

Agility course times: A statistical comparison of heights and their speeds

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Introduction

This analysis is based on data extracted from K9 Entries (<https://www.k9entries.com/>), for both Victorian and Queensland Agility competitions from 2016 to 2018. Thanks to Alison Muddle for extracting the data and to Judy Kloeden for initial analyses. There are almost 18,000 individual entries in this analysis.

All of the data analyses were conducted in R Statistical Software and compiled using R Markdown in the R Studio package. Note that where there was more than one entry per dog, entries were averaged for the analysis. In addition, speeds faster than 10 m/s and slower than .8 m/s were cropped from the analysis to reduce the effect of outliers. Pariwise comparisons are corrected with the Tukey method, which is fairly conservative.

Results for Novice Agility

Overall, there was a strongly significant difference between rates of travel for the different heights, $F(4, 594) = 25.98$, $p < .001$. The 500 height dogs were significantly faster than all the other heights, all p-values $< .01$, corrected (see tables below for estimated marginal means and details).

Table 1: Overall results for ROT by height, Novice Agility - ANOVA table

	num Df	den Df	MSE	F	ges	Pr(>F)
Height	4	594	0.5922	25.9814	0.1489	0

Table 2: Estimated marginal means for ROT by height, Novice Agility

Height	emmean	SE	df	lower.CL	upper.CL
200	2.5613	0.1382	594	2.2898	2.8327
300	2.7693	0.0744	594	2.6232	2.9154
400	3.1474	0.0926	594	2.9655	3.3294
500	3.5066	0.0448	594	3.4186	3.5946
600	3.0847	0.0781	594	2.9313	3.2382

Table 3: Pairwise comparisons for ROT by height, Novice Agility

contrast	estimate	SE	df	t.ratio	p.value
200 - 300	-0.2081	0.1570	594	-1.3257	0.6753
200 - 400	-0.5862	0.1664	594	-3.5231	0.0042
200 - 500	-0.9453	0.1453	594	-6.5064	0.0000
200 - 600	-0.5235	0.1588	594	-3.2971	0.0091
300 - 400	-0.3781	0.1188	594	-3.1824	0.0133
300 - 500	-0.7373	0.0868	594	-8.4894	0.0000
300 - 600	-0.3154	0.1079	594	-2.9234	0.0295
400 - 500	-0.3591	0.1029	594	-3.4900	0.0047
400 - 600	0.0627	0.1212	594	0.5175	0.9856
500 - 600	0.4219	0.0901	594	4.6837	0.0000

