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The effects of rearing conditions on sexual traits and preferences in zebra finches

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Citation

Holveck, M. J. (2008, February 28). *The effects of rearing conditions on sexual traits and preferences in zebra finches*. Retrieved from <https://hdl.handle.net/1887/12621>

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Literature cited

- Alonso-Alvarez C, Bertrand S, Devevey G, Prost J, Faivre B, Chastel O, Sorci G, 2006. An experimental manipulation of life-history trajectories and resistance to oxidative stress. *Evolution* 60:1913-1924.
- Andersson M, 1994. *Sexual selection*. Princeton, New Jersey: Princeton University Press.
- Badyaev AV, Qvarnström A, 2002. Putting sexual traits into the context of an organism: A life-history perspective in studies of sexual selection. *Auk* 119:301-310.
- Bakker TCM, Kunzler R, Mazzi D, 1999. Sexual selection - Condition-related mate choice in sticklebacks. *Nature* 401:234-234.
- Basolo AL, 1990. Female preference predates the evolution of the sword in swordtail fish. *Science* 250:808-810.
- Bateson P, Barker D, Clutton-Brock T, Deb D, D'Udine B, Foley RA, Gluckman P, Godfrey K, Kirkwood T, Lahr MM, McNamara J, Metcalfe NB, Monaghan P, Spencer HG, Sultan SE, 2004. Developmental plasticity and human health. *Nature* 430:419-421.
- Baumel JJ, King AS, Lucas AM, Breazile JE, Evens HE, 1979. *Nomina anatomica avium: an annotated anatomical dictionary of birds*. London: Academic Press.
- Becker WA, 1984. *Manual of Quantitative Genetics*, 4th ed. Pullman, Washington: Academic Enterprises.
- Birkhead TR, Fletcher F, Pellatt EJ, 1998. Sexual selection in the zebra finch *Taeniopygia guttata*: condition, sex traits and immune capacity. *Behavioral Ecology and Sociobiology* 44:179-191.
- Birkhead TR, Fletcher F, Pellatt EJ, 1999. Nestling diet, secondary sexual traits and fitness in the zebra finch. *Proceedings of the Royal Society of London Series B-Biological Sciences* 266:385-390.
- Blount JD, Metcalfe NB, Arnold KE, Surai PF, Devevey GL, Monaghan P, 2003. Neonatal nutrition, adult antioxidant defences and sexual attractiveness in the zebra finch. *Proceedings of the Royal Society of London Series B-Biological Sciences* 270:1691-1696.
- Braaten RF, Petzoldt M, Colbath A, 2006. Song perception during the sensitive period of song learning in zebra finches (*Taeniopygia guttata*). *Journal of Comparative Psychology* 120:79-88.
- Brainard MS, Doupe AJ, 2002. What songbirds teach us about learning. *Nature* 417:351-358.
- Brooks R, Endler JA, 2001. Female guppies agree to differ: phenotypic and genetic variation in mate-choice behavior and the consequences for sexual selection. *Evolution* 55:1644-1655.
- Buchanan KL, Leitner S, Spencer KA, Goldsmith AR, Catchpole CK, 2004. Developmental stress selectively affects the song control nucleus HVC in the zebra finch. *Proceedings of the Royal Society of London Series B-Biological Sciences* 271:2381-2386.
- Buchanan KL, Spencer KA, Goldsmith AR, Catchpole CK, 2003. Song as an honest signal of past developmental stress in the European starling (*Sturnus vulgaris*). *Proceedings of the Royal Society of London Series B-Biological Sciences* 270:1149-1156.

