SUPPORTING INFORMATION

Table S1. Data sources by species.

Species	Numerical Discrimination Studies	Anatomical Data Sources	Socioecological Data Sources
Chimpanzee *(Pan troglodytes)*	(1–5)	(6)	(7–9)
Bonobo *(Pan paniscus)*	(3)	(6)	(8–10)
Gorilla *(Gorilla gorilla)*	(3,11,12)	(6,13)	(7–9)
Orangutan *(Pongo pygmaeus)*	(3,14,15)	(6,13)	(7–9)
Rhesus Macaque *(Macaca mulatta)*	(16–24)	(6,13,25)	(7–9)
Long-Tailed Macaque *(Macaca fascicularis)*	(26)	(6,13,27)	(7–9)
Tufted Capuchin *(Sapajus apella)*	(16,28–31)	(6,13,25)	(7–9)
Mongoose Lemur *(Eulemur mongoz)*	(20)	(6)	(8,9,32)
Ring-Tailed Lemur *(Lemur catta)*	(20)	(6)	(7–9)
Blue-Eyed Black Lemur *(Eulemur macaco flavifrons)*	(20)	(6)	N/A
Hamadryas Baboon *(Papio hamadryas)*	(33)	(6)	(7–9)
Olive Baboon *(Papio anubis)*	(26,34)	(6)	(8,9,35)
Squirrel Monkey *(Saimiri sciureus)*	(33)	(6,13,25)	(7–9)
Cotton-Top Tamarin *(Saguinus oedipus)*	(36,37)	(6)	(8,38)
Common Marmoset *(Callithrix jacchus)*	(37)	(6,13,25)	(7–9)
Brown Rat *(Rattus norvegicus)*	(39)	(13,40,41)	(42)
Horse *(Equus ferus caballus)*	(43)	N/A	N/A

Coyote *(Canis latrans)*	(44,45)	(46)	(47)
Grey Wolf *(Canis lupus)*	(48)	(46)	(49)
Dog *(Canis familiaris)*	(50,51)	(13,40,52)	N/A
Domestic Cat *(Felis silvestris catus)*	(53)	(46,52)	N/A
American Black Bear *(Ursus americanus)*	(54)	(46)	(55)
African Elephant *(Loxodonta africana)*	(56)	(13,57,58)	(59)
Asian Elephant *(Elephas maximus)*	(60)	(57)	(61)
South American Sea Lion *(Otaria flavescens)*	(62)	(63)	(64)
Common Bottlenose Dolphin *(Tursiops truncatus)*	(65–67)	(68)	(69)
Beluga Whale *(Delphinapterus leucas)*	(70)	(68)	(71)
Clark's Nutcracker *(Nucifraga columbiana)*	(72)	(73)	(74)
Carrion Crow *(Corvus corone)*	(75)	(76)	(74)
Jackdaw *(Corvus monedula)*	(77)	(76,78)	(74)
North Island robin, Māori name toutouwai (*Petroica longipes*)	(79)	N/A	N/A
African Grey Parrot *(Psittacus erithacus)*	(80)	(78,81)	(82)
Pigeon *(Columba livia)*	(83)	(40,78)	(84)