Plot of Novice Agility ROT by height

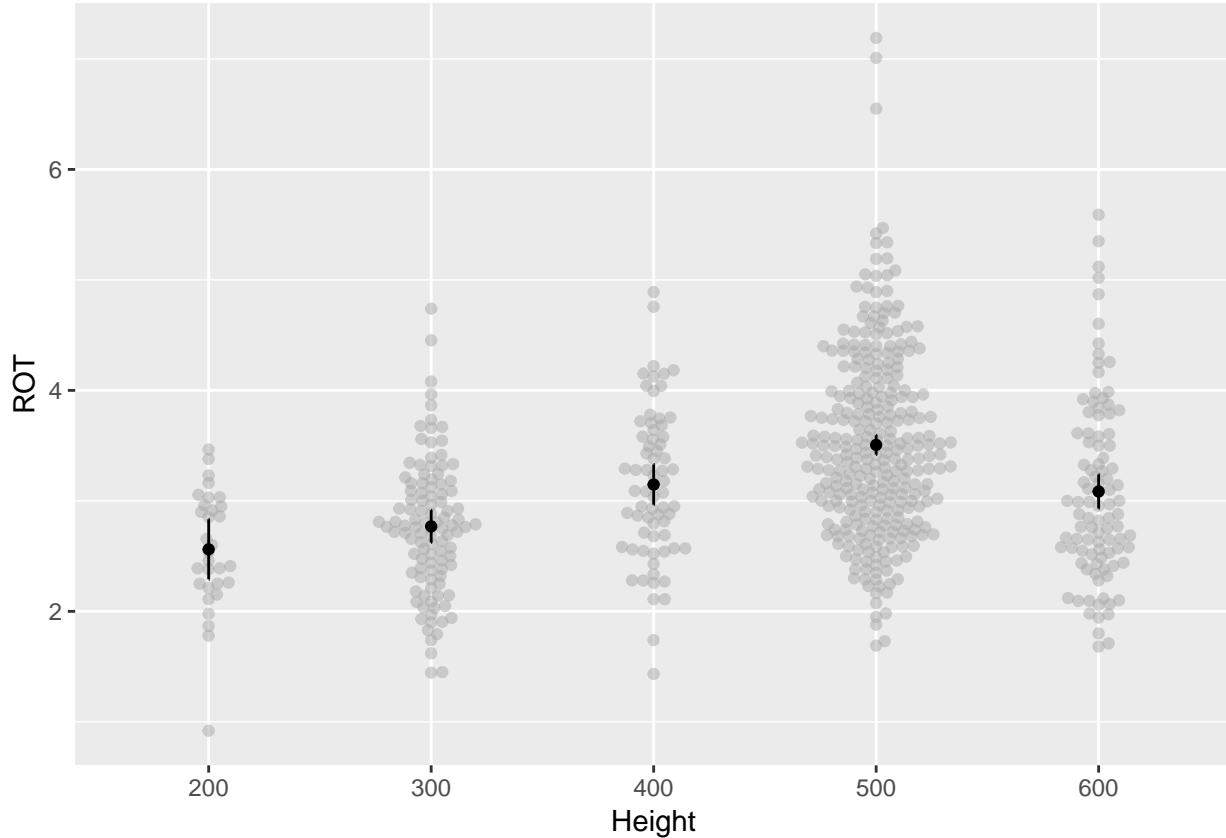


Table 4: Overall results for ROT by height, Excellent Agility - ANOVA table

	num Df	den Df	MSE	F	ges	Pr(>F)
Height	4	346	0.5173	11.0779	0.1135	0

Table 5: Estimated marginal means for ROT by height, Excellent Agility

Height	emmean	SE	df	lower.CL	upper.CL
200	2.6870	0.1650	346	2.3625	3.0115
300	3.0459	0.0961	346	2.8569	3.2350
400	3.3862	0.1137	346	3.1625	3.6099
500	3.5851	0.0533	346	3.4802	3.6899
600	3.4038	0.0979	346	3.2113	3.5963

Results for Excellent Agility

Overall, there was a strongly significant difference between rates of travel for the different heights, $F(4,346) = 11.08$, $p < .001$. The 500 height dogs were significantly faster than 300 and 200 but not 400 and 600 dogs, with p-values $< .01$, corrected (see tables below for estimated marginal means and details).

