, his experiments were controlled by computers, but, by now, the demands of being head of department made it necessary to delegate the responsibility of programming them. Despite the heavy demands on his time, Nick made sure they did not get in the way of his daily visits to the lab, normally at tea time, to discuss the progress that had been made.

The experiments Nick performed shed light on an unusually wide range of topics. In addition to learned irrelevance and perceptual learning, the list of phenomena he investigated includes: blocking, overshadowing, peak shift, serial reversal learning, extradimensional and intradimensional shifts in discrimination learning, behavioural contrast, the partial reinforcement effect, transposition, transfer along a continuum, and spatial learning. The species he worked with were equally diverse: octopus, rats, pigeons, rooks, jays, chicks, a parrot and goldfish.

**Psychology in Spain**

Shortly after his death, the Spanish Society for Comparative Psychology organized a symposium at the University of Seville to commemorate Nick and his work. Gabriel Ruiz,
a professor of history of psychology, described the profound contribution that Nick had made to the study of animal psychology in Spain (see Ruiz 2016). From the mid 1930s to the mid 1970s, the study of animal psychology in Spain was heavily influenced by Franco’s government education policy. Thus, the behaviour of bees was said to be guided by the mind of God, and the work of Pavlov was derided as a relic of the past. In this context, it is hardly surprising that by the early 1970s there was only a single university with an animal psychology laboratory in the entire country. This state of affairs changed in 1974, when Antonio Guillamón, from the Autonomous University of Madrid, attended a seminar presented by Nick at Oxford University. Antonio talked to Nick after the seminar and returned to Spain with a signed copy of the recently published, *Psychology of animal learning*. This copy was passed among his students and the immediate excitement it generated was responsible, in part, for the foundation of an animal laboratory in 1976 in Madrid. Once the seed had been planted it spread rapidly, with animal laboratories springing up across the country.

An important spur to this growth was a series of seminars organized in 1985, 1987 and 1988 by Victoria Chamizo at the University of Barcelona. Nick attended each of these meetings and they tested his stamina to the limit. He was asked to present not just one, but a series of lectures on each occasion. The day-long sessions were broken by lengthy lunches, and concluded with meals that lasted well into the night (see figure 4), followed by visits to bars that seemed to remain open until breakfast time. The sacrifice
Figure 6. Nicholas Mackintosh in 2009 enjoying retirement in his garden in Suffolk after completing his spell as editor of the *Journal of Experimental Psychology: Animal Behavior Processes*. (Online version in colour.)

was worthwhile. Those who attended the meetings were left with a desire to form a society where it would be possible to discuss research guided by the theoretical framework they had gleaned from Nick’s lectures and books. The Spanish Society for Comparative Psychology (SEPC) was formed a few months after the third of these meetings. Antonio Maldonado, from the University of Granada, was the first president, while Nick was the honorary president and the invited speaker at its first meeting, which was held in Granada in 1989. He attended many subsequent meetings (see figure 5) and was due to present the invited address at the 2009 meeting in Salamanca until ill-health forced him to withdraw. Nick’s contribution to Spanish psychology was summarized by Ruiz (2016, p. 250) as follows:

When . . . I listen to the studies being presented at the conferences of the SEPC and I read the articles by Spanish authors published in the specialist journals, I can clearly see that the prevailing orientation in the study of learning in this country continues to be associative. And I believe that this orientation, which owes much to the ideas of Mackintosh, due to his conceptual rigour and strictly experimental nature, has been determinant [sic] for the overall development of Spanish experimental psychology.

At a more local level, Nick’s visits to Barcelona led to a 33-year collaboration with Victoria Chamizo that investigated how animals learn to navigate through a familiar environment. Their work pointed to the important conclusion that the principles of associative learning, which were derived from simple experiments in simple test chambers, also apply to complex behaviour in complex environments. Nick was awarded posthumously the Gold Medal of the
University of Barcelona in recognition of his services to the university, and his outstanding services to the scientific community. The medal was received by his wife, Lee, at a ceremony held at the University of Barcelona in November 2015.

CLOSING COMMENTS

Nick wrote in his 1998 book on human intelligence (11) that ‘Intelligence is not synonymous with virtue . . . Honesty and integrity are more valuable, and may be more effective than unprincipled sophistry’ (p. 3). This conclusion was obviously important to him, as he expressed a similar view when interviewed about his work on BBC Radio 4. Of course, Nick was highly intelligent, but he also possessed in abundance the virtues that he saw as being so important.

He had all the virtues necessary to be a successful and well-respected head of department. He was keen to ensure that both academic and support staff felt appreciated, were treated fairly and as equals, and never exploited. He is remembered for his complete lack of pomposity and self-importance, which was revealed on more than one occasion by his insistence on washing up the glasses after a departmental party.

Another virtue was his kindness. This virtue was particularly evident when performing his editorial duties. Nick was the editor of the Quarterly Journal of Experimental Psychology (1997–1984) and the Journal of Experimental Psychology: Animal Behavior Processes (2003–2009), and he was widely regarded as the outstanding editor of his generation (see figure 6). New submissions rarely reached the threshold set by his high standards, but his response to the authors was always helpful, courteous and provided clear advice about how a suitable revision should be constructed. Often this advice helped authors to develop their theoretical ideas, or to design better experiments. Even when a submission fell well short of the acceptable standard, rather than write an outright letter of rejection, he preferred to temper the blow by suggesting how the author might go about improving their work. In this way, he was able to mould, encourage, and enhance the quality of a generation of research into the mechanisms of associative learning.

Running a top psychology department, and indeed the School of Biology, being a journal editor, writing outstanding books and conducting high quality research requires a huge amount of time, but these demands did not mean Nick was difficult to approach. His office door was always open, and he was always happy to talk with whoever wanted to engage him in conversation. Even if there was a conflict of views, he would take a genuine interest in the opposing point and treat it with respect. His willingness to engage in conversation highlighted his modesty, as he invariably talked as an equal to anyone who approached him. Numerous graduate students and early-career researchers have fond memories of talking to Nick late into the night in a conference bar—long after his younger colleagues, with less stamina, had retired to bed.

HONOURS AND AWARDS

1982 Elected Fellow of the British Psychological Society
1984 Biological Medal, British Psychological Society
1986 President’s Award, British Psychological Society
Nicholas John Seymour Mackintosh

1987 Elected Fellow of the Royal Society
2004 W. Horsley Gantt Medal of the Pavlovian Society of North America
2015 Gold Medal of the University of Barcelona, awarded posthumously

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AUTHOR PROFILE

I was a second-year PhD student at the Laboratory of Experimental Psychology, University of Sussex, when Nick joined it in 1973. We would probably have had rather little contact professionally, if it was not for the fact that Nick’s wife, Bundy, and my wife, Victoria, were good friends. During the many family visits to each other’s homes, Nick and I would find a quiet room in the evenings where we would discuss our different theories over a bottle of red wine. This enjoyable routine continued after Nick’s marriage to Lee. We also met regularly at conferences throughout the world, and annually at Gregynog Hall, in mid Wales, for an associative learning symposium that I have co-organized since 1997. To commemorate Nick, the lecture presented by the invited speaker at this symposium is now named the Mackintosh Lecture.

REFERENCES TO OTHER AUTHORS


Biographical Memoirs

BIBLIOGRAPHY

The following publications are those referred to directly in the text. A full bibliography is available as electronic supplementary material at http://rsbm.royalsocietypublishing.org.


