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R code used to fit nonlinear asymptotic growth models, estimate cranial capacities for given Taung starting ages, and increase Taung juvenile cranial capacity estimates to generate adult estimates:

```
# Plot the data:
# For xlim, change 2nd number to max age +2 (to make it look
# nice). For ylim, set to a value above the maximum ECV value
# in the dataset. Currently configured for gorillas.
plot(data, xlab = "age", ylab = "ECV", xaxs = "i", yaxs = "i",
    xlim = c(-2, 42),
    ylim = c(0, 600), main = "ECV during ontogeny" # or whatever else you
    want the title to be

# Fit an initial curve:
xfit <- seq(min(-5), max(data$age) * 1.1, length.out = 100)

# Self-starting standard asymptotic regression model (with a vertical offset):
print(getInitial(ECV ~ SSasymp(age, Asym, R0, lrc), data = data))
nlsfit1 <- nls(ECV ~ SSasymp(age, Asym, R0, lrc), data = data)
summary(nlsfit1)
coef(nlsfit1)
logLik(nlsfit1)
yfit <- predict(nlsfit1, list(age = xfit))
lines(xfit, yfit, col = "blue", lty = 3, lwd = 3)

# Here is code to read x for a given value of y. To use this,
# you could either input a value, or input a value times a
# percentage, as demonstrated below for 90%:
# Use the model to predict the expected age value for a particular ECV
```

```r
given.ECV <- (404*0.9)
coefs <- coef(nlsfit1)
pred.age <- -log((given.ECV - coefs[1]) / (coefs[2] - coefs[1])) / exp(coefs[3])
print(pred.age)

# Code to add a vertical line at a particular age:
abline(v=pred.age) # Add vertical line

# Automate the above function:
# Set starting ages for Taung adult estimates:
Taung.age <- c(3.73, 3.83, 3.93, 3.3, 3.5, 4.0, 4.5, 5.0,
        5.5, 6.0, 6.5, 7.0, 15)
Taung.cc <- c(404, 404, 404, 404, 404, 404, 404, 404, 404, 404, 404, 404, 404)

# Predict cranial capacity at starting age:
given.age <- Taung.age
pred.ECV <- predict(nlsfit1, list(age = given.age))
pred.ECV <- pred.ECV[1:length(Taung.age)]
pred.ECV

# Calculate % changes and estimate Taung adult values:
Taung.percent_changes <- (pred.ECV[13]-pred.ECV)/pred.ECV
Taung.adult.values <- (Taung.cc * Taung.percent_changes)+Taung.cc

# Wrap the above up as a dataset:
a <- cbind(Taung.age, Taung.percent_changes, Taung.adult.values)
print(a)


# For more information about SSasymp, see Pinheiro and Bates[1].
```

Table 1: Adult cranial capacity estimates (cm^3) for different juvenile cranial capacities at a starting age of 3.83 years

Starting value (cm^3)	Gorilla[2]		Chimp[3.4]		Human2[5]		Range of estimates
	M	F	M	F	M	F	
382[6]	382	391	384	383	405	401	382–405
402[7]	402	411	404	403	426	421	402–426
404[7]	404	413	406	405	428	424	404–428
405[7]	405	414	407	406	429	425	405–429
407[7]	407	416	409	408	432	427	407–432
410[7]	410	419	412	411	435	430	410–435
450[8]	450	460	452	451	477	472	450–477
452	452	462	454	453	479	474	452–479
494[Table 1]	494	505	496	495	524	518	494–524
500[9]	500	511	502	501	530	524	500–530
520[10]	520	532	522	521	551	545	520–551

Table 2: Growth percentages and adult cranial capacity estimates for a juvenile starting cranial capacity of 404 cm^3 estimated using combined-sex growth models at different starting ages

Starting age (years)	Gorilla[2]		Chimpanzee[3,4]		Human2[5]	
	%	Estimate (cm^3)	%	Estimate (cm^3)	%	Estimate (cm^3)
3.3[11-13]	3.7034	419	0.5360	406	8.7341	439
3.5[14,15]	3.1874	417	0.4019	406	7.5577	435
4.0[16,17]	2.1966	413	0.1960	405	5.2954	425
4.5[18]	1.5184	410	0.0956	404	3.7338	419
5.0[18,19]	1.0517	408	0.0467	404	2.6443	415
5.5[18,19]	0.7295	407	0.0228	404	1.8784	412
6.0[18,19]	0.5065	406	0.0111	404	1.3373	409
6.5[18,19]	0.3519	405	0.0054	404	0.9535	408
7.0[18,19]	0.2446	405	0.0027	404	0.6806	407