Table 6: Pairwise comparisons for ROT by height, Excellent Agility

contrast	estimate	SE	df	t.ratio	p.value
200 - 300	-0.3589	0.1909	346	-1.8796	0.3303
200 - 400	-0.6992	0.2004	346	-3.4891	0.0049
200 - 500	-0.8980	0.1734	346	-5.1791	0.0000
200 - 600	-0.7168	0.1918	346	-3.7363	0.0020
300 - 400	-0.3403	0.1489	346	-2.2854	0.1521
300 - 500	-0.5391	0.1099	346	-4.9055	0.0000
300 - 600	-0.3579	0.1372	346	-2.6089	0.0709
400 - 500	-0.1989	0.1256	346	-1.5834	0.5090
400 - 600	-0.0176	0.1500	346	-0.1173	1.0000
500 - 600	0.1813	0.1114	346	1.6265	0.4815

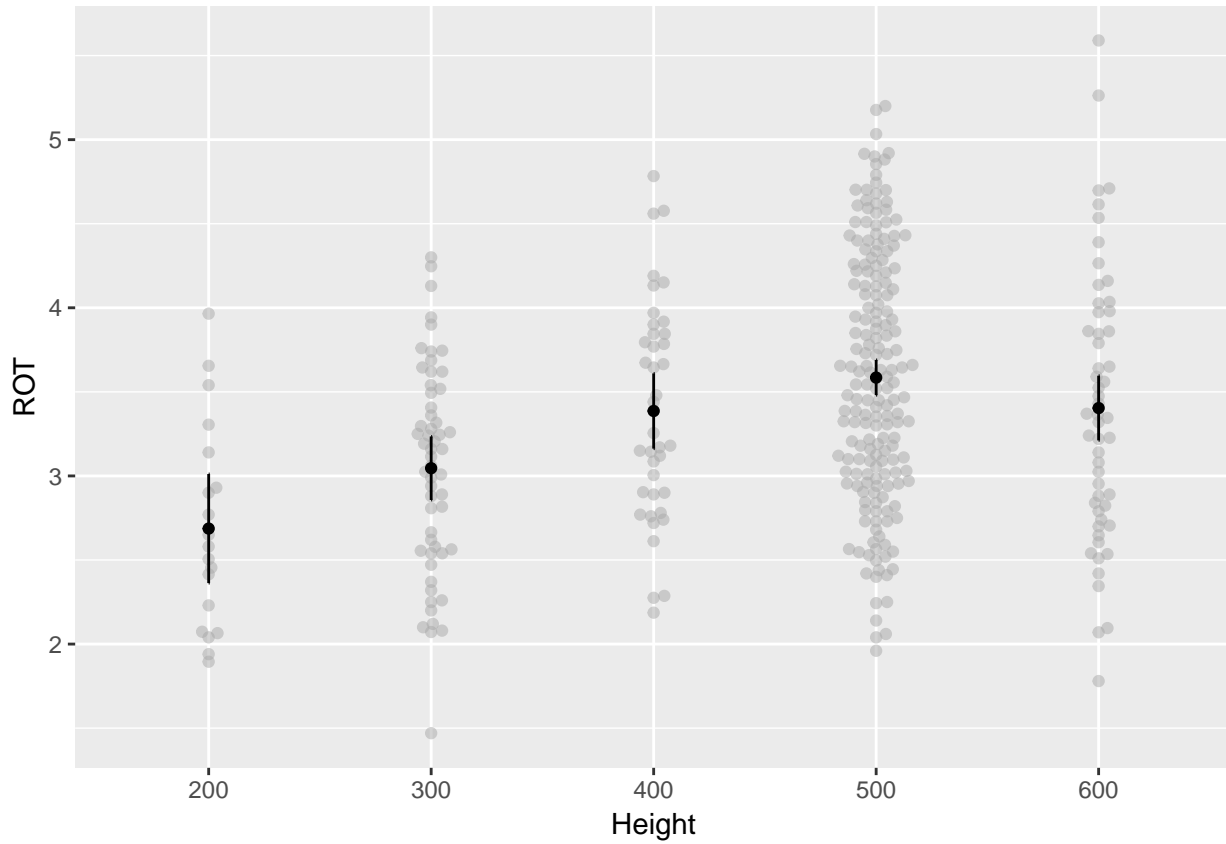
Table 7: Overall results for ROT by height, Masters Agility - ANOVA table

