

**RESEARCH DOSSIER**  
**Professor Michael R.W. Dawson**  
**Department of Psychology, Faculty of Arts, University of Alberta**  
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**1. RESEARCH AWARDS:**

Name of Award	Year	Awarded by:
McCalla Professorship	2007-2008	Faculty of Arts, University of Alberta
Research Award (Full Professor)	2005-2006	Faculty of Arts, University of Alberta
Killam Annual Professorship	1997-1998	University of Alberta

**2. RESEARCH PHILOSOPHY:**

*Certum quod factum* (Giambattista Vico, 1710) – “one is certain only of what one builds”. I advance understanding in cognitive science by building simulations and artefacts that serve as media for exploring and discovering new ideas.

**Implications of My Research Philosophy**

- ✓ I have achieved national and international prominence for my work on the interdisciplinary foundations of cognitive science, in particular the study of how artificial neural networks and simple robots impact these foundations
  - Publication of four books on foundations of cognitive science and modeling
  - Extensive theoretical contributions that have been motivated by my simulation results
- ✓ I have achieved national and international prominence for my work in developing the theory and application of artificial neural networks, accomplished by building working simulations and analyzing their internal structure
  - Invention of learning rule for a new neural network architecture (networks of value units), and new techniques for interpreting the internal structure of these networks
  - Application of neural networks to a wide array of content areas, including associative learning, music perception, movement perception, human reasoning, cognitive neuroscience, developmental psychology, and spatial navigation
- ✓ I have used advances in my research as a stimulus for introducing students to new research ideas and results
  - Extensive training of graduate and undergraduate students in my laboratory techniques
  - Development of new lecture themes (e.g., embodied cognitive science, synthetic psychology) in my undergraduate courses, fuelled by new empirical and theoretical results in my lab and beyond
  - Distribution of my results and methods through a variety of frequently-accessed web pages

**3. MOST SIGNIFICANT RESEARCH CONTRIBUTIONS:**

- ✓ One of my most significant research contributions is my training of graduate students in the theoretical and experimental aspects of cognitive science. The productive interdisciplinary cooperation between these students develops highly skilled and well-balanced future cognitive scientists. Since 1996 I have graduated 11 Ph.D. students who now have academic positions in departments of psychology, educational psychology, philosophy, computer science, and neurology; details about these students can be found on my teaching dossier.
- ✓ Dawson, M.R.W. (1998). *Understanding cognitive science*. Oxford, UK: Blackwell Publishers. Unlike other cognitive science textbooks, this monograph doesn't carve cognitive science up into content areas. Instead, it is organized around the foundational assumptions made by cognitive scientists regardless of their area of research. In addition to providing an excellent introduction to cognitive science, it also integrates my research in vision, connectionism, network interpretation, and the theory of mind. While this text is older, it is still being used as a primary text to introduce students to cognitive science at several programs in North America and Australia.
- ✓ Dawson, M.R.W. (2004). *Minds and machines: Connectionism and psychological modeling*. Oxford, UK: Blackwell Publishers. This monograph provides a detailed analysis of the use of different kinds of models in psychology, and explores the idea of using artificial neural networks as synthetic models – tools for the creation of understanding that don't require immediate evaluation by fitting a model to existing data. It provides a detailed introduction to the mathematics of artificial neural networks, and proceeds to show how network interpretation can be used to make valuable contributions to cognitive science. A 2006 review of this book published in *Connection Science* noted that “This book is ideal for anyone who seeks a thoughtful reconsideration of the principles of connectionist modelling. Like his previous book (Dawson 1998), *Minds and Machines* provides a well-thought-out perspective on the purposes and practice of modelling and, in the case of the current text, with the additional

emphasis on synthetic rather than analytic concerns”.