Literature cited

- Burley N, 1986. Sexual selection for aesthetic traits in species with biparental care. *American Naturalist* 127:415-445.
- Burley NT, Foster VS, 2006. Variation in female choice of mates: condition influences selectivity. *Animal Behaviour* 72:713-719.
- Byers BE, 2007. Extrapair paternity in chestnut-sided warblers is correlated with consistent vocal performance. *Behavioral Ecology* 18:130-136.
- Candolin U, 2003. The use of multiple cues in mate choice. *Biological Reviews* 78:575-595.
- Catchpole CK, 1996. Song and female choice: Good genes and big brains? *Trends in Ecology & Evolution* 11:358-360.
- Catchpole CK, Slater PJB, 1995. *Bird song: Biological themes and variations*. Cambridge, England: Cambridge University Press.
- Christians JK, 2002. Avian egg size: variation within species and inflexibility within individuals. *Biological Reviews* 77:1-26.
- Christie PJ, Mennill DJ, Ratcliffe LM, 2004. Pitch shifts and song structure indicate male quality in the dawn chorus of black-capped chickadees. *Behavioral Ecology and Sociobiology* 55:341-348.
- Clayton NS, 1987. Song tutor choice in zebra finches. *Animal Behaviour* 35:714-721.
- Clayton NS, 1988. Song discrimination learning in zebra finches. *Animal Behaviour* 36:1016-1024.
- Cohen J, 1988. *Statistical power analysis for the behavioral sciences*. Hillsdale, NJ: Lawrence Earlbaum Associates.
- Collins SA, 1994. Male displays: cause or effect of female preference? *Animal Behaviour* 48:371-375.
- Collins SA, 1995. The effect of recent experience on female choice in zebra finches. *Animal Behaviour* 49:479-486.
- Collins SA, 1999. Is female preference for male repertoires due to sensory bias? *Proceedings of the Royal Society of London Series B-Biological Sciences* 266:2309-2314.
- Collins SA, Hubbard C, Houtman AM, 1994. Female mate choice in the zebra finch - the effect of male beak color and male song. *Behavioral Ecology and Sociobiology* 35:21-25.
- Collins SA, ten Cate C, 1996. Does beak colour affect female preference in zebra finches? *Animal Behaviour* 52:105-112.
- Cotton S, Small J, Pomiankowski A, 2006. Sexual selection and condition-dependent mate preferences. *Current Biology* 16:R755-R765.
- Cuthill IC, 2005. The study of function in behavioural ecology. *Animal Biology* 55:399-417.
- Cynx J, 1990. Experimental determination of a unit of song production in the zebra finch (*Taeniopygia guttata*). *Journal of Comparative Psychology* 104:3-10.
- Darwin C, 1871. *The descent of man and selection in relation to sex*, 2nd ed. London: Murray.
- Dawkins R, Krebs J, 1978. Animal signals: information or manipulation? In: *Behavioural ecology* (Krebs JR DN, ed). Sunderland, Massachusetts: Sinauer; 282-309.
- de Kogel CH, 1997. Long-term effects of brood size manipulation on morphological development and sex-specific mortality of offspring. *Journal of Animal Ecology* 66:167-178.

