

such as the removal of strings from nettles by a mountain gorilla, possibly inducing program-level imitation by a conspecific. Preferences are expressed as payoffs representing units of subjective utility associated with maternal pride, satisfaction of hunger, social approval, or, more generally, any form of reinforcement or (in evolutionary games) change in Darwinian fitness. The fundamental game-theoretic assumption is that players are motivated solely to maximize their own individual payoffs. [See also Maynard Smith: "Game Theory Without Rationality" *BBS* 7(1) 1984.]

There is a large class of games in which players end up choosing the same strategy. The strategy sets from which they choose may be large, but for simplicity consider a familiar two-strategy example, the Prisoner's Dilemma game:

	<i>C</i>	<i>D</i>
<i>C</i>	(3, 3)	(1, 4)
<i>D</i>	(4, 1)	(2, 2)

One player chooses column *C* (cooperate) or *D* (defect), the other player row *C* or *D*, and for each possible strategy combination, the pair of numbers in the payoff matrix indicates the (ordinal-level) payoffs to the row-chooser and the column-chooser, respectively. The experimental literature on this game includes numerous studies of human behavior (reviewed by Colman 1995, pp. 134–85) and some of nonhuman behavior (e.g., Flood et al. 1983; Gardner et al. 1984). The evidence confirms that a row-chooser who has reason to expect the column-chooser to defect usually defects, as well, and this makes sense because if the column-chooser opts for *D*, then the row-chooser receives a higher payoff by also opting for *D* (2 units) than by opting for *C* (1 unit). It follows that in a sequential version of the game in which the column-chooser moves first and opts for *D*, the row-chooser, moving second with perfect information of the column-chooser's strategy, is almost certain to follow suit.

Should such behavioral convergence be interpreted as imitation? I believe it should not, for the following reason. The row-chooser selects the same strategy as the column-chooser but does not select it *because* it is the same. The strategic structure of the game encourages the row-player to defect, irrespective of the action of the column-chooser, because the defecting strategy is dominant in the sense that it yields a better payoff to the row-chooser, irrespective of the column-chooser's strategy. Consequently, in the sequential version of the game, a row-chooser who responds to a column-chooser's defecting strategy by following suit cannot validly be described as imitating the column-chooser's action, because defection is mandated by self-interest in any case.

Interestingly, this objection does not apply to all strategic interactions. Consider next the Stag Hunt game (Lewis 1969):

	<i>C</i>	<i>D</i>
<i>C</i>	(3, 3)	(1, 2)
<i>D</i>	(2, 1)	(2, 2)

Here again, a self-interested player will seek to choose the same strategy as the co-player, but in this case the strategy will be chosen precisely because it is the same as the co-player's. The row-chooser will defect if there is reason to expect the column-chooser to defect but will cooperate if there is reason to expect the column-chooser to cooperate. Thus, in a sequential version of this game, the row-chooser, moving second, will respond to *D* with *D* to receive a payoff of 2 rather than 1 and will respond to *C* with *C* to receive a payoff of 3 rather than 2. The players' choices will tend to converge, as in the Prisoner's Dilemma game, but in the sequential version of this game it seems reasonable to interpret such behavioral convergence as imitative, because the row-chooser's strategy is directly induced by the column-chooser's.

Byrne & Russon (B&R) may reject this as a model of imitation because it is explicable by the more fundamental process of utility maximization (and also perhaps by priming). This objection could be dismissed on the ground that all voluntary behavior involves choice and all choice can be interpreted in terms of maxi-

Modelling imitation with sequential games

Andrew M. Colman

Department of Psychology, University of Leicester, Leicester LE1 7RH, England. amc@leicester.ac.uk www.le.ac.uk/psychology/amc/amc.html

Abstract: A significant increase in the probability of an action resulting from observing that action performed by another agent cannot, on its own, provide persuasive evidence of imitation. Simple models of social influence based on two-person sequential games suggest that both imitation and pseudo-imitation can be explained by a process more fundamental than priming, namely, subjective utility maximization.

Imitation has been operationally defined as a significant increase in the probability of an action as a result of observing another agent performing that action. Byrne & Russon (B&R) have argued persuasively that this interpretation can lead to behavior being defined as imitative when it can be explained more simply by priming. I shall argue that such behavior can be explained even more simply by subjective utility maximization and that this need not necessarily rule out imitation.

Two-person game theory is applicable to any social interaction involving two agents (players), each choosing between two or more ways of acting (strategies), the outcome depending on the choices of both agents and the agents having well-defined preferences among the possible outcomes. Imitation, impersonation, emulation, and observational learning can all be modelled by two-person games. Potential strategies range from simple behavioral acts such as tongue protrusion by a mother, possibly inducing action-level imitation by an infant, to complex behavioral sequences

mizing subjective expected utility (Jeffrey 1983; Kahneman & Tversky 1979). B&R would certainly reject it in cases in which the strategies represent non-novel forms of behavior, though the model is neutral on this point. The counterargument to this is that an action directly induced by observing the same action being performed by another agent may be imitative even if it lacks novelty. A teenager who is induced to wear an old pair of jeans by observing an admired role model wearing jeans is evidently imitating the role model, and any interpretation of imitation that excludes such a case seems perverse and at odds with the conventional meaning of the concept.

What is the essential structural difference between games such as the Prisoner's Dilemma and those such as the Stag Hunt, which allow strategic convergence to be interpreted as imitation in the latter class but not the former? The answer relates to Nash equilibria. A Nash equilibrium is a combination of strategies that are the best responses to each other. In the Prisoner's Dilemma game, the best response to *C* is *D* and the best response to *D* is also *D*; hence the only Nash equilibrium in the game is the strategy combination *DD* in the lower-right cell, yielding payoffs of 2 units to each player. Consequently, in the sequential version of this game, the best response of the row-chooser, moving second and pursuing self-interest, is *D*, irrespective of the column-chooser's strategy. However, in the Stag Hunt game, the best response to *C* is *C* and the best response to *D* is *D*, yielding two Nash equilibria in the top-left and bottom-right cells, and these two equilibria correspond to different strategies of the row-chooser. It seems reasonable to define an action as imitative if it results from observing another agent making the same voluntary choice and is directly induced by the other agent's choice, as in games belonging to the Stag Hunt class.