- ✓ Dawson, M.R.W. (2005). *Connectionism: A hands-on approach*. Oxford, UK: Blackwell Publishers. This monograph provides an introduction to three major classes of artificial neural networks, with an accessible overview of the architectures, and with a large number of simulation exercises that can be undertaken by students. In addition, it is supported by a software platform that is freely available, and which enables anyone in the world to replicate my studies, or to use my software to explore new phenomena. I have been particularly pleased by the fact that several students who have taken this course have gone on to publish neural network results that were provided by defining new training sets to be used with this software.
- ✓ Dawson, M.R.W. (2008). Connectionism and classical conditioning. *Comparative Cognition and Behavior Reviews*. This recent monograph challenges some widely established views on learning theory – views that are so established that they can easily be found in introductory texts – through the use formal analyses and computer simulations. It demonstrates that a great deal of important work can still be conducted by considering the implications of simple formalisms that have been around for decades (the delta rule since the 1950s, the Rescorla-Wagner model since the 1970s). It also shows quite clearly that advances in the theory of learning can only be accomplished by carefully exploring assumed relationships, rather than by merely accepting published claims without any inspection.
- ✓ Dawson, M.R.W., Dupuis, B., and Wilson, M. (2010). *From Bricks To Brains: The Embodied Cognitive Science Of LEGO Robots*. Edmonton, AB: Athabasca University Press. This recent book introduces embodied cognitive science, using the construction and observation of simple robots to illustrate its foundational ideas. It focuses on the characteristics that distinguish embodied cognitive science from classical cognitive science, placing a renewed emphasis on sensing and acting, the importance of embodiment, the exploration of distributed notions of control, and how theories can be developed by synthesizing simple systems and exploring their behavior. It uses numerous examples to illustrate a key theme: the importance of an agent’s environment. Even simple agents, such as LEGO robots, are capable of exhibiting very complex behavior when they can sense and affect the world around them.

#### 4. GRANT SUPPORT (SINCE 2005):

2009-2012	SSHRC Standard Research Grant, “Interpreting symbolic and subsymbolic regularities in artificial neural networks that classify musical stimuli” \$81,312 (\$26,512 for year one, \$26,400 for year two and \$28,400 for year 3)
2007-2012	NSERC Discovery Grant, “Artificial neural networks, contingency, and associative learning”, \$24,745/yr
2007-2008	McCalla Professorship, Faculty of Arts, University of Alberta. “Exploring Stigmergy in Collections of Very Simple Robots” \$32,000
2002-2006	SSHRC Research Grant “Relating symbolic and subsymbolic theories of mind” \$105,000
2002-2007	NSERC Research Grant “Interpreting the internal structure of PDP networks” \$34,000/yr

#### 5. RECENT RESEARCH CONTRIBUTIONS (SINCE 2005):

##### Under Editorial Review

1. Dawson, M.R.W. *The Cognitive Sciences* (book manuscript under review, 9 chapters, 222,973 words, Submitted to Wiley-Blackwell May 30, 2011)

##### Books and Monographs

1. Dawson, M.R.W., Dupuis, B., & Wilson, M. (2010). *From Bricks to Brains: The Embodied Cognitive Science of LEGO Robots*. Athabasca University Press, Edmonton.
2. Dawson, M.R.W. (2008). Connectionism and classical conditioning. *Comparative Cognition and Behavior Reviews*, 3 (monograph), 1-115. Retrieved from <http://psyc.queensu.ca/ccbr/index.html>
3. Dawson, M.R.W. (2005). *Connectionism: A Hands-On Approach*. Oxford, UK: Blackwell.

##### Refereed Journal Articles

1. Guillette, L.M., Bloomfield, L.L., Batty, E.R., Dawson, M.R.W. & Sturdy, C.B. (in press). Development of a contact call in black-capped chickadees (*Poecile atricapillus*) hand-reared in different acoustic environments *Journal of the Acoustical Society of America*. (Accepted for publication July, 2011. 7023 words).