- de Kogel CH, Prijs HJ, 1996. Effects of brood size manipulations on sexual attractiveness of offspring in the zebra finch. *Animal Behaviour* 51:699-708.
- Deerenberg C, de Kogel CH, Overkamp GFJ, 1996. Costs of reproduction in the zebra finch *Taeniopygia guttata*: Manipulation of brood size in the laboratory. *Journal of Avian Biology* 27:321-326.
- Desai M, Hales CN, 1997. Role of fetal and infant growth in programming metabolism in later life. *Biological Reviews of the Cambridge Philosophical Society* 72:329-348.
- Doutrelant C, Blondel J, Perret P, Lambrechts MM, 2000. Blue tit song repertoire size, male quality and interspecific competition. *Journal of Avian Biology* 31:360-366.
- Draganoiu TI, Nagle L, Kreutzer M, 2002. Directional female preference for an exaggerated male trait in canary (*Serinus canaria*) song. *Proceedings of the Royal Society of London Series B-Biological Sciences* 269:2525-2531.
- Endler JA, 1992. Signals, signal conditions, and the direction of evolution. *American Naturalist* 139:S125-S153.
- Faivre B, Gregoire A, Preault M, Cézilly F, Sorci G, 2003. Immune activation rapidly mirrored in a secondary sexual trait. *Science* 300:103.
- Fawcett TW, Johnstone RA, 2003. Mate choice in the face of costly competition. *Behavioral Ecology* 14:771-779.
- Field A, 2000. *Discovering Statistics using SPSS for Windows*. London, Thousand Oaks, New Delhi: SAGE Publications.
- Forstmeier W, 2004. Female resistance to male seduction in zebra finches. *Animal Behaviour* 68:1005-1015.
- Forstmeier W, Birkhead TR, 2004. Repeatability of mate choice in the zebra finch: consistency within and between females. *Animal Behaviour* 68:1017-1028.
- Franz M, Goller F, 2002. Respiratory units of motor production and song imitation in the zebra finch. *Journal of Neurobiology* 51:129-141.
- Franz M, Goller F, 2003. Respiratory patterns and oxygen consumption in singing zebra finches. *Journal of Experimental Biology* 206:967-978.
- Funabiki Y, Konishi M, 2003. Long memory in song learning by zebra finches. *Journal of Neuroscience* 23:6928-6935.
- Gebhardt-Henrich SG, Richner H, 1998. Causes of growth variation and its consequences for fitness. In: *Avian growth and development. Evolution within the altricial-precocial spectrum* (Ricklefs JMSRE, ed). New York, NY: Oxford University Press; 324-339.
- Gil D, Gahr M, 2002. The honesty of bird song: multiple constraints for multiple traits. *Trends in Ecology & Evolution* 17:133-141.
- Gil D, Naguib M, Riebel K, Rutstein A, Gahr M, 2006. Early condition, song learning, and the volume of song brain nuclei in the zebra finch (*Taeniopygia guttata*). *Journal of Neurobiology* 66:1602-1612.
- Gluckman PD, Hanson MA, Spencer HG, Bateson P, 2005. Environmental influences during development and their later consequences for health and disease: implications for the interpretation of empirical studies. *Proceedings of the Royal Society B-Biological Sciences* 272:671-677.
- Goller F, Daley MA, 2001. Novel motor gestures for phonation during inspiration enhance the acoustic complexity of birdsong. *Proceedings of the Royal Society of London Series B-Biological Sciences* 268:2301-2305.