In some sequential games, an action may be directly induced by another agent's voluntary choice but may nevertheless fail to satisfy this definition of imitation. Consider, for example, the Hawk-Dove game (Maynard Smith & Price 1973):

	<i>C</i>	<i>D</i>
<i>C</i>	(3, 3)	(2, 4)
<i>D</i>	(4, 2)	(1, 1)

In this game there are two asymmetric Nash equilibria. The best response to *C* is *D*, and the best response to *D* is *C*, hence the bottom-left and top-right cells represent Nash equilibria. In a sequential version of this game, although the strategy of the row-chooser, moving second, is induced by the action of the column-chooser who moves first, it does not satisfy my definition of imitation, because the behavior that is induced differs from the behavior that induces it. There are many other games of this type in which the players, by acting to maximize their individual self-interests, end up choosing different strategies.

ACKNOWLEDGMENT

Preparation of this article was facilitated by Grant No. L122251002 from the Economic and Social Research Council of the U.K. as part of the research program on Economic Beliefs and Behaviour.

References

Letters “a” and “r” before authors’ initials stand for target and response article references, respectively.

- Abravanel, E. (1991) Does immediate imitation influence long-term memory for observed actions? *Journal of Experimental Child Psychology* 51:235–44. [aRWB]
- Abravanel, E. & Gingold, H. (1985) Learning via observation during the second year of life. *Developmental Psychology* 21:614–23. [aRWB]
- Altmann, J. (1974) Observational study of behaviour: Sampling methods. *Behaviour* 49:227–65. [rRWB]
- Akins, C. K. & Zentall, T. R. (1995) Imitative learning in male Japanese quail (*Coturnix japonica*) using the two-action method. *Journal of Comparative Psychology* 110:316–20. [FBMdW, AM, TRZ]
- Anisfeld, M. (1991) Neonatal imitation. *Developmental Review* 11(1):60–97. [aRWB]
- Baddeley, A. (1990) *Human memory: Theory and practice*. Erlbaum. [aRWB]
- Baldwin, D. A., Markman, E. M. & Melartin, R. L. (1993) Infants’ ability to draw inferences about non-obvious object properties-evidence from exploratory play. *Child Development* 64:711–28. [AM]
- Bandura, A. (1986) *Social foundations of thought and action: A social cognitive theory*. Prentice Hall. [aRWB]
- Bargh, J. A., Chen, M. & Burrows, L. (1996) The automaticity of social behavior: Direct effects of trait concept and stereotype activation on action. *Journal of Personality and Social Psychology* 71:230–44. [MC]
- Bargh, J. A. & Gollwitzer, P. M. (1994) Environmental control of goal-directed action. *Nebraska Symposium on Motivation* 41:71–124. [MC]
- Barnat, S., Klein, P. & Meltzoff, A. N. (1996) Deferred imitation across changes in context and object: Memory and generalization. *Infant Behavior and Development* 19:241–52. [HH, AM]
- Barr, R., Dowden, A. & Hayne, H. (1996) Developmental changes in deferred imitation by 6- to 24-month-old infants. *Infant Behavior and Development* 19:159–70. [HH]