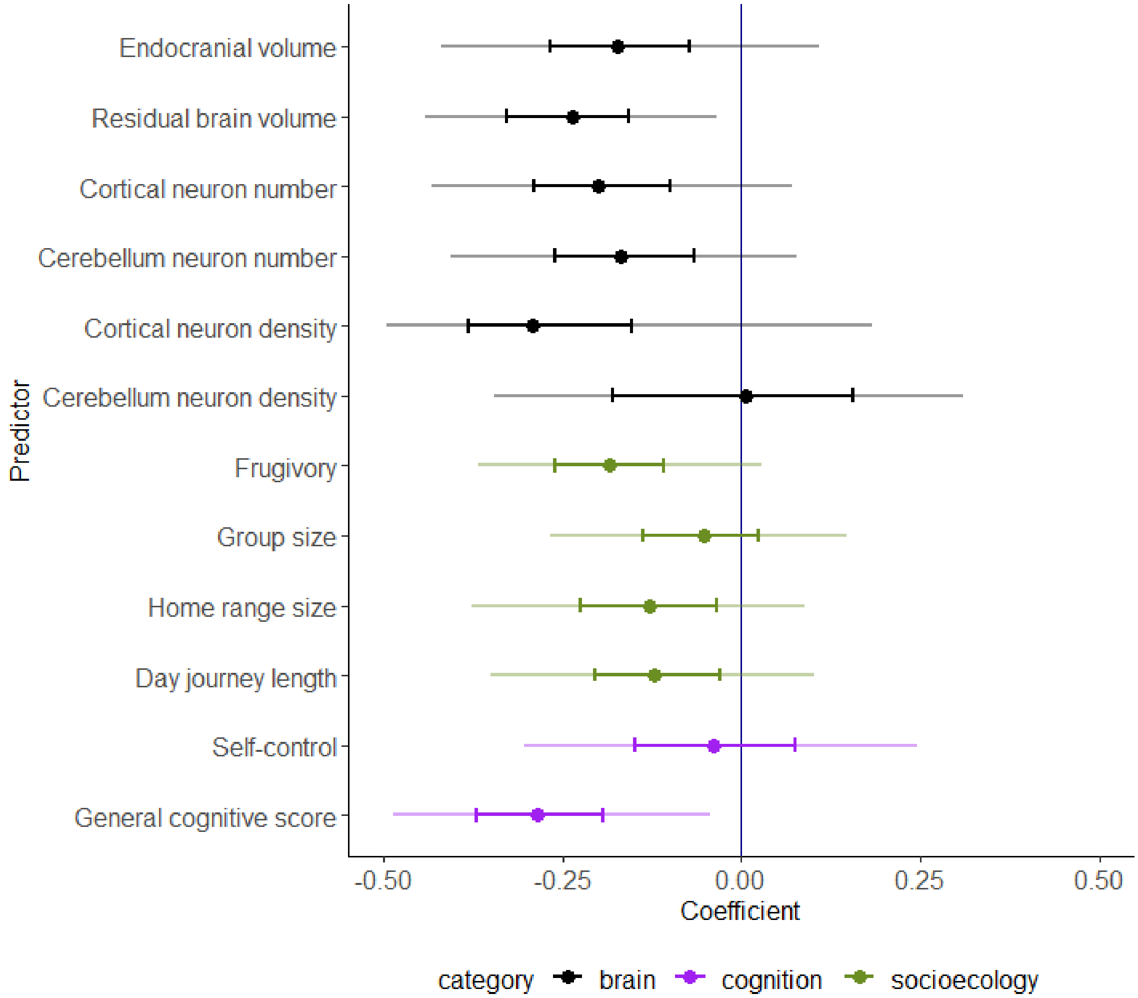

Figure S1. Posterior distribution for the coefficient for each predictor from model run with primate species only (N=15 species). 95% credible interval represents the central 95% of the posterior distribution, while the 50% credible interval represents the central 50% of the posterior distribution. A parameter with no effect would be centered at 0 (as we found for cerebellum neuron density for primates) with wide symmetrical error bars.

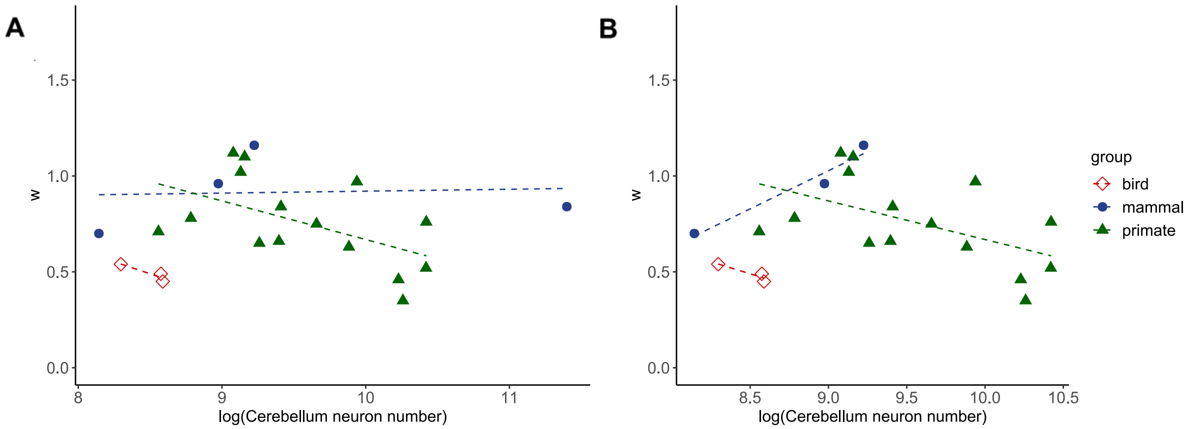

Figure S2. Scatterplot shows species w (generated via a model with no predictors and only species, study, subject and task effects) by log of cerebellum neuron number, (A) with versus (B) without the African elephant. Mammals are blue circles, primates are green triangles, and birds are red diamonds. African elephants are an outlier in that 98% of their neurons are in their cerebellum (58).