Literature cited

- Gosler AG, Greenwood JJD, Baker JK, Davidson NC, 1998. The field determination of body size and condition in passerines: a report to the British Ringing Committee. *Bird Study* 45:92-103.
- Grafen A, 1990. Biological signals as handicaps. *Journal of Theoretical Biology* 144:517-546.
- Hager BJ, Teale SA, 1994. Repeatability of female response to ipsdienol enantiomeric mixtures by pine engraver, *Ips pini* (Coleoptera, Scolytidae). *Journal of Chemical Ecology* 20:2611-2622.
- Hårdling R, Kokko H, 2005. The evolution of prudent choice. *Evolutionary Ecology Research* 7:697-715.
- Hebets EA, Papaj DR, 2005. Complex signal function: developing a framework of testable hypotheses. *Behavioral Ecology and Sociobiology* 57:197-214.
- Hill JA, Enstrom DA, Ketterson ED, Nolan V, Ziegenfus C, 1999. Mate choice based on static versus dynamic secondary sexual traits in the dark-eyed junco. *Behavioral Ecology* 10:91-96.
- Houtman AM, 1992. Female zebra finches choose extra-pair copulations with genetically attractive males. *Proceedings of the Royal Society of London Series B-Biological Sciences* 249:3-6.
- Houx BB, ten Cate C, 1999. Song learning from playback in zebra finches: is there an effect of operant contingency? *Animal Behaviour* 57:837-845.
- Hunt J, Brooks R, Jennions MD, 2005. Female mate choice as a condition-dependent life-history trait. *American Naturalist* 166:79-92.
- Jakob EM, Marshall SD, Uetz GW, 1996. Estimating fitness: a comparison of body condition indices. *Oikos* 77:61-67.
- Jennions MD, Petrie M, 1997. Variation in mate choice and mating preferences: a review of causes and consequences. *Biological Reviews of the Cambridge Philosophical Society* 72:283-327.
- Johnsen TS, Zuk M, 1996. Repeatability of mate choice in female red jungle fowl. *Behavioral Ecology* 7:243-246.
- Johnstone RA, 1996. Multiple displays in animal communication: 'backup signals' and 'multiple messages'. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences* 351:329-338.
- Johnstone RA, 1997. The tactics of mutual mate choice and competitive search. *Behavioral Ecology and Sociobiology* 40:51-59.
- Jones AE, ten Cate C, Bijleveld CJH, 2001a. The interobserver reliability of scoring sonagrams by eye: a study on methods, illustrated on zebra finch songs. *Animal Behaviour* 62:791-801.
- Jones AE, ten Cate C, Slater PJB, 1996. Early experience and plasticity of song in adult male zebra finches (*Taeniopygia guttata*). *Journal of Comparative Psychology* 110:354-369.
- Jones KM, Monaghan P, Nager RG, 2001b. Male mate choice and female fecundity in zebra finches. *Animal Behaviour* 62:1021-1026.
- Kirkpatrick M, Ryan MJ, 1991. The evolution of mating preferences and the paradox of the lek. *Nature* 350:33-38.
- Kodric-Brown A, Nicoletto PF, 2001. Age and experience affect female choice in the guppy (*Poecilia reticulata*). *American Naturalist* 157:316-323.
- Lambrechts M, Dhondt AA, 1986. Male quality, reproduction and survival in the great tit (*Parus major*). *Behavioral Ecology and Sociobiology* 19:57-63.

- Leadbeater E, Goller F, Riebel K, 2005. Unusual phonation, covarying song characteristics and song preferences in female zebra finches. *Animal Behaviour* 70:909-919.
- Lessells CM, 1991. The evolution of life histories. In: *Behavioural ecology: an evolutionary approach* (Davies JRKNB, ed). Oxford, UK: Blackwell Scientific Publications; 32–68.
- Lessells CM, Boag PT, 1987. Unrepeatable repeatabilities: a common mistake. *Auk* 104:116-121.
- Lindström J, 1999. Early development and fitness in birds and mammals. *Trends in Ecology & Evolution* 14:343-348.
- Little AC, Burt DM, Penton-Voak IS, Perrett DI, 2001. Self-perceived attractiveness influences human female preferences for sexual dimorphism and symmetry in male faces. *Proceedings of the Royal Society of London Series B-Biological Sciences* 268:39-44.
- Lummaa V, Clutton-Brock T, 2002. Early development, survival and reproduction in humans. *Trends in Ecology & Evolution* 17:141-147.
- Mann NI, Slater PJB, 1994. What causes young male zebra finches, *Taeniopygia guttata*, to choose their father as song tutor? *Animal Behaviour* 47:671-677.
- Marler CA, Foran C, Ryan MJ, 1997. The influence of experience on mating preferences of the gynogenetic Amazon molly. *Animal Behaviour* 53:1035-1041.
- Marler P, Peters S, 1977. Selective vocal learning in a sparrow. *Science* 198:519-521.
- Marler P, Peters S, 1988. The role of song phonology and syntax in vocal learning preferences in the song sparrow, *Melospiza melodia*. *Ethology* 77:125-149.
- Martins TLF, 2004. Sex-specific growth rates in zebra finch nestlings: a possible mechanism for sex ratio adjustment. *Behavioral Ecology* 15:174-180.
- McNamara JM, Forslund P, Lang A, 1999. An ESS model for divorce strategies in birds. *Philosophical Transactions of the Royal Society of London Series B-Biological Sciences* 354:223-236.
- McNamara JM, Houston AI, 1996. State-dependent life histories. *Nature* 380:215-221.
- Miller DB, 1979a. The acoustic basis of mate recognition by female zebra finches (*Taeniopygia guttata*). *Animal Behaviour* 27:376-380.
- Miller DB, 1979b. Long-term recognition of father's song by female zebra finches. *Nature* 280:389-391.
- Møller AP, Pomiankowski A, 1993. Why have birds got multiple sexual ornaments. *Behavioral Ecology and Sociobiology* 32:167-176.
- Møller AP, Saino N, Taramino G, Galeotti P, Ferrario S, 1998. Paternity and multiple signalling: effects of a secondary sexual character and song on paternity in the barn swallow. *American Naturalist* 151:236-242.
- Morris MR, Nicoletto PF, Hesselman E, 2003. A polymorphism in female preference for a polymorphic male trait in the swordtail fish *Xiphophorus cortezi*. *Animal Behaviour* 65:45-52.
- Naguib M, Nemitz A, Gil D, 2006. Maternal developmental stress reduces reproductive success of female offspring in zebra finches. *Proceedings of the Royal Society B-Biological Sciences* 273:1901-1905.
- Naguib M, Riebel K, Marzal A, Gil D, 2004. Nestling immunocompetence and testosterone covary with brood size in a songbird. *Proceedings of the Royal Society of London Series B-Biological Sciences* 271:833-838.