- Bates, E. (1979) *The emergence of symbols: Cognition and communication in infancy*. Academic Press. [PJB]
- Bates, E., Thal, D. & Marchman, V. (1991) Symbols and syntax: A Darwinian approach to language development. In: *Biological and behavioral determinants of language development*, ed. N. Krasnegor, D. Rumbaugh, R. Schiefelbusch & M. Studdert-Kennedy. Erlbaum. [PJB]
- Bateson, G. (1972) Steps to an ecology of mind. *Ballantine*. [MC]
- Bauer, P. J., Hertzsgaard, L. A., Dropik, P. & Daly, B. P. (1998) When even arbitrary order becomes important: Developments in reliable temporal sequencing of arbitrarily ordered events. *Memory* 6:165–98. [PJB]
- Bauer, P. J. & Mandler, J. (1989) One thing follows another: Effects of temporal structure on 1- and 2-year olds' recall of events. *Developmental Psychology* 25:197–206. [arRWB]
- Bauer, P. J., Schwade, A. A., Wewerka, S. S. & Delaney, K. (1997) *Planning ahead: Goal-directed problem solving by two-year-olds*. Manuscript in review. [PJB]
- Beck, B. (1980) *Animal tool behavior*. Garland STPM Press. [arRWB]
- Bekkering, H., Wohlschläger, A. & Gattis, M. (1997) *Imitation of gestures in children is goal directed*. (submitted). [MeG]
- Berkowitz, L. (1984) Some effects of thoughts on anti- and prosocial influences of media events: A cognitive-neoassociation analysis. *Psychological Bulletin* 95:410–27. [MC]
- Boyd, R. & Richerson, P. J. (1988) An evolutionary model of social learning: The effects of spatial and temporal variation. In: *Social learning: Psychological and biological approaches*, ed. T. R. Zentall & B. G. Galef. Erlbaum. [arRWB]
- Boysen, S. T. (1993) Counting in chimpanzees: Nonhuman principles and emergent properties of number. In: *The development of numerical competence: Animal and human models*, ed. S. T. Boysen & E. J. Capaldi. Erlbaum. [arRWB]
- (1996) "More is less": The elicitation of rule-governed resource distribution in chimpanzees. In: *Reaching into thought: The minds of great apes*, ed. A. E. Russon, K. A. Bard & S. T. Parker. Cambridge University Press. [arRWB]
- Brentano, F. (1874/1960) The distinction between mental and physical phenomena. In: *Realism and the background of phenomenology*, ed. R. Chisholm. Free Press of Glencoe. [EMA]
- Brockmann, H. J. (1980) The control of next depth in a digger wasp (*Sphex ichneumoneus* L.). *Animal Behaviour* 28:426–45. [PEM]
- Bruner, J. S. (1970) The growth and structure of skill. In: *Mechanisms of motor skill development*, ed. K. J. Connolly. Academic Press. [rRWB]
- (1972) Nature and use of immaturity. *American Psychologist* 27:687–708. [AM]
- Bugnyar, T. & Huber, L. (1997) Push or pull: An experimental study of imitation in marmosets. *Animal Behaviour* 54:817–31. [rRWB, LH, AM]
- Byrne, R. W. (1977) Planning meals: Problem-solving on a real data-base. *Cognition* 5:289–332. [arRWB]
- (1993) Hierarchical levels of imitation. Commentary on "Cultural learning," by M. Tomasello, A. C. Kruger & H. H. Ratner. *Behavioral and Brain Sciences* 16:516–17. [arRWB]
- (1994) The evolution of intelligence. In: *Behaviour and evolution*, ed. P. J. B. Slater & T. R. Halliday. Cambridge University Press. [arRWB]
- (1995a) *The thinking ape: Evolutionary origins of intelligence*. Oxford University Press. [arRWB, MeG]
- (1995b) Primate cognition: Comparing problems and skills. *American Journal of Primatology* 37:127–41. [arRWB]
- (1996) The misunderstood ape: Cognitive skills of the gorilla. In: *Reaching into thought: The minds of the great apes*, ed. A. E. Russon, K. A. Bard & S. T. Parker. Cambridge University Press. [rRWB]
- (1997) The technical intelligence hypothesis: An additional evolutionary stimulus to intelligence? In: *Machiavellian intelligence II: Extensions and evaluations*, ed. A. Whiten & R. W. Byrne. Cambridge University Press. [rRWB]
- Byrne, R. W. & Byrne, J. M. E. (1991) Hand preferences in the skilled gathering tasks of mountain gorillas (*Gorilla g. beringei*). *Cortex* 27:5221–46. [arRWB]
- (1993) Variability and standardization in the complex leaf-gathering tasks of mountain gorillas (*Gorilla g. beringei*). *American Journal of Primatology* 31:241–61. [arRWB]
- Byrne, R. W. & Tomasello, M. (1995) Do rats ape? *Animal Behaviour* 50:1417–20. [arRWB]
- Call, J. & Tomasello, M. (1994) The social learning of tool use by orangutans (*Pongo pygmaeus*). *Human Evolution* 9:297–313. [arRWB, MT]
- (1995) The use of social information in the problem-solving of orangutans (*Pongo pygmaeus*) and human children (*Homo sapiens*). *Journal of Comparative Psychology* 109:308–20. [PJB, arRWB, AM, MT, SCW]
- (1996) The effect of humans on the cognitive development of apes. In: *Reaching into thought: The minds of the great apes*, ed. A. E. Russon, K. A. Bard & S. T. Parker. Cambridge University Press. [MT]
- Carey, D. P., Perrett, D. I. & Oram, M. W. (1997) Recognizing, understanding and reproducing action. In: *Handbook of neuropsychology, vol. 11*, ed. F. Boller & J. Grafman. Elsevier. [SV]