2. Dawson, M.R.W. (2011). Cognitive architecture. in P.C Hogan (Ed.) *The Cambridge Encyclopedia of the Language Sciences*. Cambridge University Press, Cambridge. (pp. 160-162).
3. Guillette, L.M., Farrell, T.M., Hoeschele, M., Nickerson, C.M., Dawson, M.R.W., & Sturdy, C.B. (2010). Mechanisms of call note type perception in black-capped chickadees (*Poecile atricapillus*): Peak Shift in a note type continuum. *Journal of Comparative Psychology*, 124, 109-115.
4. Dawson, M.R.W. (2010). Review of Philip Robbins and Murat Aydede (Editors) *The Cambridge Handbook of Situated Cognition*. *Canadian Psychologist*, 51, 69-71.
5. Guillette, L.M., Bloomfield, L.L., Batty, E.R., Dawson, M.R.W. & Sturdy, C.B. (2010). Black-capped (*Poecile atricapillus*) and mountain chickadee (*Poecile gambeli*) contact call contains species, sex, and individual identity features. *Journal of the Acoustical Society of America*, 127, 1116-1123.
6. Dawson, M.R.W., Kelly, D.M, Spetch, M.L., & Dupuis, B. (2010). Using perceptrons to explore the reorientation task. *Cognition*, 114, 207-226.
7. Dawson, M.R.W., Dupuis, B., Spetch, M.L., & Kelly, D.M. (2009). Simple artificial neural networks that match probability and exploit, and explore when confronting a multiarmed bandit. *IEEE Transactions on Neural Networks* 20(8), 1368-1371.
8. Dawson, M.R.W., Kelly, D.M., Spetch, M.L., & Dupuis, B. (2008). Learning about environmental geometry: A flaw in Miller and Shettleworth's (2007) operant model. *Journal of Experimental Psychology: Animal Behavior Processes*, 34, 425-428.
9. Yaremchuk, V., & Dawson, M.R.W. (2008). Artificial neural networks that classify musical chords. *Journal of Cognitive Informatics and Natural Intelligence*, 2(3), 22-30.
10. Nickerson, C.M., Bloomfield, L.L., Dawson, M.R.W., Charrier, I., & Sturdy, C.B. (2007). Feature weighting in 'chick-a-dee' call notes of *Poecile atricapillus*. *Journal of the Acoustic Society of America* 122, 2451-2458.
11. Dawson, M.R.W., & Boechler, P.M. (2007). Representing an intrinsically nonmetric space of compass directions in an artificial neural network. *Journal of Cognitive Informatics and Natural Intelligence*, 1, 53-65
12. Nickerson, C., Bloomfield, L.L., Dawson, M.R.W., & Sturdy, C.B. (2006). Artificial neural networks that discriminate notes from the 'chick-a-dee' call of *Poecile atricapillus*: The effect of pitch transformations. *Journal of the Acoustical Society of America*, 120, 1111-1117.
13. Dawson, M.R.W., Bloomfield, L.L., Charrier, I., & Sturdy, C. B. (2006). Statistical classification of black-capped (*Poecile atricapillus*) and mountain chickadee (*Poecile gambeli*) call notes. *Journal of Comparative Psychology*, 120, 147-153.
14. Dawson, M.R.W., Charrier, I., & Sturdy, C.B. (2006). Using an artificial neural network to classify black-capped chickadee (*Poecile atricapillus*) call note types. *Journal of the Acoustical Society of America*, 119, 3161-3172.
15. Lowry, R., & Dawson, M.R.W. (2005). Connectionist selectionism: A case study of parity. *Neural Information Processing: Letters & Reviews*, 9, 59-67.
16. Graham, R., & Dawson, M.R.W. (2005). Using artificial neural networks to examine event-related potentials of face memory. *Neural Network World*, 15, 215-227.
17. Dawson, M.R.W., Boechler, P.M., & Orsten, J. (2005). An artificial neural network that uses coarse allocentric coding of direction to represent distances between locations in a metric space. *Spatial Cognition and Computation*, 5, 29-67.
18. Dawson, M.R.W., & Spetch, M.L. (2005). Traditional perceptrons do not generate the overexpectation effect. *Neural Information Processing: Letters & Reviews*, 7(1), 11-17.
19. Boechler, P.M., & Dawson, M.R.W. (2005). The effects of spatial layout on relationships between performance, path patterns and mental representation in a hypermedia information search task. *Interactive Technology and Smart Education*, 2, 31-45.
20. Yaremchuk, V., Willson, L.R., Spetch, M.L., & Dawson, M.R.W. (2005). The implications of null patterns and output unit activation functions on simulation studies of learning: A case study of patterning. *Learning & Motivation*, 36, 88-103.
21. Medler, D.A., Dawson, M.R.W., & Kingstone, A. (2005). Functional localization and double dissociations: The relationship between internal structure and behavior. *Brain and Cognition*, 57, 146-150.

#### Papers In Refereed Conference Proceedings

1. Dawson, M.R.W. (2009). Computation, cognition – and connectionism. In D. Dedrick and L. Trick (eds) *Cognition, Computation, and Pylyshyn*. Cambridge, MA: MIT Press. (pp. 175-199).
2. Yaremchuk, V. and Dawson, M. R. W. (2005). Chord classifications by artificial neural networks revisited: Internal representations of circles of major thirds and minor thirds. *Artificial Neural Networks: Biological Inspirations - Icnan 2005, Pt 1, Proceedings* 3696: 605-610.
3. Boechler, P., Steffler, D., Dawson, M., & Mansour, J. (2005). Incidental Learning in Hypemedia Environments: The Impact of Individual Differences and Spatial Overviews. In *Proceedings of World Conference*