Literature cited

- Nakagawa S, 2004. A farewell to Bonferroni: the problems of low statistical power and publication bias. *Behavioral Ecology* 15:1044-1045.
- Neubauer RL, 1999. Super-normal length song preferences of female zebra finches (*Taeniopygia guttata*) and a theory of the evolution of bird song. *Evolutionary Ecology* 13:365-380.
- Neuenschwander S, Brinkhof MWG, Kolliker M, Richner H, 2003. Brood size, sibling competition, and the cost of begging in great tits (*Parus major*). *Behavioral Ecology* 14:457-462.
- Nowicki S, Peters S, Podos J, 1998. Song learning, early nutrition and sexual selection in songbirds. *American Zoologist* 38:179-190.
- Nowicki S, Searcy WA, Peters S, 2002a. Brain development, song learning and mate choice in birds: a review and experimental test of the "nutritional stress hypothesis". *Journal of Comparative Physiology a-Neuroethology Sensory Neural and Behavioral Physiology* 188:1003-1014.
- Nowicki S, Searcy WA, Peters S, 2002b. Quality of song learning affects female response to male bird song. *Proceedings of the Royal Society of London Series B-Biological Sciences* 269:1949-1954.
- Oberweger K, Goller F, 2001. The metabolic cost of birdsong production. *Journal of Experimental Biology* 204:3379-3388.
- Okanoya K, Yamaguchi A, 1997. Adult Bengalese finches (*Lonchura striata var. domestica*) require real-time auditory feedback to produce normal song syntax. *Journal of Neurobiology* 33:343-356.
- Owens IPF, Rowe C, Thomas ALR, 1999. Sexual selection, speciation and imprinting: separating the sheep from the goats. *Trends in Ecology & Evolution* 14:131-132.
- Patricelli GL, Uy JAC, Borgia G, 2003. Multiple male traits interact: attractive bower decorations facilitate attractive behavioural displays in satin bowerbirds. *Proceedings of the Royal Society of London Series B-Biological Sciences* 270:2389-2395.
- Podos J, 1996. Motor constraints on vocal development in a songbird. *Animal Behaviour* 51:1061-1070.
- Podos J, Peters S, Nowicki S, 2004. Calibration of song learning targets during vocal ontogeny in swamp sparrows, *Melospiza georgiana*. *Animal Behaviour* 68:929-940.
- Pomiankowski A, 1987. The costs of choice in sexual selection. *Journal of Theoretical Biology* 128:195-218.
- Price PH, 1979. Developmental determinants of structure in zebra finch song. *Journal of Comparative and Physiological Psychology* 93:260-277.
- Qvarnström A, 2001. Context-dependent genetic benefits from mate choice. *Trends in Ecology & Evolution* 16:5-7.
- Qvarnström A, Part T, Sheldon BC, 2000. Adaptive plasticity in mate preference linked to differences in reproductive effort. *Nature* 405:344-347.
- Råberg L, Stjernman M, Nilsson JA, 2005. Sex and environmental sensitivity in blue tit nestlings. *Oecologia* 145:496-503.
- Real LA, 1991. Search theory and mate choice. 2. Mutual interaction, assortative mating, and equilibrium variation in male and female fitness. *American Naturalist* 138:901-917.