- Carpenter, M., Akhtar, N. & Tomasello, M. (in press) Sixteen-month-old infants differentially imitate intentional and accidental actions. *Infant Behavior and Development*. [MT]
- Carver, L. J. & Bauer, P. J. (in press) When the event is more than the sum of its parts: Nine-month-olds' long-term ordered recall. *Memory*. [PJB]
- Case, R. (1985) *Intellectual development: Birth to adulthood*. Academic Press. [arRWB]
- Chartrand, T. L. & Bargh, J. A. (1996) Automatic activation of impression formation and memorization goals: Nonconscious goal priming reproduces effects of explicit task instructions. *Journal of Personality and Social Psychology* 71:464–78. [MC]
- (1998) *The chameleon effect: The perception-behavior link as "social glue."* New York University Press (submitted). [MC]
- Chen, M. & Bargh, J. A. (1997) Nonconscious behavioral confirmation processes: The self-fulfilling nature of automatically-activated stereotypes. *Journal of Experimental Social Psychology* 33:541–60. [MC]
- Cheng, P. W. & Holyoak, K. J. (1985) Pragmatic reasoning schemas. *Cognitive Psychology* 17:391–416. [DDC]
- Chomsky, N. (1957) *Syntactic structures*. Mouton. [arRWB]
- Colman, A. M. (1995) *Gene theory and its application in the social and biological sciences*, 2nd edition. Routledge. [AMC]
- Connolly, K. J. & Dalgleish, M. (1989) The emergence of a tool-using skill in infancy. *Developmental Psychology* 25(6):894–912. [rRWB]
- Connolly, K. J. & Manoel, E. de J. (1991) Hierarchies and tool-using strategies. *Behavioral and Brain Sciences* 14(4):554–55. [rRWB]
- Cosmides, L. (1989) The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. *Cognition* 31:187–276. [DDC]
- Cummins, D. D. (1994) Analogical reasoning. In: *The encyclopedia of human behavior*. Academic Press. [DDC]
- (1996) Dominance hierarchies and the evolution of human reasoning. *Minds and Machines* 6:463–80. [DDC]
- Custance, D. M. (1994) Social learning and imitation in human and nonhuman primates. PhD thesis, University of St. Andrews.
- Custance, D. M. & Bard, K. A. (1994) The comparative and developmental study of self-recognition and imitation. In: *Self-awareness in animals and humans. Developmental perspectives*, ed. S. T. Parker, R. W. Mitchell & M. L. Boccia. Cambridge University Press. [arRWB]
- Custance, D. M., Whiten, A. & Bard, K. A. (1995) Can young chimpanzees (*Pan troglodytes*) imitate arbitrary actions? Hayes & Hayes (1952) revisited. *Behaviour* 132:11–12. [arRWB, AM]
- Darwin, C. (1871/1981) *The descent of man and selection in relation to sex*. Princeton University Press. [FBMdw]
- Dawkins, R. (1976) Hierarchical organization: A candidate principle for ethology. In: *Growing points in ethology*, ed. P. P. G. Bateson & R. A. Hinde. Cambridge University Press. [arRWB]
- Dawson, B. V. & Foss, B. M. (1965) Observational learning in budgerigars. *Animal Behaviour* 13:470–74. [arRWB, AM]
- Decety, J. (1996) Do imagined and executed actions share the same neural substrate? *Cognitive Brain Research* 3:87–93. [MeG]
- Decety, J., Grèzes, J., Costes, N., Perani, D., Jeannerod, M., Procyk, E., Grassi, F. & Fazio, F. (1997) Brain activity during observation of actions. Influence of action content and subject's strategy. *Brain* 120:1763–77. [JD]
- Dennett, D. (1983) Intentional systems in cognitive ethology: The Panglossian paradigm defended. *Behavioral and Brain Sciences* 6:343–90. [HLR]
- (1996) *Kinds of minds: Towards an understanding of consciousness*. Weidenfeld & Nicholson. [EMA]
- de Waal, F. B. M. (1991) Complementary methods and convergent evidence in the study of primate social cognition. *Behaviour* 118:297–320. [FBMdw]
- (1996) *Good natured: The origins of right and wrong in humans and other animals*. Harvard University Press. [FBMdw]
- Dijksterhuis, A. & van Knippenberg, A. (in press) Behavioral effects of stereotype activation, or how to win a game of Trivial Pursuit. *Journal of Personality and Social Psychology*. [MC]
- Di Pellegrino, G., Faddiga, L., Fogassi, L., Vallesse, V. & Rizzolatti, G. (1992) Understanding motor events: A neurophysiological study. *Experimental Brain Research* 91:176–80. [NM]
- Driver, J. & Baylis, G. C. (1993) Cross-modal negative priming and interference in selective attention. *Bulletin of the Psychonomic Society* 31:45–48. [MG]
- Dugatkin, L. A. & Godin, J. J. (1992) Reversal of female mate choice by copying in the guppy (*Poecilia reticulata*). *Proceedings of the Royal Society of London* 249:179–84. [FBMdw]
- Epstein, R., Kirshnit, C. E., Lanza, R. P. & Rubin, L. C. (1984) Insight in the pigeon: Antecedents and determinants of an intelligent performance. *Nature* 308:61–62. [MC]
- Fadiga, L., Fogassi, L., Pavesi, G. & Rizzolatti, G. (1995) Motor facilitation during action observation: A magnetic study. *Journal of Neurophysiology* 73:2608–11. [MeG]