SI REFERENCES

1. Beran MJ. Summation and numerousness judgments of sequentially presented sets of items by chimpanzees (Pan troglodytes). J Comp Psychol. 2001;115(2):181–91.
2. Dooley GB, Gill T V. Acquisition and use of mathematical skills by a linguistic chimpanzee. In: Rumbaugh DM, editor. Language Learning by a Chimpanzee: The Lana Project. New York: Academic Press; 1977. p. 247–60.
3. Hanus D, Call J. Discrete quantity judgments in the great apes (Pan paniscus, Pan troglodytes, Gorilla gorilla, Pongo pygmaeus): the effect of presenting whole sets versus item-by-item. J Comp Psychol. 2007;121(3):241–9.
4. Hayes KJ, Nissen CH. Higher mental functions of a home-raised chimpanzee. In: Schrier AM, Stollnitz F, editors. Behavior of Nonhuman Primates: Modern Research Trends. New York: Academic Press; 1971. p. 59–115.
5. Tomonaga M. Relative numerosity discrimination by chimpanzees (Pan troglodytes): Evidence for approximate numerical representations. Anim Cogn. 2008;11(1):43–57.
6. Isler K, Christopher Kirk E, Miller JMA, Albrecht GA, Gelvin BR, Martin RD. Endocranial volumes of primate species: scaling analyses using a comprehensive and reliable data set. J Hum Evol. 2008;55(6):967–78.
7. Barton R. The evolutionary ecology of the primate brain. In: Lee PC, editor. Comparative Primate Socioecology. Cambridge, UK: Cambridge University Press; 2009. p. 167–203.
8. Nunn CL, van Schaik CP. A comparative approach to reconstructing the socioecology of extinct primates. In: Plavcan JM, Jungers WL, Kay RF, van Schaik CP, editors. Reconstructing Behavior in the Fossil Record. New York: Kluwer/Plenum; 2001. p. 159–216.
9. Reader SM, Hager Y, Laland KN. The evolution of primate general and cultural intelligence. Philos Trans R Soc Lond B Biol Sci. 2011;366(1567):1017–27.
10. Bean A. Ecology of sex differences in great ape foraging. In: Lee PC, editor. Comparative Primate Socioecology. Cambridge, UK: Cambridge University Press; 2009. p. 339–62.
11. Anderson US, Stoinski TS, Marr MJ, Smith AD, Bloomsmith MA, Maple TL. Relative numerousness judgment and summation in young and old Western lowland gorillas. J Comp Psychol. 2005;119(3):285–95.
12. Vonk J, Torgerson-White L, McGuire M, Thueme M, Thomas J, Beran MJ. Quantity estimation and comparison in western lowland gorillas (Gorilla gorilla gorilla). Anim Cogn. 2013;1–11.
13. Herculano-Houzel S, Catania K, Manger PR, Kaas JH. Mammalian brains are made of these: A dataset of the numbers and densities of neuronal and nonneuronal cells in the brain of Glires, Primates, Scandentia, Eulipotyphlans, Afrotherians and Artiodactyls, and their relationship with body mass. Brain Behav Evol. 2015;86(3–4):145–63.
14. Anderson US, Stoinski TS, Bloomsmith M a, Maple TL. Relative numerousness judgment and summation in young, middle-aged, and older adult orangutans (Pongo pygmaeus abelii and Pongo pygmaeus pygmaeus). J Comp Psychol. 2007;121(1):1–11.
15. Call J. Estimating and operating on discrete quantities in orangutans (Pongo