	num Df	den Df	MSE	F	ges	Pr(>F)
Height	4	407	0.4522	23.4262	0.1871	0

Table 8: Estimated marginal means for ROT by height, Masters Agility

Height	emmean	SE	df	lower.CL	upper.CL
200	3.1782	0.1319	407	2.9189	3.4374
300	3.1921	0.0810	407	3.0329	3.3512
400	3.4474	0.0971	407	3.2565	3.6382
500	3.9537	0.0452	407	3.8647	4.0426
600	3.6075	0.0971	407	3.4167	3.7983

Plot of Excellent Agility ROT by height



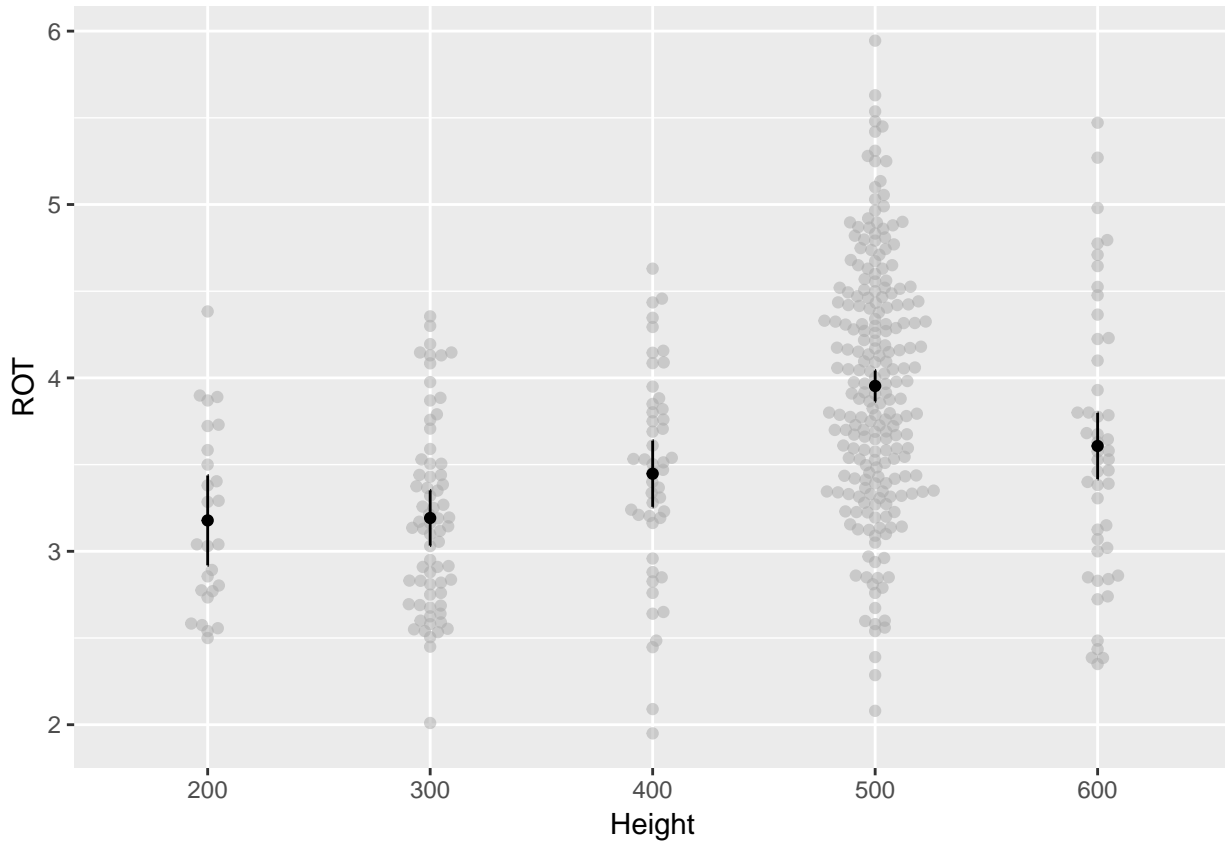
Results for Masters Agility

Overall, there was a strongly significant difference between rates of travel for the different heights, $F(4,407) = 23.43$, $p < .001$. The 500 height dogs were significantly faster than all other heights, with p-values $< .001$, except for the difference between 500 and 600 ($p = .011$), corrected (see tables below for estimated marginal means and details).

Table 9: Pairwise comparisons for ROT by height, Excellent Agility

contrast	estimate	SE	df	t.ratio	p.value
200 - 300	-0.0139	0.1547	407	-0.0899	1.0000
200 - 400	-0.2692	0.1637	407	-1.6438	0.4702
200 - 500	-0.7755	0.1394	407	-5.5622	0.0000
200 - 600	-0.4293	0.1637	407	-2.6218	0.0683
300 - 400	-0.2553	0.1264	407	-2.0196	0.2584
300 - 500	-0.7616	0.0927	407	-8.2124	0.0000
300 - 600	-0.4154	0.1264	407	-3.2867	0.0097
400 - 500	-0.5063	0.1071	407	-4.7282	0.0000
400 - 600	-0.1601	0.1373	407	-1.1667	0.7704
500 - 600	0.3462	0.1071	407	3.2327	0.0115

Plot of Masters Agility ROT by height



Results for Open Agility

Overall, there was a strongly significant difference between rates of travel for the different heights, $F(4,392) = 14.68$, $p < .001$. The 500 height dogs were significantly faster than all other dogs, with p-values $< .01$, corrected (see tables below for estimated marginal means and details).

Table 10: Overall results for ROT by height, Open Agility - ANOVA table

	num Df	den Df	MSE	F	ges	Pr(>F)
Height	4	392	0.6929	14.6787	0.1303	0

Table 11: Estimated marginal means for ROT by height, Open Agility

Height	emmean	SE	df	lower.CL	upper.CL
200	2.8281	0.2019	392	2.4312	3.2250
300	3.2549	0.1241	392	3.0110	3.4989
400	3.4758	0.1300	392	3.2202	3.7314
500	3.9551	0.0530	392	3.8509	4.0592
600	3.5490	0.1214	392	3.3103	3.7877

Table 12: Pairwise comparisons for ROT by height, Excellent Agility

contrast	estimate	SE	df	t.ratio	p.value
200 - 300	-0.4268	0.2370	392	-1.8010	0.3744
200 - 400	-0.6477	0.2401	392	-2.6973	0.0561
200 - 500	-1.1270	0.2087	392	-5.3992	0.0000
200 - 600	-0.7209	0.2356	392	-3.0599	0.0199
300 - 400	-0.2209	0.1797	392	-1.2290	0.7344
300 - 500	-0.7002	0.1349	392	-5.1893	0.0000
300 - 600	-0.2941	0.1736	392	-1.6938	0.4389
400 - 500	-0.4793	0.1404	392	-3.4141	0.0063
400 - 600	-0.0732	0.1779	392	-0.4115	0.9940
500 - 600	0.4061	0.1325	392	3.0654	0.0196