- Fagen, R. (1981) *Animal play behaviour*. Oxford University Press. [AM]
- Fishbein, H. D. (1984) *The psychology of infancy and childhood*. Erlbaum. [HDF]
- Flood, M. M., Lendenmann, K. & Rapoport, A. (1983) 2 x 2 games played by rats: Different delays of reinforcement as payoffs. *Behavioral Science* 28:65–78. [AMC]
- Florito, G. & Scotto, P. (1992) Observational learning in *Octopus vulgaris*. *Science* 256:545–47. [FBMdw]
- Fossey, D. (1979) Development of the mountain gorilla (*Gorilla gorilla beringei*): The first thirty-six months. In: *The great apes*, ed. D. A. Hamburg & D. R. McCowan. Benjamin/Cummings. [RWM]
- Galef, B. G., Jr. (1988) Imitation in animals: History, definitions, and interpretation of data from the psychological laboratory. In: *Social learning: Psychological and biological perspectives*, ed. T. Zentall & B. G. Galef, Jr. Erlbaum. [arRWB]
- (1992) The question of animal culture. *Human Nature* 3:157–78. [arRWB]
- Galef, B. G., Manzig, L. A. & Field, R. M. (1986) Imitation learning in budgerigars: Dawson and Foss (1965) revisited. *Behavioural Processes* 13:191–202. [arRWB]
- Gardner, H. (1983) *Frames of mind: The theory of multiple intelligences*. Basic Books. [DDC]
- Gardner, M. R. (1997) Imitation: The methodological adequacy of directional control tests. Unpublished Ph. D. dissertation. University of London. [MG]
- Gardner, R. M., Corbin, T. L., Beltramo, J. S. & Nickell, G. G. (1984) The Prisoner's Dilemma Game and cooperation in the rat. *Psychological Reports* 55:687–96. [AMC]
- Gibson, J. J. (1979) *The ecological approach to visual perception*. Houghton Mifflin. [PEM]
- Gibson, K. R. (1990) New perspectives on instincts and intelligence: Brain size and the emergence of hierarchical mental construction skills. In: *"Language" and intelligence in monkeys and apes*, ed. S. T. Parker & K. R. Gibson. Cambridge University Press. [arRWB]
- (1993) Animal minds, human minds. In: *Tools, language, and cognition*, ed. K. R. Gibson & T. Ingold. Cambridge University Press. [arRWB]
- Goodale, M. A. (1997) Visual routes to perception and action in the cerebral cortex. In: *Handbook of neuropsychology, vol. 11*, ed. F. Boller & J. Grafman. Elsevier. [JD]
- Gopnik, A. & Meltzoff, A. N. (1995) Minds, bodies, and persons: Young children's understanding of the self and others as reflected in imitation and theory of mind research. In: *Self-awareness in animals and humans. Developmental perspectives*, ed. S. T. Parker, R. W. Mitchell & M. L. Boccia. Cambridge University Press. [AM]
- Greenfield, P. (1991) Language, tools and the brain: The ontogeny and phylogeny of hierarchically organized sequential behavior. *Behavioral and Brain Sciences* 14:531–95. [arRWB]
- Greenough, W. T. & Black, J. E. (1992) Induction of brain structure by experience: Substrates for cognitive development. *Child Psychology* 24:155–200. [DT]
- Grèzes, J., Costes, N. & Decety, J. (in press) Top-down effect of the strategy on the perception of biological motion: a PET investigation. *Cognitive Neuropsychology*. [JD]
- Guillaume, P. (1926) *Imitation in children*. University of Chicago Press. [arRWB]
- Harris, P. L. & Kavanaugh, R. D. (1993) Young children's understanding of pretense. *Society for Research in Child Development Monographs* 58:Serial No. 231. [SCW]
- Harris, P. L., Kavanaugh, R. D. & Meredith, M. (1996) Young children's comprehension of pretend episodes: The integration of successive actions. *Child Development* 65:16–30. [SCW]
- Hayes, K. J. & Hayes, C. (1952) Imitation in a home-raised chimpanzee. *Journal of Comparative Physiological Psychology* 45:450–59. [arRWB, AM]
- Hayne, H., MacDonald, S. & Barr, R. (1997) Developmental changes in the specificity of memory over the second year of life. *Infant Behavior and Development* 20:233–45. [HH]
- Heimann, M. (1989) Neonatal imitation, gaze aversion, and mother-infant interaction. *Infant Behavior and Development* 12:493–503. [MH]
- (1994) *Do temperamental factors influence young infants' tendency to imitate?* Poster presented at the 13th Biennial Meeting of ISSBD, Amsterdam, The Netherlands. [MH]
- (1998) Imitation in neonates, in older infants, and in children with autism: Feedback to theory. In: *Intersubjective communication and emotion in ontogeny. A source book*, ed. S. Bråten. Cambridge University Press. [MH]
- Heimann, M., Nelson, K. E. & Schaller, J. (1989) Neonatal imitation of tongue protrusion and mouth opening: Methodological aspects and evidence of early individual differences. *Scandinavian Journal of Psychology* 30:90–101. [MH]
- Heyes, C. M. (1993) Imitation, culture, and cognition. *Animal Behaviour* 46:999–1010. [arRWB]
- (1994) Social learning in animals: Categories and mechanisms. *Biological Reviews* 69:207–31. [MG, AM]
- Heyes, C. M. & Dawson, G. R. (1990) A demonstration of observational learning in rats using a bidirectional control. *Quarterly Journal of Experimental Psychology* 42B:59–71. [arRWB, AM]
- Heyes, C. M., Dawson, G. R. & Nokes, T. (1992) Imitation in rats: Initial responding and transfer evidence from a bidirectional control procedure. *Quarterly Journal of Experimental Psychology, Section B: Comparative and Physiological Psychology* 45B:229–40. [arRWB, PEM]
- Holmlund, C. (1995) Development of turntakings as a sensorimotor process in the first 3 months: A sequential analysis. In: *Children's language, vol. 8*, ed. K. E. Nelson & Z. Réger. Erlbaum. [MH]
- Hultsch, H. (1980) Beziehungen zwischen Struktur, zeitlicher Variabilität und sozialem Einsatz im Gesang der Nachtigall (*Luscinia megarhynchos*). Ph. D. dissertation, FU Berlin. [DT]
- (1991) Early experience can modify singing styles - evidence from experiments with nightingales (*Luscinia megarhynchos*). *Animal Behaviour* 42:883–89. [DT]
- (1992) Time window and unit capacity: Dual constraints on the acquisition of serial information in songbirds. *Journal of Comparative Physiology A* 170:275–80. [DT]
- (1993) Tracing the memory mechanisms in the song acquisition of birds. *Netherlands Journal of Zoology* 43:155–71. [DT]
- Hultsch, H. & Todt, D. (1982) Temporal performance roles during vocal interactions in nightingales. *Behavioral Ecology and Sociobiology* 11:253–60. [DT]
- (1989) Memorization and reproduction of songs in nightingales (*Luscinia megarhynchos*): Evidence for package formation. *Journal of Comparative Physiology A* 165:197–203. [DT]
- (1996) Discontinuous and incremental processes in the song learning of birds: Evidence for a primer effect. *Journal of Comparative Physiology A* 179:291–99. [DT]
- Humphrey, N. K. (1976) The social function of intellect. In: *Growing points in ethology*, ed. P. P. G. Bateson & R. A. Hinde. Cambridge University Press. [FBMdw]
- Inoue-Nakamura, N. & Matsuzawa, T. (1997) Development of stone tool use by wild chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology* 111:159–73. [AM]
- James, W. (1890) *Principles of psychology*. Holt. [MC]
- Jeannerod, M. (1994) The representing brain: Neural correlates of motor intention and imagery. *Behavioral and Brain Sciences* 17:187–245. [SV]
- Jeffrey, R. C. (1983) *The logic of decision*, 2nd edition. University of Chicago Press. [AMC]
- Jorion, P. (1990) *Principes des systèmes intelligents*. Collection Sciences Cognitives. Masson. [PJM]
- (1994) L'intelligence artificielle: Au confluent des neurosciences et de l'informatique. *Lektion* 4(2):85–114. [PJM]
- (1997) Ce qui fait encore cruellement défaut à l'intelligence. *Informations In Cognito* 7:1–4. [PJM]
- Kahneman, D. & Tversky, A. (1979) Prospect theory: An analysis of decision under risk. *Econometrica* 47:263–91. [AMC]
- Koestler, A. (1967) *The ghost in the machine*. Hutchinson. [MC]
- Koffka, K. (1935/1980) *Growth of the mind*. Transaction Books. [SV]
- Kohl, R. M. & Shea, C. H. (1992) Pew (1966) revisited: Acquisition of hierarchical control as a function of observational practice. *Journal of Motor Behavior* 24:247–60. [BV]
- Köhler, W. (1925/1976) *The mentality of apes*. Routledge & Kegan Paul/Liveright. [arRWB, AM]
- Konishi, M. (1989) Bird song for neurobiologists. *Neuron* 3:541–49. [DT]
- Kroodsma, D. E. & Miller, E. H. (1996) *Ecology and evolution of acoustic communication in birds*. Cornell University Press. [DT]
- Kuczynski, L., Zahn-Waxler, C. & Radke-Yarrow, M. (1987) Development and content of imitation in the second and third years of life: A socialization perspective. *Developmental Psychology* 23:276–82. [SCW]
- Kugiumtzakis, J. (1993) Intersubjective vocal imitation in early mother-infant interaction. In: *New perspectives in early communication development*, ed. J. Nadel & L. Camioni. Routledge. [MH]
- Langer, J. (1993) Comparative cognitive development. In: *Tools, language, and cognition*, ed. K. R. Gibson & T. Ingold. Cambridge University Press. [arRWB]
- Langer, J. (1996) Heterochrony and the evolution of primate cognitive development. In: *Reaching into thought: The minds of great apes*, ed. A. E. Russon, K. A. Bard & S. T. Parker. Cambridge University Press. [arRWB]
- Lashley, K. S. (1951) The problem of serial order in behavior. In: *Cerebral mechanisms in behavior: The Hixon symposium*, ed. L. A. Jeffress. Wiley. [arRWB]
- Lefebvre, A. & Giraldeau, L. (1994) Cultural transmission in pigeons is affected by the number of tutors and bystanders present. *Animal Behaviour* 47:331–37. [FBMdw]

