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A CANADIAN PIONEER OF COMPARATIVE PSYCHOLOGY: T. WESLEY MILLS (1847-1915)

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ABSTRACT: A brief survey is given of the life and writings of T. Wesley Mills (1847-1915) with particular emphasis on his work on comparative psychology. He represented a position closer to Romanes than to Thorndike insofar as he felt that the intelligence of certain species of animals was often underestimated. He was also a pioneer in the keeping of diaries describing the development of sensory and cognitive abilities in the first days of life in puppies, kittens and the young of other species. He also tried to relate the development of these abilities to developments in the excitability of the cerebral cortex.

In the early days of experimental psychology, at the turn of the century, the best known Canadian writer on psychology was probably Thomas Wesley Mills, Professor of Physiology at McGill University. Although Mills was widely known among physiologists for his textbooks and various researches on the heart, the brain and the voice, he was equally well known among psychologists for his observation and theories concerning animal behaviour. In this paper, a brief account will be given of Mills' career, then a few remarks will be made on the condition of animal psychology at the time when he was most active in this area. Finally an evaluation will be made of his contributions to animal psychology. In this way we shall try to establish why Mills deserves credit both as a pioneer of Canadian psychology and as a pioneer of comparative psychology.

Mills was born in Brockville, Ontario, on February 22, 1847. He took his B.A. degree at the University of Toronto in 1871, and his M.A. in 1872. Then he went to study physiology and medicine at McGill University, where he was a colleague of the young William Osler, who went on to become one of the most famous doctors Canada has produced and who bequeathed his collection of medical books to McGill University; Osler also actively aided Mills in his subsequent career. In 1878, Mills obtained his M.D. and went to study in Europe for about 4 years, both in London and in Germany. In London he qualified for the Royal College of Physicians, and studied with Sir

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John Burdon-Sanderson. In Germany he worked with the eminent physiologist Kronecker. He also spent short periods of time with Professor Newall Martin at John Hopkins University in Baltimore. His early papers on physiology were particularly concerned with differences in the structure of the heart in various species, notably reptiles and fish, and he also worked on the cerebral cortex. In 1882, he was invited back to McGill where he successively became Demonstrator (1882-1884), Lecturer (1884-1886) and finally Professor (1886-1910) in the Physiology Department. It was while he was a Lecturer that he helped in founding an Association for the Study of Comparative Psychology in 1885; this society met regularly in Montreal and its members were mainly students and teachers of the School of Veterinary Medicine in Montreal. It seems to have provided a forum for Mills to express his views on a topic that he may have come to initially as a hobby; he kept a variety of pets himself, including dogs, and over the next 15 years or so, he wrote a sequence of articles on animal psychology which were published in the *Transactions of the Royal Society of Canada*, the *Sherbrooke Examiner* and other Canadian outlets as well as in international journals such as *Science*.

However his chief claim to fame in his own profession was his writing of outstanding textbooks such as the *Textbook of Animal Physiology* (1889). This book is noteworthy for having over 500 illustrations, and I found it unexpectedly useful, as I was skimming through it, because it contained valuable information on the "rete mirabile," that mysterious organ that Galen and the medieval scholars thought was important in the manufacturing of "animal spirits." Mills has a drawing of the rete mirabile, which is a net-like structure of blood vessels found in various places in various species and which Mills believed was important in maintaining a constant supply of arterial blood to a body region without congesting it—it is found, for example, in horses' feet. In another work written for his students, the *Outlines of Lectures on Physiology* (1886), I found Mills clarifying another part of ancient physiology for me: apparently "yellow bile," so important in Galen's theory of personality, is only found in carnivorous animals; the bile in herbivorous animals is not yellow, but green; and in humans it is yellowish-green. Another ancient humour, "black bile," probably has no referent in reality, but was guessed at by the doctors of antiquity—a full treatment of "black bile" and its variations will be found in Jackson's recent book on melancholia (Jackson, 1986). Both books clearly attest to Mills' extensive knowledge of ongoing research in physiology, including his own research on the different numbers of chambers of the heart in different species, and both books have sections that foreshadow his later writings on a branch of physiology on which he eventually became particularly expert. This was the study of voice production. All his life he

was interested in music; he contributed frequently to musical criticism and bequeathed his collection of musical literature and his violin to the McGill Conservatory of Music. His second wife, whom he married after the death of his first wife when he was 53, was an opera singer. His later books included what is apparently a classical work on *Voice Production in Singing and Speaking* (1906) notable for its excellent illustrations of the vocal apparatus. After his retirement from McGill in 1910, he spent the last years of his life active in musical circles in London, England.

