

Forensic analysis of Lucy I and Lucy II

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Abstract

A quantitative test for the probability that two sets of photos are of the same woman. The result for 7 facial characteristics in each photo is that the odds are 13 million to 1 that Lucy I and Lucy II are the same person.

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Although facial recognition has advanced rapidly with technology, standard statistical methods are still often effective in achieving low tech solutions.

A case history will be analyzed as to whether photo sets, Lucy I and Lucy II, represent the same woman at different ages. The fundamental assumption to be statistically tested is that

Lucy I = Lucy II, the null hypothesis.

The facial features of nine pix of Lucy prior to 1960 (Lucy I) will be analyzed versus five of Lucy post 1960 (Lucy II) by using the means and errors of seven facial dimensions. The t test is relevant here, since the means and standard deviations are measured and the distributions are normal.

Statistical method of choice - the t test

What is computed by the t test is the statistical probability P that the photos are of the same woman, but only differ in individual measurements by reasonable random errors. The more photos are tested, the greater likelihood of a correct interpretation.

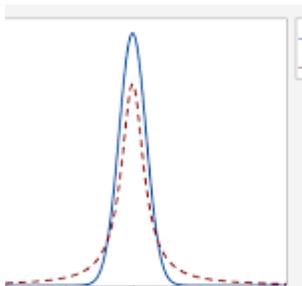


Fig 1 P => 1

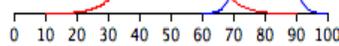


Fig 2 P => 0

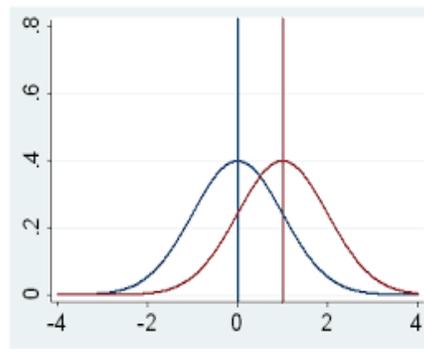


Fig 3 0 < P < 1

When two sample sets have the same mean, as in Fig 1, the probability P is virtual certainty $P \sim 1$. If the means are separated so the curves barely overlap, as at 70 in Fig 2, $P \sim 0$. So the t statistical method computes the amount of overlap in general, for any two sets of means and variances(Fig 3 - area between vertical blue and red lines). This overlapping area provides a quantitative measure of the probability P that the two sample sets are from the same population.

The data presented below is documented at <https://sisterlucytruth.org/animeetrics-report/>. Here is provided the analytical details of determining P.

Selected facial lengths using common landmarks

Code	Feature
a	Nose length
b	Philtrum1
c	Philtrum 2
d	Chin length
e	Eye width
f	Nose width
g	Mouth width

The philtrum is the distance from nose to lip line, either the nose tip(Philtrum1) or between nostrils(Philtrum 2)

Lucy I Data Analysis

Nine photos of Lucy I



Lucy I

Photo # => Code v	1	2	3	4	5	7	8	11	12	Mean and error
a	44.0	41.6	43.3	44.5	47.1	42.3	40.3	40.5	42.7	43.3 +- 4%
b	31.8	38.0	36.6	39.1	36.9	40.1	35.7	35.8	36.3	36.9 +- 4%
c	21.1	24.0	22.1	24.4	24.2	23.0	21.7	22.3	22.7	22.9 +-4%
d	36.3	38.5	32.8	40.4	42.2	38.4	34.9	33.0	33.6	37.6 +-8%
e	36.6	36.4	35.6	35.9	36.1	36.0	35.1	36.2	36.1	36.0 +-1%
f	36.3	34.3	34.6	34.9	34.1	34.2	32.4	32.4	34.6	34.4 +- 1%
g	46.8	46.8	49.2	49.6	49.0	46.0	46.5	43.8	48.7	47.7 +- 3%

Table of Lucy I facial lengths

Each photo represents different magnification of the facial features, as different cameras and distances were used. But the feature ratio for pairs of measurements is independent of the magnification; within each photo all features have the same m.