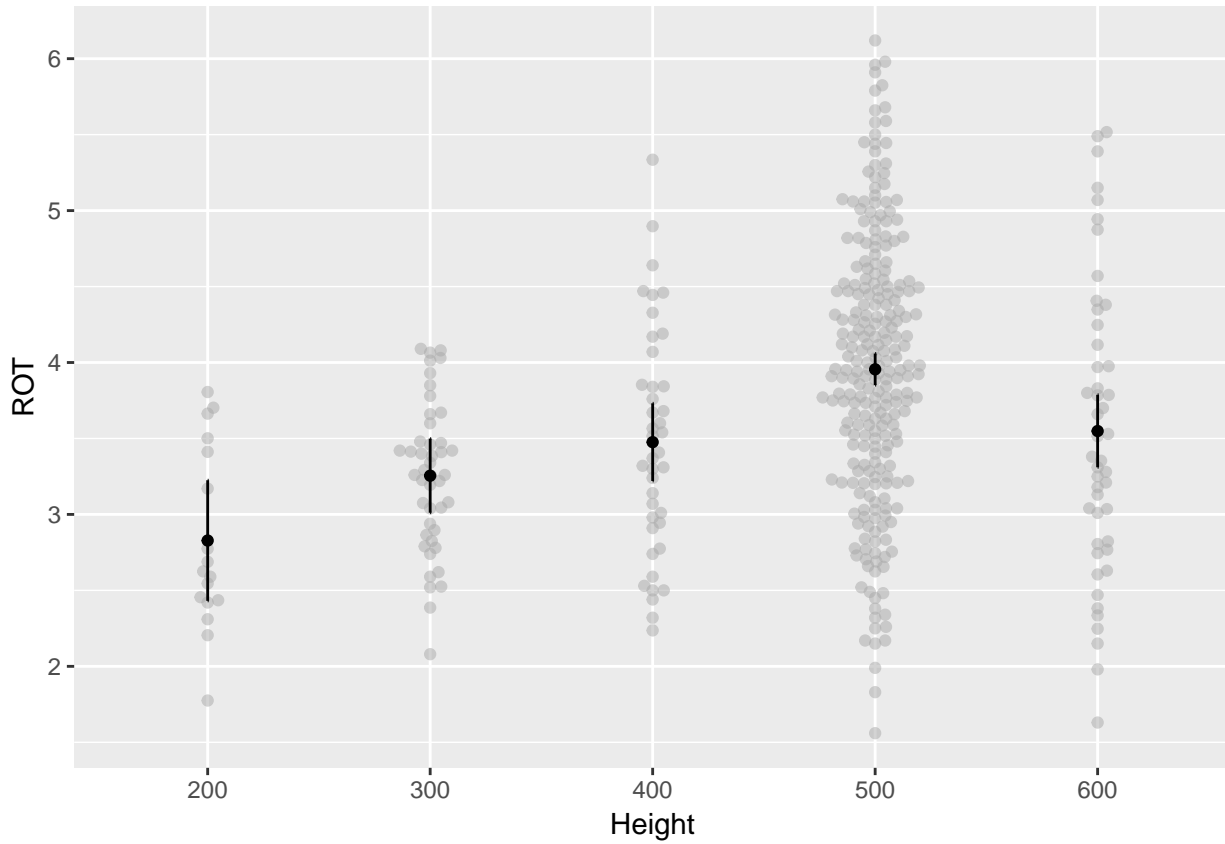
Table 13: Overall results for ROT by height, Novice Agility - ANOVA table

	num Df	den Df	MSE	F	ges	Pr(>F)
Height	4	619	1.0544	41.1608	0.2101	0

Table 14: Estimated marginal means for ROT by height, Novice Agility

Height	emmean	SE	df	lower.CL	upper.CL
200	3.1824	0.1644	619	2.8595	3.5053
300	3.5644	0.1032	619	3.3617	3.7671
400	4.1355	0.1141	619	3.9115	4.3596
500	4.7522	0.0586	619	4.6371	4.8673
600	4.0367	0.1037	619	3.8330	4.2404