pygmaeus). J Comp Psychol. 2000;114(2):136–47.
16. Beran MJ, Decker S, Schwartz A, Schultz N. Monkeys (Macaca mulatta and Cebus apella) and human adults and children (Homo sapiens) compare subsets of moving stimuli based on numerosity. Front Psychol. 2011;2(APR):1–7.
17. Brannon EM, Terrace HS. Representation of the numerosities 1-9 by rhesus macaques (Macaca mulatta). J Exp Psychol Anim Behav Process. 2000;26(1):31–49.
18. Cantlon JF, Brannon EM. Shared system for ordering small and large numbers in monkeys and humans. Psychol Sci. 2006;17(5):401–6.
19. Hauser MD, Carey S, Hauser LB. Spontaneous number representation in semi-free-ranging rhesus monkeys. Proc Biol Sci. 2000;267(1445):829–33.
20. Jones SM, Pearson J, DeWind NK, Paulsen D, Tenekedjieva A-M, Brannon EM. Lemurs and macaques show similar numerical sensitivity. Anim Cogn. 2014;17(3):503–15.
21. Jordan KE, Brannon EM. Weber's Law influences numerical representations in rhesus macaques (Macaca mulatta). Anim Cogn. 2006;9(3):159–72.
22. Merten K, Nieder A. Compressed scaling of abstract numerosity representations in adult humans and monkeys. J Cogn Neurosci. 2009;21(2):333–46.
23. Nieder A, Miller EK. Coding of cognitive magnitude: Compressed scaling of numerical information in the primate prefrontal cortex. Neuron. 2003;37(1):149–57.
24. Wood JN, Hauser MD, Glynn DD, Barner D. Free-ranging rhesus monkeys spontaneously individuate and enumerate small numbers of non-solid portions. Cognition. 2008;106(1):207–21.
25. Herculano-Houzel S, Collins CE, Wong P, Kaas JH. Cellular scaling rules for primate brains. Proc Natl Acad Sci. 2007;104(9):3562–7.
26. Schmitt V, Fischer J. Representational format determines numerical competence in monkeys. Nat Commun. 2011;2(1):255–7.
27. Gabi M, Collins CE, Wong P, Torres LB, Kaas JH, Herculano-Houzel S. Cellular scaling rules for the brains of an extended number of primate species. Brain Behav Evol. 2010;76(1):32–44.
28. Evans TA, Beran MJ, Harris EH, Rice DF. Quantity judgments of sequentially presented food items by capuchin monkeys (Cebus apella). Anim Cogn. 2009;12(1):97–105.
29. Evans TA, Beran MJ, Harris EH, Rice DF. Quantity judgments of sequentially presented food items by capuchin monkeys (Cebus apella). Anim Cogn. 2009;12(1):97–105.
30. Judge PG, Evans TA, Vyas DK. Ordinal representation of numeric quantities by brown capuchin monkeys (Cebus apella). J Exp Psychol Anim Behav Process. 2005;31(1):79–94.
31. VanMarle K, Aw J, McCrink K, Santos LR. How capuchin monkeys (Cebus apella) quantify objects and substances. J Comp Psychol. 2006;120(4):416–26.
32. Ossi K, Kamilar JM. Environmental and phylogenetic correlates of Eulemur behavior and ecology (Primates: Lemuridae). Behav Ecol Sociobiol. 2006;61(1):53–64.
33. Smith BR, Piel AK, Candland DK. Numerity of a socially housed hamadryas