Mills died of a heart ailment in 1915, and his obituary in the *Canadian Medical Association Journal* of that year was written by William Osler. Osler made it clear that Mills was not of a particularly sunny or optimistic temperament. Possibly Mills felt that his work was not properly appreciated in his lifetime, even though Osler stressed his sterling service in building up the Physiology Department at McGill. Even now Mills' work on animal psychology is little known, possibly because he did not actually work in a psychology department. In his lifetime, however, Mills' interests seem gradually to have shifted from comparative physiology to comparative psychology and Osler noted in his obituary how Mills kept private kennels and wrote two books on dogs, *How to keep a dog in the city* (1891) and *The dog in health and disease* (1892).

But the work for which he is best remembered was a compilation of his various articles on animal psychology entitled *The Nature and Development of Animal Intelligence*. The work appeared in 1898, at almost the same time as Thorndike's classic monograph on cats escaping from puzzle boxes; and indeed, Mills became intrigued with Thorndike's work and wrote a surprisingly scathing criticism of it in the *Psychological Review* for 1905. We know that Mills also corresponded with Karl Groos, the eminent German comparative physiologist, and that he engaged in a correspondence in *Science* magazine with Lloyd Morgan and James Mark Baldwin (this correspondence is reproduced in the book under discussion). In his monograph on *The Play of Animals* (English translation, 1898), Groos acknowledged that Mills was writing about young animals at the same time as Groos, and quite independently. On p. 86, Groos indirectly compared Mills' work on animals with that of Preyer on infant humans. Before describing these researches, let us briefly set the scene as it existed in comparative psychology in the 1880s and 1890s when Mills was most active. Much of what follows is based on the excellent account by Robert Boakes in his book *From Darwinism to Behaviourism* (1986).

When Darwin introduced the theory of evolution in 1859, he made it clear from the outset that instinctive behaviour in animals was itself the subject of evolutionary processes: behaviours that had been found useful in the primitive species were propagated to later

offspring. Of course, the tricky question was whether behaviour first performed by a parent could be passed on to the offspring directly in a Lamarckian fashion, or whether the mechanism of natural selection sufficed to explain the evolution of instincts as well as physical characteristics. Closely related was the issue of animal intelligence: how had intelligence evolved? Was man the end-species in the gradual evolution of intelligence? Given that animals possess intelligence of a lower order than human intelligence, what were the limits of animal intelligence? On the first issue, Lamarckianism, Darwin himself and his successor Romanes seem to have shared a propensity to believe in the inheritance of acquired characteristics and it was only at the turn of the century that the idea fell into disfavour. However, Mills wrote little on this topic and we may content ourselves by noting that in *Textbook of Animal Physiology*, Mills noted that "Instincts seem to be but crystallized habits, the inherited results of ages of functional activity in certain well-defined directions" (p. 41). On the second issue, animal intelligence, Darwin and Romanes both tended to ascribe intelligence of a fairly high order to sub-human mammals, with Romanes giving a detailed account of how dogs and apes, which he believed to possess roughly the same problem-solving abilities and memory capacities, lay only a short way below the human on the "tree" of the evolution of intelligence. But Lloyd Morgan argued for great caution in ascribing human-like qualities to animals; it was not only his canon of parsimony that made him famous, but also his belief that animals often carried out what seemed like "reasoning" or "problem-solving" on the basis of chance alone. Thorndike in 1898 pushed the pendulum even further in the direction of arguing for "animal stupidity" rather than "animal intelligence:" his cats could not apparently learn by imitation of another cat how to get out of a confining box to get food, nor could a person passively manipulate their paws to teach them the task. After Thorndike, "trial and error behaviour" became a fashionable term replacing the other anecdotal evidence favouring high intelligence on the parts of dogs and cats.

It was into this controversial milieu that Mills, with his large collection of animals, interjected a plea for caution: he tried to stop the pendulum in mid-movement and swing it back in the direction of arguing for high intelligence on the part of animals. In his 1905 paper, he gave anecdotal evidence of learning by imitation in cats and by "passive doing" in dogs, and, whereas Thorndike had claimed that a vast gulf existed between the memory abilities of animals and humans, Mills argued that the memory of a dog seemed to be surprisingly similar in nature and form to that of a human, with the difference being that humans had a "more varied fringe around that memory core" (p. 269).

In various addresses to the Association for the Study of Compara-

tive Psychology, published in his book, Mills raised a number of questions that had been discussed at the Association meetings and which warranted further enquiry. These questions included: how far can dogs be said to “understand” language? How similar is a dog’s “understanding” of its own name to that of a child’s? Can animals be said to possess moral characteristics? How good is the intelligence of the pig or the horse compared with that of the dog? Can animals sense the presence of water? Can sheep anticipate weather changes? How do intelligence and instinct interact in the beaver’s dam-building behaviour? How do dogs and migrating birds find their way? Why are domesticated animals apparently more intelligent than their wild cousins? How do animals behave when they lose a sense, such as when they become blind? In all of these questions Mills stressed the similarities rather than the differences between animal “thought” and human “thought.” He suggested that in the world of nature, the achievement of a pigeon migrating 600 miles is almost as awe-inspiring as the achievement of Mozart in writing an opera. His tendency to relate animal behaviour to human behaviour is particularly exemplified in an essay he wrote on hibernation, in which he drew parallels between hibernation in animals and unusual sleep states (“lethargy” or “stupor” states) in human patients.