Table 3: Means, standard deviations (s.d.), ranges, and coefficients of variation (CV) for historical estimates of *A. africanus* cranial capacity with differing values for Taung included in the fossil sample

Study	Year	Taung estimate	*n*	Mean	s.d.	Range	CV (%)[a]
Schepers	1946[20]	500/520[b,21]	3	505.0	63.84	85	12.6
Broom and Robinson	1948[22]	600+	5[c]	549.0	82.90	185	15.1
Ashton	1950[23]	500[b,24]	6	529.2	72.28	215	13.7
Schepers	1950[25]	650	6	528.3	70.83	200	13.4
Tobias	1963[26]	600	6	504.0	56.25	165	11.2
Tobias	1965[27]	562	7	502.0	47.00[d]	127	9.4
Robinson	1966[28]	?	6	430.0	–	250[e]	–
Tobias	1967[29], 1991[30]	562	6	497.8	44.14	127	8.9
Holloway	1970[31]	440	6	442.0	21.59	57	4.9
Tobias	1971[32]	540	6	494.2	38.26	105	7.7
Holloway	1973[33], 1983[34,35], 1996[36]	440	7[f]	450.3	29.48	72	6.6
Falk	1987[37]	412	5	440.0	31.51	73	7.2
Conroy et al.; Tobias	1990[38], 1994[39]	440	6	440.3	22.60	60	5.1
Conroy et al.	1998[40]	440	7	440.3	35.00	90	7.8
Lockwood and Kimbel	1998[41]	440	7	464.6	62.89	172	13.5
Conroy et al.	2000[42]	431[g]	7	449.7	35.59	90	7.9
Conroy et al.	2000[42]	422[h]	7	448.4	36.53	93	8.1
Conroy et al.	2000[42]	455[i]	7	453.1	34.63	90	7.6
Falk et al.	2000[43]	440	7	451.0	34.96	90	7.8
Holloway et al.	2004[44]	440	9	460.7	47.93	155	10.4
Holloway et al.; Holloway	2008[45], 2009[46]	440	9	462.3	49.18[j]	160	10.7[j]
Carlson et al.	2011[47]	440[k]	8	459.4	37.70	90	8.2
Neubauer et al.	2012[48]	428	6	452.3	63.29	177	14.0
Schoenemann	2013[49]	461	9	461.2	49.18	160	10.7
Beaudet et al.	2019[24]	431	5	457.0	36.91	94	8.1
This study	2020	405–406	10	445.8	60.36	205	13.5
This study (-Sts 25)	2020	405–406	9	454.9	56.10	177[l]	12.3
This study (most complete crania)	2020	405–406	6	448.6	65.64	177[l]	14.6

[a] *CV values recalculated from original data when available without correction for small sample sizes (in order to maintain strict comparability between values)*

[b] *Did not attempt adult estimate*

[c] *Included an estimate for cranial capacity from Sts 7, a mandible*

[d] *Calculated estimate of population standard deviation*

[e] *Calculated as 2.5x the standard deviation; raw data not available for recalculation*

[f] *Including MLD 1 in A. africanus, which Holloway considered to be indeterminate taxonomically*

[g] *405 cm^3 increased to approximate 94% growth completion based on chimpanzee combined-sex growth curve*

[h] *405 cm^3 increased to approximate 94% growth completion based on chimpanzee female growth curve*

[i] *405 cm^3 increased to approximate 94% growth completion based on chimpanzee male growth curve*

[j] *Not presented in original papers–reconstructed from individual values for fossil endocasts*

[k] *Carlson et al.[47] note an adult value of 406 cm^3 for Taung in the text, but recalculation based on the specimens listed and their sources indicate that they used a value of 440 cm^3 for Taung.*

[l] *Smallest and largest cranial capacity values are both from Neubauer et al.[48]*

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