- Lewis, D. K. (1969) *Convention: A philosophical study*. Harvard University Press. [AMC]
- Lorenz, K. Z. (1977) *Behind the mirror: A search for a natural history of human knowledge*. Methuen. [LH]
- Mac Aogáin, E. (1986) The concept of belief in cognitive theory. *Annals of Theoretical Psychology* 4:315–50. [EMA]
- MacFarlane, D. A. (1930) The role of kinesthesia in maze learning. *University of California Publications in Psychology* 4:277–305. [HLR]
- Mackintosh, N. J. (1994) Classical and operant conditioning. In: *Learning and skills*, ed. N. J. Mackintosh & A. M. Colman. Longman Essential Psychology. [aRWB]
- Marler, P. (1976) Sensory templates in species-specific behavior. In: *Simpler networks and behavior*, ed. J. C. Fentress. Sinauer Associates. [DT]
- (1991) Differences in behavioural development in closely related species: Bird song. In: *The development and integration of behaviour*, ed. P. Bateson. Cambridge University Press. [DT]
- Martens, R., Burwitz, L. & Zuckerman, J. (1976) Modeling effects on motor performance. *Research Quarterly* 47:277–91. [BV]
- Martin, P. & Bateson, P. (1986) *Measuring behaviour: An introductory guide*. Cambridge University Press. [rRWB]
- Masur, E. & Ritz, E. G. (1984) Patterns of gestural, vocal, and verbal imitation in infancy. *Merrill-Palmer Quarterly* 29:69–82. [HH]
- Matsuzawa, T. (1994) Field experiments on use of stone tools by chimpanzees in the wild. In: *Chimpanzee cultures*, ed. R. W. Wrangham, W. C. McGrew, F. B. M. de Waal & P. C. Heltne. Harvard University Press. [aRWB]
- Maynard Smith, J. & Price, G. R. (1973) The logic of animal conflict. *Nature* 246:15–80. [AMC]
- Meltzoff, A. N. (1988a) Infant imitation after a 1-week delay: Long-term memory for novel acts and multiple stimuli. *Developmental Psychology* 24:470–76. [HH]
- (1988b) Infant imitation and memory: Nine-month-olds in immediate and deferred tasks. *Child Development* 59:217–25. [HH]
- (1988c) Imitation, objects, tools and the rudiments of language in human ontogeny. *Human Evolution* 1(2):45–64. [AM]
- (1990) Foundations of developing a concept of self: The role of imitation in relating self to other and the value of social mirroring and self practice in infancy. In: *The self in transition: Infancy to childhood*, ed. D. Cicchetti & M. Beeghly. University of Chicago Press. [AM]
- (1995a) What infant memory tells us about infantile amnesia: Long-term recall and deferred imitation. *Journal of Experimental Psychology* 59:497–515. [HH]
- (1995b) Understanding the intentions of others: Re-enactment of intended acts by 18-month-old children. *Developmental Psychology* 31:838–50. [HH, MT, SCW]
- Meltzoff, A. N. & Gopnik, A. (1993) The role of imitation in understanding persons and developing a theory of mind. In: *Understanding other minds. Perspectives from autism*, ed. S. Baron-Cohen, H. Tager-Flusberg & D. J. Cohen. Oxford University Press. [aRWB]
- Meltzoff, A. N. & Moore, M. K. (1977) Imitation of facial and manual gestures by human neonates. *Science* 198:75–78. [aRWB, MeG]
- (1983) Newborn infants imitate adult facial gestures. *Child Development* 54:702–09. [aRWB]
- (1994) Imitation, memory, and the representation of persons. *Infant Behavior and Development* 17:83–99. [MH, SV]
- (1997) Explaining facial imitation: A theoretical model. *Early Development and Parenting* 6:179–92. [SV]
- Miles, H. L., Mitchell, R. W. & Harper, S. (1996) Simon says: The development of imitation in an enculturated orangutan. In: *Reaching into thought: The minds of the great apes*, ed. A. E. Russon, K. A. Bard & S. T. Parker. Cambridge University Press. [aRWB, RWM]
- Miller, G. A., Galanter, E. & Pribram, K. (1960) *Plans and the structure of behaviour*. Holt, Rinehart & Winston. [aRWB, EMA, SCW]
- Milner, A. D. & Goodale, M. A. (1995) *The visual brain in action*. Oxford University Press. [JD]
- Mineka, S., Davidson, M., Cook, M. & Keir, R. (1984) Observational conditioning of snake fear in rhesus monkeys. *Journal of Abnormal Psychology* 93:355–72. [MG]
- Mitchell, R. W. (1987) A comparative developmental approach to understanding imitation. *Perspectives in Ethology* 7:183–215. [aRWB]
- (1993) Mental models of mirror-self-recognition: Two theories. *New Ideas in Psychology* 11:295–325. [aRWB]
- (1994) The evolution of primate cognition: Simulation, self-knowledge, and knowledge of other minds. In: *Hominid culture in primate perspective*, ed. D. Quiatt & J. Itani. University Press of Colorado. [RWM]
- Moerk, E. L. (1989) The fuzzy set called “imitations.” In: *The many faces of imitation in language learning*, ed. G. E. Speidel & K. E. Nelson. Springer-Verlag. [aRWB]
- Moore, B. R. (1992) Avian movement imitation and a new form of mimicry: Tracing the evolution of a complex form of learning. *Behaviour* 122:231–63. [aRWB, AM]