- Riebel K, 2000. Early exposure leads to repeatable preferences for male song in female zebra finches. *Proceedings of the Royal Society of London Series B-Biological Sciences* 267:2553-2558.
- Riebel K, 2003a. Developmental influences on auditory perception in female zebra finches - Is there a sensitive phase for song preference learning? *Animal Biology* 53:73-87.
- Riebel K, 2003b. The "mute" sex revisited: vocal production and perception learning in female songbirds. *Advances in the Study of Behavior* 33:49-86.
- Riebel K, Slater PJB, 1998. Testing female chaffinch song preferences by operant conditioning. *Animal Behaviour* 56:1443-1453.
- Riebel K, Smallegange IM, 2003. Does zebra finch (*Taeniopygia guttata*) preference for the (familiar) father's song generalize to the songs of unfamiliar brothers? *Journal of Comparative Psychology* 117:61-66.
- Riebel K, Smallegange IM, Terpstra NJ, Bolhuis JJ, 2002. Sexual equality in zebra finch song preference: evidence for a dissociation between song recognition and production learning. *Proceedings of the Royal Society of London Series B-Biological Sciences* 269:729-733.
- Rønning B, Moe B, Bech C, 2005. Long-term repeatability makes basal metabolic rate a likely heritable trait in the zebra finch *Taeniopygia guttata*. *Journal of Experimental Biology* 208:4663-4669.
- Rosnow RL, Rosenthal R, 1996. Computing contrasts, effect sizes, and counternulls on other people's published data: General procedures for research consumers. *Psychological Methods* 1:331-340.
- Rowe L, Houle D, 1996. The lek paradox and the capture of genetic variance by condition dependent traits. *Proceedings of the Royal Society of London Series B-Biological Sciences* 263:1415-1421.
- Rowland WJ, Bolyard KJ, Jenkins JJ, Fowler J, 1995. Video playback experiments on stickleback mate choice: female motivation and attentiveness to male color cues. *Animal Behaviour* 49:1559-1567.
- Ryan MJ, Akre KL, Kirkpatrick M, 2007. Mate choice. *Current Biology* 17:R313-R316.
- Scharff C, Nottebohm F, 1991. A comparative study of the behavioral deficits following lesions of various parts of the zebra finch song system: implications for vocal learning. *Journal of Neuroscience* 11:2896-2913.
- Scheuber H, Jacot A, Brinkhof MWG, 2003a. Condition dependence of a multicomponent sexual signal in the field cricket *Gryllus campestris*. *Animal Behaviour* 65:721-727.
- Scheuber H, Jacot A, Brinkhof MWG, 2003b. The effect of past condition on a multicomponent sexual signal. *Proceedings of the Royal Society of London Series B-Biological Sciences* 270:1779-1784.
- Searcy WA, Yasukawa K, 1996. Song and female choice. In: *Ecology and Evolution of Acoustic Communication in Birds* (Kroodsma DE, Miller EH, eds). New York: Comstock/Cornell Publishing Associates, Ithaca; 454-473.
- Siegel S, Castellan NJJ, 1988. *Nonparametric statistics for the behavioral sciences*. New-York: McGraw-Hill Book Company.
- Slater PJB, 1989. Bird song learning - Causes and consequences. *Ethology Ecology & Evolution* 1:19-46.