baboon (Papio hamadryas) and a socially housed squirrel monkey (Saimiri sciureus). J Comp Psychol. 2003;117(2):217–25.
34. Barnard AM, Hughes KD, Gerhardt RR, DiVincenti L, Bovee JM, Cantlon JF. Inherently analog quantity representations in olive baboons (Papio anubis). Front Psychol. 2013;4(MAY):1–11.
35. Nunn CL. Spleen size, disease risk, and sexual selection: A comparative study in primates. Evol Ecol Res. 2002;4(1):91–107.
36. Banerjee K, Chabris CF, Johnson VE, Lee JJ, Tsao F, Hauser MD. General intelligence in another primate: Individual differences across cognitive task performance in a new world monkey (Saguinus oedipus). PLoS One. 2009;4(6):e5883.
37. Stevens JR, Wood JN, Hauser MD. When quantity trumps number: discrimination experiments in cotton-top tamarins (Saguinus oedipus) and common marmosets (Callithrix jacchus). Anim Cogn. 2007;10(4):429–37.
38. Fleagle JG. Primate Adaptation and Evolution. 3rd ed. New York: Academic Press; 2013.
39. Cox L, Tamara Montrose V. Quantity discrimination in domestic rats, Rattus norvegicus. Animals. 2016;6(8).
40. Crile G, Quiring DP. A record of the body weight and certain organ and gland weight of 3734 animals. Appendix. G Crile, Intell Power Personal. 1941;40(5):?-?
41. Herculano-Houzel S, Mota B, Lent R. How to build a bigger brain: Cellular scaling rules for rodent brains. Proc Natl Acad Sci. 2006;103(32):12138–43.
42. Schweinfurth MK. The social life of Norway rats (Rattus norvegicus). Elife. 2020;9:e54020.
43. Henselek Y, Fischer J, Schloegl C. Does the stimulus type influence horses' performance in a quantity discrimination task? Front Psychol. 2012;3(NOV):1–8.
44. Baker JM, Shivik J, Jordan KE. Tracking of food quantity by coyotes (Canis latrans). Behav Processes. 2011;88(2):72–5.
45. Mahamane S, Grunig KL, Baker J, Young JK, Jordan KE. Memory-based quantity discrimination in coyotes (Canis latrans). Anim Behav Cogn. 2014;1(3):341.
46. Gittleman JL. Carnivore brain size, behavioral ecology, and phylogeny. J Mammal. 1986;67(1):23–36.
47. Atwood TC. The influence of habitat patch attributes on coyote group size and interaction in a fragmented landscape. Can J Zool. 2006;84(1):80–7.
48. Utrata E, Virányi Z, Range F. Quantity discrimination in wolves (canis lupus). Front Psychol. 2012;3(NOV):1–9.
49. Kittle AM, Anderson M, Avgar T, Baker JA, Brown GS, Hagens J, et al. Wolves adapt territory size, not pack size to local habitat quality. J Anim Ecol [Internet]. 2015 Sep 1;84(5):1177–86. Available from: https://doi.org/10.1111/1365-2656.12366
50. Baker JM, Morath J, Rodzon KS, Jordan KE. A shared system of representation governing quantity discrimination in canids. Front Psychol. 2012;3(October):1–6.
51. Range F, Jenikejew J, Schröder I, Virányi Z. Difference in quantity discrimination in dogs and wolves. Front Psychol. 2014;5(November):1299.
52. Jardim-Messeder D, Lambert K, Noctor S, Pestana FM, de Castro Leal ME, Bertelsen MF, et al. Dogs have the most neurons, though not the largest brain:

Trade-Off between body mass and number of neurons in the cerebral cortex of large carnivoran species. Front Neuroanat. 2017;11.

53. Bánszegi O, Urrutia A, Szenczi P, Hudson R. More or less: spontaneous quantity discrimination in the domestic cat. Anim Cogn. 2016;19(5):879–88.
54. Vonk J, Beran MJ. Bears “count” too: Quantity estimation and comparison in black bears (Ursus americanus). Anim Behav. 2012;84(1):231–8.
55. Larivière S. Ursus americanus. Mamm Species. 2001;647:1–11.
56. Perdue BM, Talbot CF, Stone AM, Beran MJ. Putting the elephant back in the herd: elephant relative quantity judgments match those of other species. Anim Cogn. 2012;15(5):955–61.
57. Shoshani J, Kupsky WJ, Marchant GH. Elephant brain Part I: Gross morphology, functions, comparative anatomy, and evolution. Brain Res Bull. 2006;70(2):124–57.
58. Herculano-Houzel S, Avelino-de-Souza K, Neves K, Porfírio J, Messeder D, Mattos Feijó L, et al. The elephant brain in numbers. Front Neuroanat. 2014;8(June):1–9.
59. Archie EA, Morrison TA, Foley CAH, Moss CJ, Alberts SC. Dominance rank relationships among wild female African elephants, Loxodonta africana. Anim Behav [Internet]. 2006;71(1):117–27. Available from: https://www.sciencedirect.com/science/article/pii/S000334720500312X
60. Irie-Sugimoto N, Kobayashi T, Sato T, Hasegawa T. Relative quantity judgment by Asian elephants (Elephas maximus). Anim Cogn. 2009;12(1):193–9.
61. Htet N, Chaiyarat R, Thongthip, N, Anuracpreeda, P Youngpoy, N Chompoopong P. Population and distribution of wild Asian elephants (Elephas maximus) in Phu Khieo Wildlife Sanctuary, Thailand. PeerJ [Internet]. 2021;9:e11896. Available from: https://doi.org/10.7717/peerj.11896
62. Abramson JZ, Hernández-Lloreda V, Call J, Colmenares F. Relative quantity judgments in South American sea lions (Otaria flavescens). Anim Cogn. 2011;14(5):695–706.
63. Perrin WF, Wursig B, Thewissen JGM, editors. Encyclopedia of marine mammals. New York: Academic Press; 2009.
64. Campagna C. The breeding cycle of the Southern sea lion, Otaria byronia. Mar Mammal Sci [Internet]. 1985 Jul 1;1(3):210–8. Available from: https://doi.org/10.1111/j.1748-7692.1985.tb00010.x
65. Jaakkola K, Fellner W, Erb L, Rodriguez M, Guarino E. Understanding of the concept of numerically “less” by bottlenose dolphins (Tursiops truncatus). J Comp Psychol. 2005;119(3):296–303.
66. Kilian A, Yaman S, von Fersen L, Güntürkün O. A bottlenose dolphin discriminates visual stimuli differing in numerosity. Learn Behav. 2003;31(2):133–42.
67. Yaman S, Kilian A, von Fersen L, Güntürkün O. Evidence for a numerosity category that is based on abstract qualities of “few” vs. “many” in the bottlenose dolphin (Tursiops truncatus). Front Psychol. 2012;3(November):473.
68. Montgomery SH, Geisler JH, McGowen MR, Fox C, Marino L, Gatesy J. The evolutionary history of cetacean brain and body size. Evolution (N Y). 2013;67(11):3339–53.