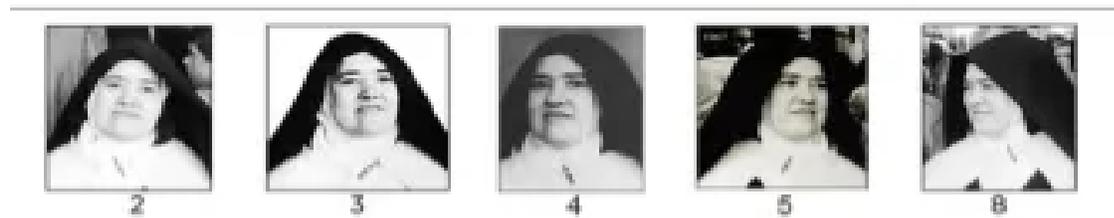
Also, there are only six independent ratios of the seven features, like those below, since all other ratios can be determined from just these six. For example, $b/c = \text{Philtrum 1}/\text{Philtrum 2} = (a/c)/(a/b) = (\text{nose length}/\text{philtrum 2})/(\text{nose length}/\text{philtrum 1})$

Ratio	1	2	3	4	5	7	8	11	12	Mean,Error
a/b	1.4	1.1	1.2	1.2	1.3	1.1	1.1	1.1	1.2	1.18 +-.097
a/c	2.1	1.7	2.0	1.8	1.9	1.8	1.9	1.8	1.9	1.88 +-.088
a/d	1.2	1.1	1.3	1.1	1.1	1.1	1.2	1.2	1.3	1.18 +-.046
a/e	1.2	1.1	1.2	1.2	1.3	1.2	1.1	1.1	1.2	1.18 +-.036
a/f	1.2	1.2	1.3	1.3	1.4	1.2	1.2	1.3	1.2	1.26 +-.062
a/g	.94	.89	.88	.90	.96	.92	.87	.92	.88	.907 +-.031

Table of Lucy I facial length ratios

Lucy II Data Analysis

5 photos of Lucy II



Lucy II

Code	2	3	4	5	8	Mean
a	38.2	37.4	40.8	43.1	41.5	40.2
b	32.9	34.6	33.5	36.1	35.5	34.5
c	18.9	20.3	20.4	22.3	22.3	20.8
d	32.5	36.0	34.8	37.4	36.4	35.4
e	35.4	36.5	36.2	36.0	35.0	36.0
f	34.1	33.8	34.0	33.2	33.7	33.8
g	48.3	48.1	47.3	47.1	49.8	48.1

Table of Lucy II facial lengths

Ratio	2	3	4	5	8	Mean and Error
a/b	1.2	1.1	1.2	1.2	1.2	1.18 +- .022
a/c	2.0	1.8	2.0	1.9	1.9	1.92 +- .082
a/d	1.2	1.0	1.2	1.2	1.1	1.14 +-072
a/e	1.1	1.0	1.1	1.2	1.1	1.10 +- .040
a/f	1.1	1.1	1.2	1.3	1.2	1.18 +- .095
a/g	.79	.78	.86	.92	.83	.836 +- .042

Table of Lucy II facial length ratios

The probability that the two sets of photo analysis represent the same woman based on the *t* statistic can be processed with software, such as at :

https://www.medcalc.org/calc/comparison_of_means.php

	Lucy I	Lucy II		
	Mean + StdDev	Mean + StdDev	Mean Difference	Prob that I = II
a/b	1.18 +- .097	1.18 +- .022	0	1
a/c	1.88 +- .088	1.92 +- .082	.04	.42
a/d	1.18 +- .046	1.14 +-072	.04	.08
a/e	1.18 +- .036	1.10 +- .040	.08	.0024
a/f	1.26 +- .062	1.18 +- .095	.08	.08
a/g	.907 +- .031	.836 +- .042	.07	.003
			Total Prob: Product =	3 x 10⁻⁸ = 0.00000003

Tabular computation of total probability that I = II

The probability of all 6 independent facial length ratios occurring is the product of each probability, times the standard error of this estimate.... $\sqrt{n} = \sqrt{6} = 2.5$

So the best estimate for the likelihood that Lucy I = Lucy II is:

$$2.5 * 3 \times 10^{-8} = 7.5 * 10^{-8} = 1/(13 * 10^6) = 1/13 \text{ million}$$

Summary

All ratio measurements are computed by the t test and then converted to probability estimates in the last column above.

We see that the mean a/b ratio of nose length to philtrum 1 is identical for Lucy I and II; the probability is 1. Were this the only comparison, the conclusion would be that the same woman was photographed. The ratio of nose length to eye width, a/e, is the least likely match of the photo set and also the most recognizable of the face.

Conclusion

**The result corresponds to about 1 chance in 13,000,000
or getting 24 consecutive heads for true coin flips....**

that all the photos had the same subject.

Lucy I <> Lucy II ... 13 million to 1 !