#### Conference Presentations

1. Dawson, M.R.W. (2011). Neural networks that use strange circles to encode musical harmony. Poster presented at the 21st annual meeting of the Canadian Society for Brain, Behaviour, and Cognitive Science (Winnipeg, MB, June 24).
2. Dupuis, B. & Dawson, M.R.W. (2011). Modules, maps, and the robots who shun them: A behavior-based model of navigation. Paper presented at the 21st annual meeting of the Canadian Society for Brain, Behaviour, and Cognitive Science (Winnipeg, MB, June 24).
3. Sturdy, C.B., Dawson, M.R.W., Guillette, L.M., Nickerson, C.M., Farrell, T.M., Hoeschele, M., Bloomfield, L.L. and Charrier, I. Birds and models: Not as different as you might think. Paper presented at the 158th Meeting of the Acoustical Society of America (San Antonio, Texas, October 29 2009)
4. Dawson, M.R.W. (2008). Students use LEGO robots to learn about Posthumanism in cognitive science. DVD and poster presented at University of Alberta Festival of Teaching (Edmonton, January 24).
5. Guillette, L.M., Farrell, T.M., Hoeschele, M., Charrier, I., Dawson, M.R.W. & Sturdy, C.B. (2008). Mechanisms of Call Note Classification Redux. Paper presented at 15th Annual International Conference on Comparative Cognition (Melbourne, FA, March).
6. Dawson, M.R.W., Kelly, D.M., & Spetch, M.L. (2007). Using artificial neural networks to simulate the reorientation task. Poster presented at the 17th annual meeting of the Canadian Society for Brain, Behaviour, and Cognitive Science (Victoria, BC, June 16).
7. Sturdy, C.B., Dawson, M.R.W., Nickerson, C., Bloomfield, L., & Charrier, I. (2007). Artificial neural networks, songbirds, and perception. Paper presented at the 17th annual meeting of the Canadian Society for Brain, Behaviour, and Cognitive Science (Victoria, BC, June 16).
8. Sturdy, C.B., Dawson, M.R.W., Nickerson, C.M., Bloomfield, L.L., & Charrier, I.B. (2007). Using artificial neural networks to understanding songbird perception. Paper presented at the 14th annual meeting of the Comparative Cognition Society (Melbourne, Florida, March 16).
9. Nickerson, C.M., Bloomfield, L.L., Dawson, M.R.W., & Sturdy, C.B. (2006). The effect of pitch transformations on artificial neural networks that discriminate notes from the 'chick-a-dee' call of *Poecile atricapillus*. Poster presented at the 16th annual meeting of the Canadian Society for Brain, Behaviour, and Cognitive Science (Saskatoon, Saskatchewan, June 23).
10. Sturdy, C.B., Dawson, M.R.W., & Charrier, I. (2006). Artificial neural network and statistical approaches to understanding natural vocal categories. Talk presented at the Annual International Conference on Comparative Cognition (Melbourne Beach, Florida, March 22, 2006).
11. Dawson, M.R.W. (2005). Computation and Cognition – and Connectionism. Invited address, Conference In Honour Of Zenon Pylyshyn (Guelph, Ontario, April 30, invited).

#### Reviews of My Own Work

1. Stafford, T. (2006). Book Review. Connectionism: A Hands-On Approach. *Connection Science*, 18, 307-308.
2. Macinnes, J. (2006). Michael R.W. Dawson. Connectionism: A Hands-On Approach. *Canadian Psychologist*, 47, 152-153.
3. Stafford, T. (2006). Book Review. Minds and Machines: Connectionism and Psychological Modeling. *Connection Science*, 18, 87-88.
4. Kalish, M., & Barousse, C. (2006). Michael R.W. Dawson, Connectionism: A Hands-On Approach, Blackwell (2005). *Trends in Cognitive Sciences*, 10, 6-8.

### **6. OTHER RESEARCH CONTRIBUTIONS (SINCE 2005):**

Reviewer for NSERC Brockhouse Prize; Reviewer of research grants for NSERC and SSHRC; Member of the Editorial Advisory Board of the Advances in Cognitive Informatics and Natural Intelligence (ACINI) Book Series; Editorial Board Member of International Journal of Cognitive Informatics and Natural Intelligence; Reviewer of book proposals and book manuscripts for several different publishers (Blackwell Publishers; Cambridge University Press; Oxford University Press; Sage Publications; Sinauer Publishing); Manuscript reviewer for many different journals (*Behavioural Processes*; *Cognition*; *Experimental Brain Research*; *IEEE Transactions On Neural Networks*; *IEEE Transactions on Systems, Man, and Cybernetics (TSMCC)*; *International Journal of Cognitive Informatics and Natural Intelligence*; *Journal of Experimental Psychology: Animal Behavior Processes*; *Journal of Field Ornithology*; *Mathematical and Computer Modelling*; *Neural Networks World*; *Perception & Psychophysics*; *Perception*; *Philosophical Psychology*); Appraiser of Carleton University's PhD program in cognitive science for the Ontario Council On Graduate Studies