Literature cited

- Slater PJB, Clayton NS, 1991. Domestication and song learning in zebra finches *Taeniopygia guttata*. *Emu* 91:126-128.
- Slater PJB, Eales LA, Clayton NS, 1988. Song learning in zebra finches: progress and prospects. *Advances in the Study of Behavior* 18:1-34.
- Slater PJB, Mann NI, 1990. Do male zebra finches learn their fathers' songs? *Trends in Ecology & Evolution* 5:415-417.
- Sokal RR, Rohlf FJ, 1995. *Biometry: the principles and practice of statistics in biological research*, 3d ed. New York: W. H. Freeman and Company.
- Sorenson LG, Derrickson SR, 1994. Sexual selection in the northern pintail (*Anas acuta*): the importance of female choice versus male-male competition in the evolution of sexually selected traits. *Behavioral Ecology and Sociobiology* 35:389-400.
- Sossinka R, Böhner J, 1980. Song types in the zebra finch *Poephila guttata castanotis*. *Zeitschrift Für Tierpsychologie-Journal of Comparative Ethology* 53:123-132.
- Speakman JR, Ergon T, Cavanagh R, Reid K, Scantlebury DM, Lambin X, 2003. Resting and daily energy expenditures of free-living field voles are positively correlated but reflect extrinsic rather than intrinsic effects. *Proceedings of the National Academy of Sciences of the United States of America* 100:14057-14062.
- Speakman JR, Król E, Johnson MS, 2004a. The functional significance of individual variation in basal metabolic rate. *Physiological and Biochemical Zoology* 77:900-915.
- Speakman JR, Talbot DA, Selman C, Snart S, McLaren JS, Redman P, Król E, Jackson DM, Johnson MS, Brand MD, 2004b. Uncoupled and surviving: individual mice with high metabolism have greater mitochondrial uncoupling and live longer. *Aging Cell* 3:87-95.
- Spencer KA, Buchanan KL, Goldsmith AR, Catchpole CK, 2003. Song as an honest signal of developmental stress in the zebra finch (*Taeniopygia guttata*). *Hormones and Behavior* 44:132-139.
- Spencer KA, Buchanan KL, Goldsmith AR, Catchpole CK, 2004. Developmental stress, social rank and song complexity in the European starling (*Sturnus vulgaris*). *Proceedings of the Royal Society of London Series B-Biological Sciences* 271:S121-S123.
- Spencer KA, Buchanan KL, Leitner S, Goldsmith AR, Catchpole CK, 2005a. Parasites affect song complexity and neural development in a songbird. *Proceedings of the Royal Society B-Biological Sciences* 272:2037-2043.
- Spencer KA, Wimpenny JH, Buchanan KL, Lovell PG, Goldsmith AR, Catchpole CK, 2005b. Developmental stress affects the attractiveness of male song and female choice in the zebra finch (*Taeniopygia guttata*). *Behavioral Ecology and Sociobiology* 58:423-428.
- Stearns SC, 1992. *The evolution of life histories*. Oxford, UK: Oxford University Press.
- Sturdy CB, Phillimore LS, Price JL, Weisman RG, 1999a. Song-note discriminations in zebra finches (*Taeniopygia guttata*): Categories and pseudocategories. *Journal of Comparative Psychology* 113:204-212.