Plot of Open Agility ROT by height



Jumping Results

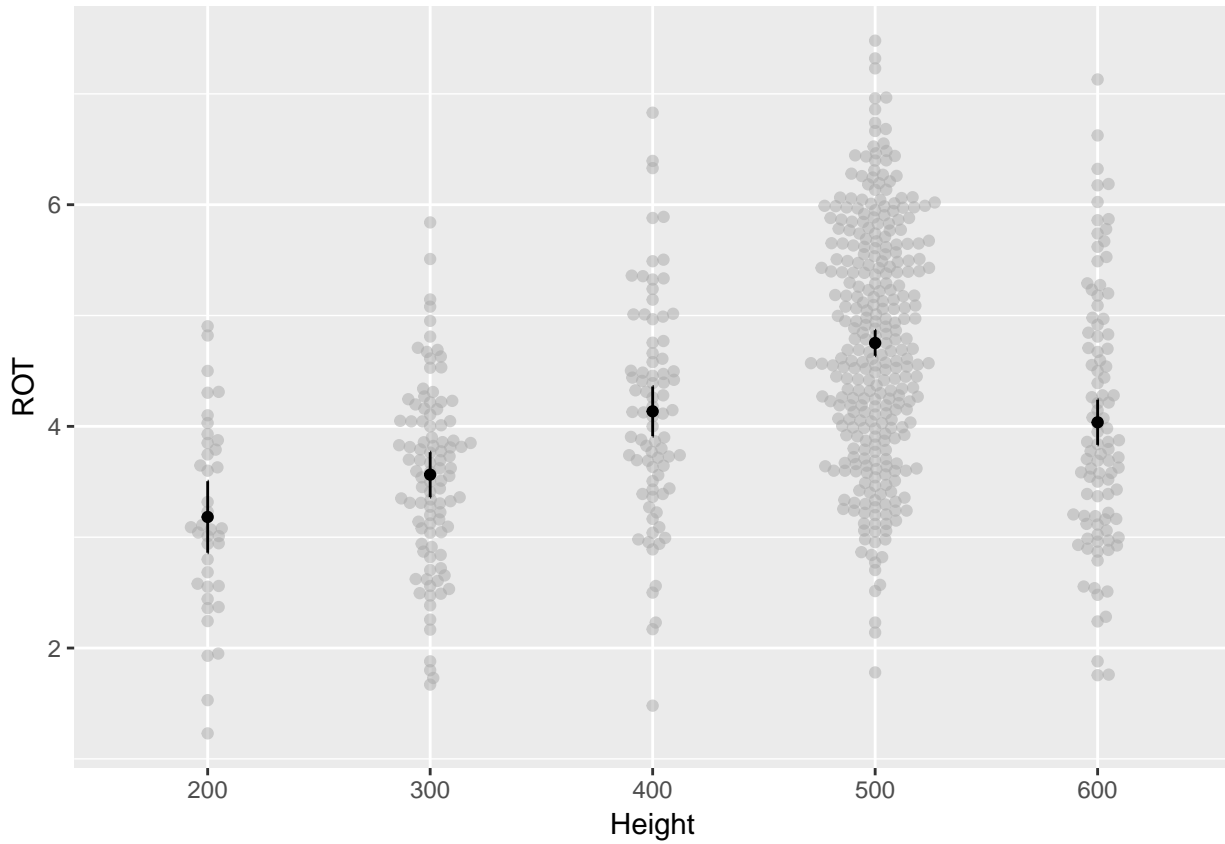
Results for Novice Jumping

Overall, there was a strongly significant difference between rates of travel for the different heights, $F(4,619) = 41.16$, $p < .001$. The 500 height dogs were significantly faster than all the other heights, all p-values $< .001$, corrected (see tables below for estimated marginal means and details).

Table 15: Pairwise comparisons for ROT by height, Novice Agility

contrast	estimate	SE	df	t.ratio	p.value
200 - 300	-0.3820	0.1941	619	-1.9675	0.2832
200 - 400	-0.9531	0.2001	619	-4.7623	0.0000
200 - 500	-1.5698	0.1746	619	-8.9929	0.0000
200 - 600	-0.8543	0.1944	619	-4.3942	0.0001
300 - 400	-0.5712	0.1538	619	-3.7125	0.0021
300 - 500	-1.1878	0.1187	619	-10.0087	0.0000
300 - 600	-0.4723	0.1463	619	-3.2280	0.0114
400 - 500	-0.6167	0.1283	619	-4.8079	0.0000
400 - 600	0.0988	0.1542	619	0.6409	0.9683
500 - 600	0.7155	0.1191	619	6.0057	0.0000

Plot of Novice Jumping ROT by height



Results for Excellent Jumping

Overall, there was a strongly significant difference between rates of travel for the different heights, $F(4,495) = 22.87$, $p < .001$. The 500 height dogs were significantly faster than all other dogs, with p-values $< .01$, corrected (see tables below for estimated marginal means and details).

Table 16: Overall results for ROT by height, Excellent Jumping - ANOVA table

	num Df	den Df	MSE	F	ges	Pr(>F)
Height	4	495	0.8172	22.8652	0.156	0

Table 17: Estimated marginal means for ROT by height, Excellent Jumping

Height	emmean	SE	df	lower.CL	upper.CL
200	3.2651	0.1598	495	2.9511	3.5790
300	3.6653	0.0986	495	3.4715	3.8591
400	4.0013	0.1167	495	3.7721	4.2306
500	4.4821	0.0580	495	4.3682	4.5960
600	3.9922	0.1004	495	3.7948	4.1895

Table 18: Pairwise comparisons for ROT by height, Excellent Jumping

contrast	estimate	SE	df	t.ratio	p.value
200 - 300	-0.4002	0.1878	495	-2.1314	0.2084
200 - 400	-0.7363	0.1979	495	-3.7209	0.0021
200 - 500	-1.2171	0.1700	495	-7.1592	0.0000
200 - 600	-0.7271	0.1887	495	-3.8523	0.0012
300 - 400	-0.3360	0.1528	495	-2.1993	0.1816
300 - 500	-0.8168	0.1144	495	-7.1389	0.0000
300 - 600	-0.3269	0.1408	495	-2.3219	0.1396
400 - 500	-0.4808	0.1303	495	-3.6892	0.0023
400 - 600	0.0092	0.1540	495	0.0597	1.0000
500 - 600	0.4900	0.1160	495	4.2244	0.0003