Mills’ objection to Thorndike’s research was that by confining the cats to enclosed environments, the cat had little chance to show its intelligence; for Mills the only proper way to evaluate the abilities of an animal species was to observe it in natural surroundings all the time so that one knew exactly what experiences the animal had had; he wrote:

“Were it possible to observe an animal, say a dog, from the moment of birth onward continuously for one year, noting the precise conditions and all that happens under these conditions, the observer being unnoticed by the creature being studied, we should, I believe, be in possession of one of the most valuable contributions it is possible to make to comparative psychology”. (p. 273).

In his book (p. 19), he stressed that animals’ sensory abilities often exceed those of humans, and made the telling point that, just as we are often mistaken about the minds of other humans, so we are likely to be even more often mistaken in understanding the minds of animals. He also believed, on the basis of observations of squirrels, that vocal communication was more widespread in animal communities than was usually realized (p. 60) and that squirrels may be more “intelligent” than chipmunks because of their closer association with humans (p. 74).

Mills himself actually came close to fulfilling his own ideal, for he was perhaps the first to make diaries of the behaviour of young

animals from birth onwards. These diaries were reported complete in his 1898 book; he was inspired to keep these diaries by the work of Spalding (1872), who had shown that the young of certain species seem to have innate instincts for certain behaviours including food-seeking (pigs, chickens) and flying (swallows), and possibly by the diaries kept of the behaviour of human babies by Darwin (1877) and Preyer (1882). For a few years Mills kept full accounts of the psychic development of a number of species, including two diaries on litters of St. Bernard puppies, one on a litter of Bedlington terriers, one on kittens of ordinary domestic cats, one on mongrel puppies, two on rabbits, one on guinea pigs, five on individual pigeons, and several on chickens. It is impossible to summarize all this information here, but what emerges clearly from these diaries is evidence for differences between the species in the preparedness for life of the newborn: cats and dogs require weeks before they can survive on their own; whereas the other species are ready after a much shorter time to fend for themselves. To give the flavour of a typical diary, here are the first few sentences of the diary of the St. Bernard puppies:

"1st day. Almost as soon as born and freed from the investing placental parts by the dam, the puppies *cry* out, though more loudly a little later, *crawl* slowly but vigorously enough toward the teats of the dam, and at once, in most cases, begin to *suck*. It is noticed, however, that other parts are sometimes sucked as well as the teats. They huddle together, and get between the legs of the dam, and where the hair is longest, or where, for any reason, there is most warmth, when not actually nursing.

Their movements are very slow. Their eyelids are still not grown apart nor their ears grown open.

Two of them weighed at the end of about twenty-four hours 1 lb. 2 oz. and 1 lb. 6 oz. respectively.

They were not examined as to reflexes other than sucking, reaction to temperature, etc.

I made, on the first day, the following experiment: placing a puppy on a surface above the floor, it was found that, when it reached the edge it became very *uneasy*, spread its claws, etc., to avoid falling off.

On this and later dates, they cry apparently from cold or hunger or when removed from the usual environment.

4th day. The last experiment is repeated under slightly varying conditions. A tortoise placed under the conditions walked or tumbled off. On this day, one puppy was conveyed to my laboratory, wrapped up warmly in a blanket, without a cry or other sign of discomfort, the journey occupying about half an hour." (p. 118)

This extract will have given some idea of Mills' reporting strategy: he does not examine the animals all the time, but at intervals;

he reports what they can do at different ages, sometimes determining the animals' abilities by small experiments and by comparing them with other species (as with the tortoise in the quotation); and he is particularly concerned to establish what seems to be innate. In this respect he was more ready to admit of the role of learning in infantile behaviour than was Spalding. In other observations, he examined the roles of taste and smell in the puppies' behaviour, the growth of the use of the eyes and ears in the first few weeks of life, the use of vocalization (he noted that a 13-day puppy will growl in its sleep), and the onset of play, which both Mills and Groos believed to be of great importance in the animal's development. Of particular interest were Mill's observations on the age at which memory and learning first seemed to show up directly. In St. Bernard puppies, Mills believed that the puppies recognised their mother by sight alone by about the 13th day, and he recounted how he accidentally trod on a puppy on the 45th day and that the puppy later showed fear of Mills; the inhibition of behaviour following punishment can be established from about this time on. Habits peculiar to dogs can be observed at certain key ages: lapping milk, as opposed to sucking movements, occurs at 17 days; barking at 25 days; scraping at a site where it will sleep occurs at 41 days, as do the movements typically made by dogs prior to defecation.