- Sturdy CB, Phillmore LS, Weisman RG, 1999b. Note types, harmonic structure, and note order in the songs of zebra finches (*Taeniopygia guttata*). *Journal of Comparative Psychology* 113:194-203.
- Suthers RA, Zollinger SA, 2004. Producing song - The vocal apparatus. In: *Behavioral Neurobiology of Birdsong*; 109-129.
- Tchernichovski O, Lints T, Mitra PP, Nottebohm F, 1999. Vocal imitation in zebra finches is inversely related to model abundance. *Proceedings of the National Academy of Sciences of the United States of America* 96:12901-12904.
- Tchernichovski O, Nottebohm F, 1998. Social inhibition of song imitation among sibling male zebra finches. *Proceedings of the National Academy of Sciences of the United States of America* 95:8951-8956.
- ten Cate C, 2000. How learning mechanisms might affect evolutionary processes. *Trends in Ecology & Evolution* 15:179-181.
- ten Cate C, Mug G, 1984. The development of mate choice in zebra finch females. *Behaviour* 90:125-150.
- ten Cate C, Slabbekoorn H, Ballintijn MR, 2002. Birdsong and male-male competition: Causes and consequences of vocal variability in the collared dove (*Streptopelia decaocto*). In: *Advances in the Study of Behavior*, Vol 31; 31-75.
- ten Cate C, Slater PJB, 1991. Song learning in zebra finches - How are elements from two tutors integrated. *Animal Behaviour* 42:150-152.
- ten Cate C, Vos DR, 1999. Sexual imprinting and evolutionary processes in birds: a reassessment. In: *Advances in the Study of Behavior*, Vol. 28; 1-31.
- Todd PM, Penke L, Fasolo B, Lenton AP, 2007. Different cognitive processes underlie human mate choices and mate preferences. *Proceedings of the National Academy of Sciences of the United States of America* 104:15011-15016.
- Trivers RL, Willard DE, 1973. Natural-selection of parental ability to vary sex-ratio of offspring. *Science* 179:90-92.
- Vallet E, Beme I, Kreutzer M, 1998. Two-note syllables in canary songs elicit high levels of sexual display. *Animal Behaviour* 55:291-297.
- van Doorn GS, Weissing FJ, 2004. The evolution of female preferences for multiple indicators of quality. *American Naturalist* 164:173-186.
- Verhulst S, Riedstra B, Wiersma P, 2005. Brood size and immunity costs in zebra finches *Taeniopygia guttata*. *Journal of Avian Biology* 36:22-30.
- Verzijden MN, Etman E, van Heijningen C, van der Linden M, ten Cate C, 2007. Song discrimination learning in zebra finches induces highly divergent responses to novel songs. *Proceedings of the Royal Society B-Biological Sciences* 274:295-301.
- Vickers MH, Breier BH, Cutfield WS, Hofman PL, Gluckman PD, 2000. Fetal origins of hyperphagia, obesity, and hypertension and postnatal amplification by hypercaloric nutrition. *American Journal of Physiology-Endocrinology and Metabolism* 279:E83-E87.
- Waas JR, Wordsworth AF, 1999. Female zebra finches prefer symmetrically banded males, but only during interactive mate choice tests. *Animal Behaviour* 57:1113-1119.
- Wagner WE, 1998. Measuring female mating preferences. *Animal Behaviour* 55:1029-1042.

Literature cited

- Widemo F, Saether SA, 1999. Beauty is in the eye of the beholder: causes and consequences of variation in mating preferences. *Trends in Ecology & Evolution* 14:26-31.
- Williams H, 1990. Models for song learning in the zebra finch - Fathers or others. *Animal Behaviour* 39:745-757.
- Williams H, 2004. Birdsong and singing behavior. In: *Behavioral Neurobiology of Birdsong*; 1-30.
- Williams H, Cynx J, Nottebohm F, 1989. Timber control in zebra finch (*Taeniopygia guttata*) song syllables. *Journal of Comparative Psychology* 103:366-380.
- Williams H, Staples K, 1992. Syllable chunking in zebra finch (*Taeniopygia guttata*) song. *Journal of Comparative Psychology* 106:278-286.
- Williams TD, Vézina F, 2001. Reproductive energy expenditure, intraspecific variation, and fitness. In: *Current Ornithology* (Nolan Jr. VT, Charles F., ed). New York, NY: Kluwer Academic / Plenum; 355-405.
- Zahavi A, 1975. Mate selection - Selection for a handicap. *Journal of Theoretical Biology* 53:205-214.
- Zann R, 1993. Variation in song structure within and among populations of Australian zebra finches. *Auk* 110:716-726.
- Zann RA, 1996. *The zebra finch: a synthesis of field and laboratory studies*. New York, Melbourne: Oxford University Press.