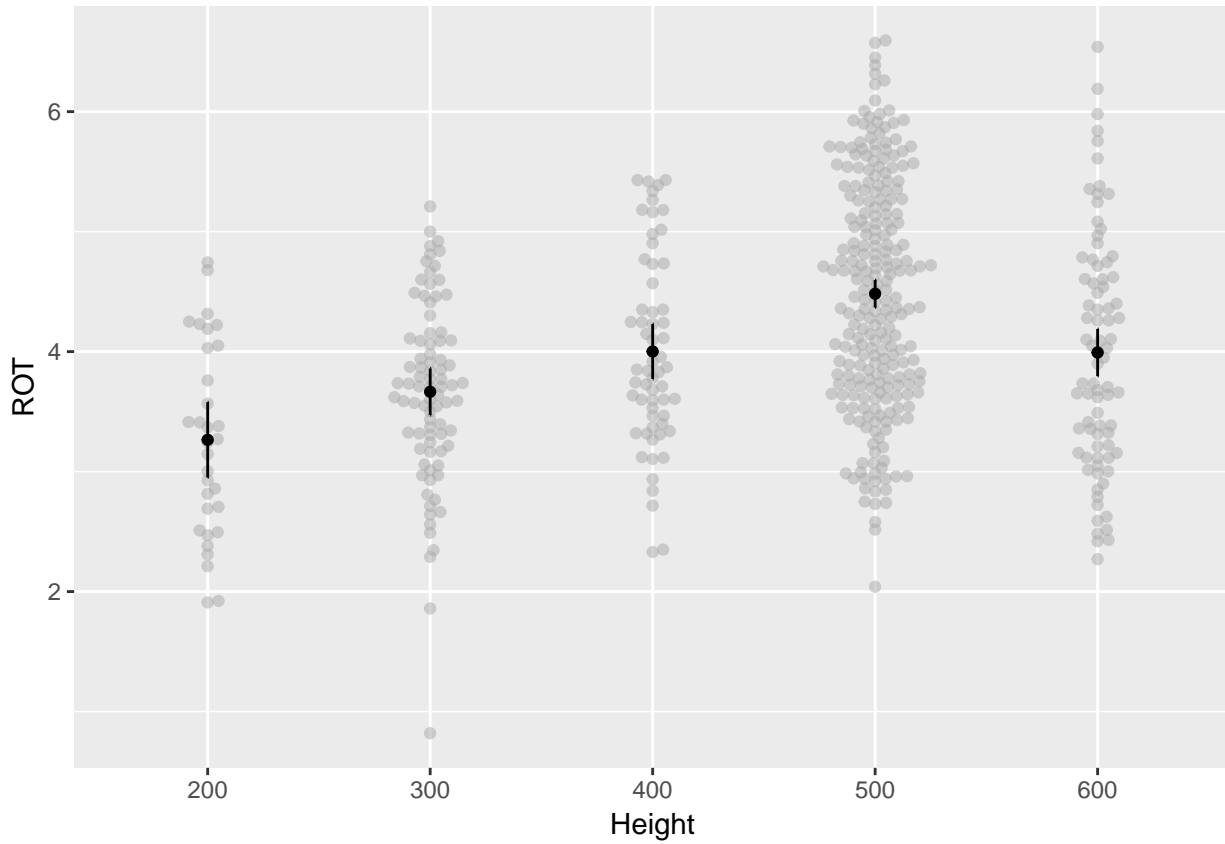
Table 19: Overall results for ROT by height, Masters Agility - ANOVA table

	num Df	den Df	MSE	F	ges	Pr(>F)
Height	4	608	0.6615	30.4158	0.1667	0

Table 20: Estimated marginal means for ROT by height, Masters Agility

Height	emmean	SE	df	lower.CL	upper.CL
200	3.1782	0.1319	407	2.9189	3.4374
300	3.1921	0.0810	407	3.0329	3.3512
400	3.4474	0.0971	407	3.2565	3.6382
500	3.9537	0.0452	407	3.8647	4.0426
600	3.6075	0.0971	407	3.4167	3.7983