69. Tardin RH, Maciel IS, Maricato G, Simão SM, Maria TF, Alves MAS. Occurrence, residency patterns and habitat use of the bottlenose dolphin, Tursiops truncatus truncatus, on two Marine Protected Areas in Southeastern Brazil. An Acad Bras Cienc. 2020;92(2):e20180843.
70. Abramson JZ, Hernández-Lloreda V, Call J, Colmenares F. Relative quantity judgments in the beluga whale (Delphinapterus leucas) and the bottlenose dolphin (Tursiops truncatus). Behav Processes. 2013;96:11–9.
71. O'Corry-Crowe G, Suydam R, Quakenbush L, Smith TG, Lydersen C, Kovacs KM, et al. Group structure and kinship in beluga whale societies. Sci Rep [Internet]. 2020;10(1):11462. Available from: https://doi.org/10.1038/s41598-020-67314-w
72. Tornick JK, Callahan ES, Gibson BM. An investigation of quantity discrimination in Clark's nutcrackers (Nucifraga columbiana). J Comp Psychol. 2015;129(1):17–25.
73. Mlíkovský J. Brain size and foramen magnum area in crows and allies (Aves: Corvidae). Acta Soc Zool Bohemoslov. 2003;67:203–11.
74. Clayton NS, Emery NJ. The social life of corvids. Curr Biol. 2007;17(16):R652.
75. Ditz HM, Nieder A. Neurons selective to the number of visual items in the corvid songbird endbrain. Pnas. 2015;2015(25):1–6.
76. Mlíkovský J. Brain size in birds: 4. Passeriformes. Vol. 54, Acta Societatis Zoologicae Bohemoslovacae. 1990. p. 27–37.
77. Ujfalussy DJ, Miklósi A, Bugnyar T, Kotrschal K. Role of mental representations in quantity judgments by jackdaws (Corvus monedula). J Comp Psychol. 2014;128(1):11–20.
78. Olkowicz S, Kocourek M, Lučan RK, Porteš M, Fitch WT, Herculano-Houzel S, et al. Birds have primate-like numbers of neurons in the forebrain. Proc Natl Acad Sci. 2016;113(26):7255–60.
79. Garland A, Low J, Burns KC. Large quantity discrimination by North Island robins (Petroica longipes). Anim Cogn. 2012;15(6):1129–40.
80. Aïn S Al, Giret N, Grand M, Kreutzer M, Bovet D. The discrimination of discrete and continuous amounts in African grey parrots (Psittacus erithacus). Anim Cogn. 2009;12(1):145–54.
81. Møller AP, Erritzøe J, Garamszegi LZ. Covariation between brain size and immunity in birds: Implications for brain size evolution. J Evol Biol. 2005;18(1):223–37.
82. Amuno JB, Massa R, Dranzoa C. Abundance, movements and habitat use by African Grey Parrots (Psittacus erithacus) in Budongo and Mabira forest reserves, Uganda. Ostrich [Internet]. 2007 Jun 1;78(2):225–31. Available from: https://doi.org/10.2989/OSTRICH.2007.78.2.17.97
83. Scarf D, Hayne H, Colombo M. Pigeons on par with primates in numerical competence. Science (80-). 2011;334(6063):1664.
84. Phelan JP. Some components of flocking behavior in the rock dove (Columba livia). J F Ornithol [Internet]. 1987 Oct 21;58(2):135–43. Available from: http://www.jstor.org/stable/4513211