- Moran, G., Krupka, A., Tutton, A. & Symons, D. (1987) Patterns of maternal and infant imitation during play. *Infant Behavior Development* 10:477–91. [AM]
- Morgan, C. L. (1900) *Animal behaviour*. Edward Arnold. [aRWB]
- Motomura, N. & Yamadori, A. (1994) A case of ideational apraxia with impairment of object use and preservation of object pantomime. *Cortex* 30:167–70. [NM]
- Nadel, J. (1986) *Imitation et communication entre jeunes enfants*. PUF. [aRWB]
- Nagell, K., Olguin, R. S. & Tomasello, M. (1993) Processes of social learning in the tool use of chimpanzees (*Pan troglodytes*) and human children (*Homo sapiens*). *Journal of Comparative Psychology* 107:174–86. [aRWB, MT]
- Newell, A., Shaw, J. C. & Simon, H. A. (1958) Elements of a theory of human problem solving. *Psychological Review* 65:151–66. [aRWB]
- Newell, A. & Simon, H. A. (1972) *Human problem solving*. Prentice-Hall. [aRWB]
- Newell, K. M. (1986) Constraints on the development of coordination. In: *Motor development in children: Aspects of coordination and control*, ed. M. G. Wade & H. T. A. Whiting. Nijhoff. [BV]
- Nottebohm, F. (1993) The search for neural mechanisms that define the sensitive period for song learning in birds. *Netherlands Journal of Zoology* 43:193–234. [DT]
- Parker, C. (1969) Responsiveness, manipulation, and implementation behavior in chimpanzees, gorillas, and orangutans. *Proceedings of the Second International Congress of Primatology* 1:160–66. S. Karger. [aRWB]
- Parker, S. T. (1996) Apprenticeship in tool-mediated extractive foraging: The origins of imitation, teaching, and self-awareness in great apes. In: *Reaching into thought: The minds of great apes*, ed. A. E. Russon, K. A. Bard & S. T. Parker. Cambridge University Press. [aRWB]
- Parker, S. T. & Gibson, K. R. (1977) Object manipulation, tool use, and sensorimotor intelligence as feeding adaptations in cebus monkeys and great apes. *Journal of Human Evolution* 6:623–41. [aRWB]
- (1990) “Language” and intelligence in monkeys and apes. Cambridge University Press. [aRWB]
- Paulignan, Y., MacKenzie, C., Marteniuk, R. & Jeannerod, M. (1991) Selective perturbation of visual input during prehension movements. I. The effects of changing object position. *Experimental Brain Research* 83:502–12. [SV]
- Pepperberg, I. M. (1993) A review of the effects of social interaction on vocal learning in African grey parrots (*Psittacus erithacus*). *Netherlands Journal of Zoology* 43:104–24. [DT]
- Pew, R. W. (1966) Acquisition of hierarchical control over the temporal organization of a skill. *Journal of Experimental Psychology* 71:764–71. [BV]
- Piaget, J. (1937/1954) *The construction of reality in the child*. Basic Books. [aRWB, EMA]
- (1945/1962) *Play, dreams, and imitation in childhood*. Norton. [aRWB, HDE, HH]
- (1946) *La formation du symbole chez l'enfant* [Symbol-formation of the child]. Delachaux & Niestlé. [MC]
- Povinelli, D. J., Boysen, S. T. & Nelson, K. E. (1990) Inferences about guessing and knowing by chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology* 104:203–10. [FBMdW]
- Povinelli, D. J. & Eddy, T. J. (1996) Factors affecting young chimpanzees’ (*Pan troglodytes*) recognition of attention. *Journal of Comparative Psychology* 110:336–45. [HLR]
- Premack, D. & Dasser, V. (1991) Perceptual origins and conceptual evidence of theory of mind in apes and children. In: *Natural theories of mind*, ed. A. Whiten. Blackwell. [SCW]
- Previde, E. P. & Poli, M. D. (1996) Social learning in the golden hamster (*Mesocricetus auratus*). *Journal of Comparative Psychology* 110:203–08. [FBMdW]
- Rescorla, R. A. (1991) Associative relations in instrumental learning. *Quarterly Journal of Experimental Psychology* 43B:1–24. [aRWB]
- Reynolds, P. C. (1982) The primate constructional system: The theory and description of instrumental tool use in humans and chimpanzees. In: *The analysis of action*, ed. M. Van Cranach & R. Hass. Cambridge University Press. [aRWB]
- Roitblat, H. L. (1988) A cognitive action theory of learning. In: *Systems with learning and memory abilities*, ed. J. Delacour & J. C. S. Levy. North Holland. [HLR]
- (1991) Cognitive action theory as a control architecture. In: *Simulation of adaptive behavior*, ed. A. Meyer & S. Wilson. MIT Press. [HLR]
- Roitblat, H. L. & von Fersen, L. (1992) Comparative cognition: Representations and processes in learning and memory. *Annual Review of Psychology* 43:671–710. [HLR]
- Romanes, G. J. (1884) *Mental evolution in animals*. AMS Press. [aRWB]
- (1889) *Mental evolution in man*. Appleton. [aRWB]
- Russon, A. E. (1996) Imitation in everyday use: Matching and rehearsal in the spontaneous imitation of rehabilitant orangutans (*Pongo pygmaeus*). In