Plot of Excellent Jumping ROT by height



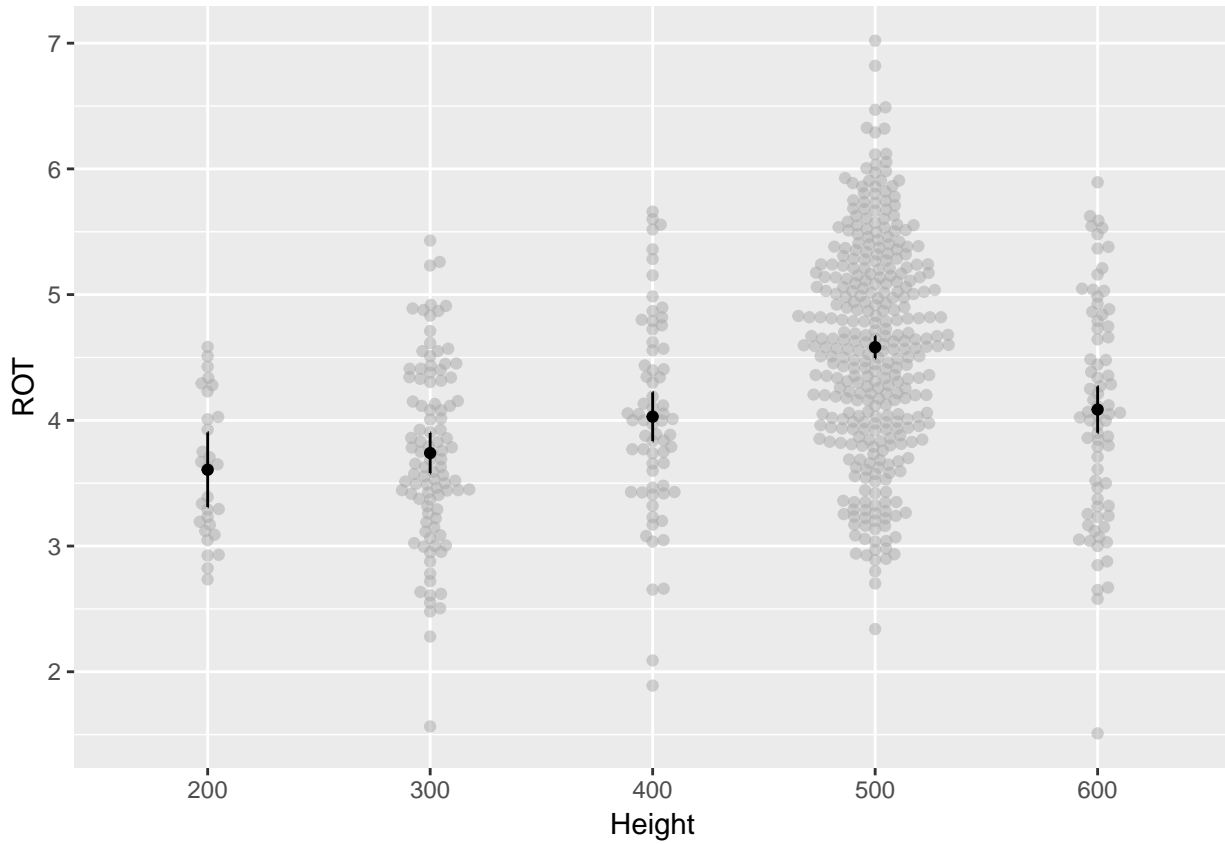
Results for Masters Jumping

Overall, there was a strongly significant difference between rates of travel for the different heights, $F(4,608) = 30.42$, $p < .001$. The 500 height dogs were significantly faster than all other heights, with p-values $< .001$, corrected (see tables below for estimated marginal means and details).

Table 21: Pairwise comparisons for ROT by height, Excellent Agility

contrast	estimate	SE	df	t.ratio	p.value
200 - 300	-0.1329	0.1715	608	-0.7746	0.9379
200 - 400	-0.4219	0.1804	608	-2.3392	0.1340
200 - 500	-0.9748	0.1573	608	-6.1964	0.0000
200 - 600	-0.4788	0.1778	608	-2.6923	0.0562
300 - 400	-0.2891	0.1278	608	-2.2613	0.1591
300 - 500	-0.8419	0.0925	608	-9.1030	0.0000
300 - 600	-0.3459	0.1242	608	-2.7846	0.0437
400 - 500	-0.5529	0.1080	608	-5.1184	0.0000
400 - 600	-0.0569	0.1362	608	-0.4176	0.9936
500 - 600	0.4960	0.1037	608	4.7817	0.0000

Plot of Masters Jumping ROT by height



Results for Open Jumping

Overall, there was a strongly significant difference between rates of travel for the different heights, $F(4,552) = 19.28$, $p < .001$. The 500 height dogs were significantly faster than all other dogs, with p-values $< .001$, corrected, for 200 and 300 dogs, $p = .032$ for 400 dogs and $p = .006$ for 600 dogs (see tables below for estimated marginal means and details).

Table 22: Overall results for ROT by height, Open Agility - ANOVA table

	num Df	den Df	MSE	F	ges	Pr(>F)
Height	4	552	0.9311	19.2803	0.1226	0

Table 23: Estimated marginal means for ROT by height, Open Agility

Height	emmean	SE	df	lower.CL	upper.CL
200	3.2240	0.2274	552	2.7772	3.6708
300	3.6872	0.1197	552	3.4521	3.9223
400	4.1781	0.1246	552	3.9334	4.4228
500	4.5692	0.0526	552	4.4658	4.6726
600	4.1564	0.1093	552	3.9418	4.3710

Table 24: Pairwise comparisons for ROT by height, Excellent Agility

contrast	estimate	SE	df	t.ratio	p.value
200 - 300	-0.4632	0.2570	552	-1.8024	0.3732
200 - 400	-0.9541	0.2593	552	-3.6791	0.0024
200 - 500	-1.3452	0.2335	552	-5.7623	0.0000
200 - 600	-0.9324	0.2523	552	-3.6953	0.0022
300 - 400	-0.4908	0.1728	552	-2.8413	0.0374
300 - 500	-0.8820	0.1308	552	-6.7456	0.0000
300 - 600	-0.4692	0.1621	552	-2.8952	0.0321
400 - 500	-0.3911	0.1352	552	-2.8923	0.0323
400 - 600	0.0217	0.1657	552	0.1307	0.9999
500 - 600	0.4128	0.1213	552	3.4038	0.0064

Plot of Open Jumping ROT by height