Mills' comments on his observations are perhaps even more interesting than the dispassionate diary entries themselves. He was among the first (perhaps *the* first) to show that infant animals fear the loss of support, a point J. B. Watson would later elevate into a dictum of child psychology (Watson, 1930, p. 153). He distinguished between genuine hearing in puppies and the sensitivity of the puppies to air-concussions on the skin. He noted that play only occurred after the animal had a full repertory of senses, with ears developed and eyes opened (the later usually taking place around the 11th day). He tracked the transition of vocal sounds from kitten-like whining through growling to barking. Emotions, he suggested, developed at different rates in different breeds, terriers, for example, being relatively early to show anger. The development of "voluntary" behaviour, a subject requiring perhaps more directed research than can be obtained by irregular periods of observation, was noticeable in Mills' subjects by about the 17th day, while evidence of reasoning, memory, and imitative behaviour were apparent after about a month. In research reported later in the book, Mills tried to establish correlations between the development of "intelligent" behaviour and the excitability of the cortex to electrical stimulation. His main discovery was that animals such as guinea pigs that matured early in comparison with cats or dogs also had brains that were excitable almost from

birth: the longer it took before "intelligent" behaviour became manifest, the less excitable the cortex during the period preceding the manifestation of such behaviour.

Mills also kept an interesting diary on kittens, whose eyes open at about 8 days, earlier than in the puppy, and who could learn to use the sandbox at about 30 days. He believed that the intelligence and "character" of cats was underestimated, noting the diligent efforts on one of his kittens to get into a favorite bookshelf when blocked from doing so. He believed that kittens had an instinctive "fear or dislike of the dog" (p. 224), and were in advance of puppies in the acquisition of voluntary behaviour and perhaps in other intellectual capacities. Readers who own pets will probably enjoy Mills' summary of the differences between cats and dogs:

"The greatest difference between the cat and dog is in their relations to man and to their own species.

The dog is essentially a social and a gregarious animal; the cat an independent and solitary creature, traits which are early shown.

The dog is docile in the highest degree; the cat to a slight degree as compared with the intelligence she possesses.

The cat is far in advance of the dog in power to execute highly complex coordinated movements.

In both the dog and the cat the play instinct is early and highly developed, but in the manifestation of this, the peculiar qualities of each are well established.

In will-power and ability to maintain an independent existence, the cat is superior to the dog.

In the higher grades of intelligence, the wisest dogs are much in advance of the most knowing cats, which is foreshadowed, if not actually exemplified, in the early months of existence." (pp. 232-233).

Mills observation on other animals, including guinea pigs, rabbits, pigeons, and domestic fowl, are noteworthy because he stresses how, the more important a capability to the life of a creature, the earlier the capability develops, be it smell in dogs, touch-sensitivity in rabbits, or pecking in hens. Mills' observations on drinking in chickens were associated with the controversy with Lloyd Morgan and Baldwin, already mentioned, in the pages of *Science*: the question was whether "drinking" in birds was instinctive or learned. Mills was one of the first to establish that if a chicken's beak be put into water, it will drink, but it would seem that it will not drink *unless* there is the prior stimulus of beak-in-water. So, as Lloyd Morgan, pointed out, a chicken could *see* water but never drink any, hence the controversy over whether chickens need to "learn" to drink. This literature, reproduced at the end of Mills' book, is a clear fore-runner of the revolution in our thinking about instincts brought about by Tinbergen (1951) and others with their conception of the "innate releasing stimulus".

As hinted earlier, it is not clear just how far these pioneering diaries were known outside Canada. What is clear is that Mills knew the literature on animal psychology that was available at the time (in 1896 he gave a short address on the expansion of animal psychology in the preceding decade; this address is reproduced on pp. 46-51 of *The Nature and Development of Animal Intelligence*). He favoured both observation and experiment, rather than anecdote, as methods for studying animal intelligence, provided the experiments gave the animal a chance to demonstrate its capabilities. And he had high hopes for the future of animal psychology. He described his own position succinctly in the 1905 paper:

“[In thinking highly of animals’ intelligence] I have been myself classed by one of my reviewers with Romanes. While I agree with much in Romanes’ attitude in regard to animal intelligence, nevertheless, since this writer preferred to work upon second-hand material rather than make observations and experiments for himself, and had, moreover, a tendency to speculate rather than the accumulation and weighing of facts, I prefer myself to be considered a humble follower of Darwin, who, so far as he went in animal psychology, best illustrates the method and especially the spirit that will, I think, prove most fruitful”. (p. 271)

This would be a fitting epitaph for a scholar whose observations on comparative psychology are as valuable now as when he made them over a hundred years ago.

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