- Reaching into thought*, ed. A. Russon, K. Bard & S. T. Parker. Cambridge University Press. [PJB, arRWB, AM]
- (in press) Imitation of tool use in orangutans: A cognitive interpretation. In: *The mentalities of gorillas and orangutans*, ed. S. T. Parker, H. L. Miles & R. W. Mitchell. Cambridge University Press. [rRWB]
- Russon, A. E. & Galdikas, B. M. F. (1993) Imitation in free-ranging rehabilitant orangutans. *Journal of Comparative Psychology* 107:147–61. [PJB, aRWB, AM, MT]
- (1994) The hierarchical organisation of complex orangutan object manipulation and tool using routines. Paper presented at the XVth Congress of the International Primatological Society. Kuta, Bali. [rRWB]
- (1995) Constraints on great apes' imitation: Model and action selectivity in rehabilitant orangutan (*Pongo pygmaeus*) imitation. *Journal of Comparative Psychology* 109:5–17. [arRWB, AM]
- Russon, A. E., Michell, R. W., Lefebvre, B. & Abravanel, E. (1998) The comparative evolution of imitation. In: *Piaget, evolution, and development*, ed. J. Langer & M. Killen. Erlbaum. [aRWB]
- Schank, R. C. (1982) *Dynamic memory*. Cambridge University Press. [PEM]
- Spence, K. W. (1937) Experimental studies of learning and higher mental processes in infra-human primates. *Psychological Bulletin* 34:806–50. [aRWB]
- Spinazzi, G. (1993) The development of spontaneous classificatory behavior in chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology* 107:193–200. [aRWB]
- Squire, L. R. (1992) Memory and the hippocampus: A synthesis from findings with rats, monkeys, and humans. *Psychological Review* 99:195–231. [MC]
- Stein, B. E. & Meredith, M. A. (1993) *The merging of the senses*. MIT Press. [MH]
- Taira, M., Mine, S., Georgopoulos, A. P. et al. (1990) Parietal cortex neurons of the monkey related to the visual guidance of hand movement. *Experimental Brain Research* 83:29–36. [NM]
- Taylor, C. K. & Saayman, G. S. (1973) Imitative behaviour by Indian ocean bottlenose dolphins (*Tursiops aduncus*) in captivity. *Behaviour* 44:286–98. [rRWB]
- Thorndike, E. L. (1898) Animal intelligence: An experimental study of the associative process in animals. *Psychological Review Monograph* 2(8):551–53. [aRWB]
- Thorpe, W. H. (1956/1963) *Learning and instinct in animals*. Methuen, 2nd edition, Harvard University Press. [aRWB, TRZ]
- Todt, D. (1970) Zur Ordnung im Gesang der Nachtigall (*Luscinia megarhynchos*). *Verhandlungen der Deutschen Zoologischen Gesellschaft* 64:249–52. [DT]
- (1971) Äquivalente und konvalente gesangliche Reaktionen einer extrem regelmässig singenden Nachtigall (*Luscinia megarhynchos* B.). *Zeitschrift für vergleichende Physiologie* 71:262–85. [DT]
- (1981) On functions of vocal matching: Effect of counter-replies on song-post choice and singing. *Zeitschrift für Tierpsychologie* 57:73–93. [DT]
- Todt, D. & Hultsch, H. (1996) Acquisition and performance of repertoires: Ways of coping with diversity and versatility. In: *Ecology and evolution of communication*, ed. D. E. Kroodsma & E. H. Miller. Cornell University Press. [DT]
- Tolman, E. C. & Honzik, C. H. (1930b) Introduction and removal of reward and maze performance in rats. *University of California Publications in Psychology* 4:257–75. [HLR]
- Tolman, E. C., Ritchie, B. F. & Kalish, D. (1946) Studies in spatial learning I. Orientation and the short-cut. *Journal of Experimental Psychology* 36:13–24. [HLR]
- Tomasello, M. (1990) Cultural transmission in the tool use and communicatory signaling of chimpanzees? In: *“Language” and intelligence in monkeys and apes*, ed. S. T. Parker & K. R. Gibson. Cambridge University Press. [arRWB, MT]
- (1996) Do apes ape? In: *Social learning in animals: The roots of culture*, ed. B. C. Galef, Jr. & C. M. Heyes. Academic Press. [MT]
- (in press) Perceiving intentions and learning words in the second year of life. In: *Language acquisition and conceptual development*, ed. M. Bowerman & S. Levinson. Cambridge University Press. [MT]
- Tomasello, M. & Call, J. (1997) *Primate cognition*. Oxford University Press. [AW]
- Tomasello, M., Call, J., Warren, J., Frost, T., Carpenter, M. & Nagell, K. (in press) The ontogeny of chimpanzee gestural signals: A comparison across groups and generations. *Evolution of Communication*. [MT]
- Tomasello, M., Davis-Dasilva, M., Camak, L. & Bard, K. (1987) Observational learning of tool use by young chimpanzees. *Human Evolution* 2:175–85. [aRWB, MDM, AM, MT]
- Tomasello, M., Kruger, A. C. & Ratner, H. H. (1993) Cultural learning. *Behavioral and Brain Sciences* 16:495–552. [MT]
- Tomasello, M., Savage-Rumbaugh, E. S. & Kruger, A. C. (1993) Imitative learning of actions on objects by children, chimpanzees, and enculturated chimpanzees. *Child Development* 64:1688–1705. [aRWB, FBMDW, MT]
- Trevarthen, C. (1993) The function of emotions in early infant communication and development. In: *New perspectives in early communication development*, ed. J. Nadel & L. Camioni. Routledge. [MH]
- Uzgiris, I. C. (1981) Two functions of imitation during infancy. *International Journal of Behavioral Development* 4:1–12. [aRWB, MH, AM]
- Uzgiris, I. C. & Hunt, J. McV. (1975) *Assessment in infancy*. University of Chicago Press. [HH]
- Visalberghi, E. & Fragaszy, D. (1990) Do monkeys ape? In: *“Language” and intelligence in monkeys and apes*, ed. S. T. Parker & K. R. Gibson. Cambridge University Press. [aRWB]
- Visalberghi, E. & Limongelli, L. (1996) Acting and understanding: Tool use revisited through the minds of capuchin monkeys. In: *Reaching into thought: The minds of great apes*, ed. A. E. Russon, K. A. Bard & S. T. Parker. Cambridge University Press. [aRWB]
- Vogt, S. (1991) Invariantenbildung im Reproduktionsversuch - ein empirischer Ansatz zu Genese und Struktur bewegungsleitender Repräsentationen. In: *Sportmotorisches Lernen und Techniktraining, vol. 2*, ed. R. Daus, H. Mechling, K. Blischke & N. Olivier. Hofmann. [SV]
- (1994) Imagery needs preparation too (Commentary on Jeannerod, 1994). *Behavioral and Brain Sciences* 17:226–27. [SV]
- (1995) On relations between perceiving, imagining and performing in the learning of cyclical movement sequences. *British Journal of Psychology* 86:191–216. [SV]
- (1996a) The concept of event generation in movement imitation - neural and behavioural aspects. *Corpus, Psyche et Societas* 3:119–32. [SV]
- (1996b) Imagery and perception-action mediation in imitative actions. *Cognitive Brain Research* 3:79–86. [MeG]
- Vogt, S., Stadler, M. & Kruse, P. (1988) Self-organization aspects in the temporal formation of movement gestalts. *Human Movement Science* 7:365–406. [SV]
- Vygotsky, L. (1962) *Thought and language*. MIT Press. [aRWB]
- Want, S. C. & Harris, P. L. (1997) Learning from other people's mistakes: Selective imitation by young children. Unpublished paper. Department of Experimental Psychology: Oxford. [SCW]
- Washburn, M. F. (1926) *The animal mind*, 3rd edition. Macmillan. [rRWB]
- Waterman, P. G., Choo, G. M., Vedder, A. L. & Watts, D. (1983) Digestibility, digestion-inhibitors and nutrients of herbaceous foliage and green stems from an African montane flora and comparison with other tropical flora. *Oecologia* 60:244–49. [aRWB]
- Watts, D. P. (1984) Composition and variability of mountain gorilla diets in the central Virungas. *American Journal of Primatology* 7:323–56. [aRWB]
- Whiten, A. (1998) Imitation of the hierarchical structure of actions by chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology* (in press). [AW]
- Whiten, A. & Custance, D. (1996) Studies of imitation in chimpanzees and children. In: *Social learning in animals: The roots of culture*, ed. C. M. Heyes & B. G. Galef. Academic Press. [aRWB]
- Whiten, A., Custance, D., Gomez, J.-C., Texeidor, P. & Bard, K. A. (1996) Imitative learning of artificial fruit processing in children (*Homo sapiens*) and chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology* 110:3–14. [aRWB, FBMDW, AM, SCW]
- Whiten, A. & Ham, R. (1992) On the nature and evolution of imitation in the animal kingdom: Reappraisal of a century of research. In: *Advances in the study of behavior, vol. 21*, ed. P. J. B. Slater, J. S. Rosenblatt, C. Beer & M. Milinski. Academic Press. [arRWB, MT, TRZ]
- Whiting, H. T. A., Vogt, S. & Vereijken, B. (1992) Human skill and motor control: Some aspects of the motor control - motor learning relation. In: *Approaches to the study of motor control and learning*, ed. J. J. Summers. North-Holland. [SV]
- Wolfgramm, I. & Todt, D. (1982) Pattern and time specificity in vocal responses of blackbirds (*Turdus merula*). *Behaviour* 81:264–86. [DT]
- Wood, D. (1989) Social interaction as tutoring. In: *Interaction in human development*, ed. M. H. Bornstein & J. S. Bruner. Erlbaum. [aRWB]
- Xitco, M. J., Jr. (1988) Mimicry of modeled behaviors by bottlenose dolphins. Unpublished Master's thesis. University of Hawaii. [SAK]
- Yando, R., Seitz, V. & Zigler, E. (1978) *Imitation: A developmental perspective*. Erlbaum. [aRWB]
- Zentall, T. R. (1996) An analysis of imitative learning in animals. In: *Social learning and tradition in animals: The roots of culture*, ed. C. M. Heyes & B. G. Galef. Erlbaum. [aRWB, TRZ]
- Zentall, T. R. & Galef, B. G., Jr., eds. (1988) *Comparative social learning*. Erlbaum. [aRWB]
- Zentall, T. R., Sutton, J. E. & Sherburne, L. M. (1996) True imitative learning in pigeons. *Psychological Science* 7:343–46. [TRZ]