

Is Greta Right- or Left-handed?

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Abstract

Most adults and older children have a dominant hand with which they can perform most tasks more proficiently. Very young children are usually ambidextrous, but develop a dominant hand as they grow older. Greta is a nine month old baby girl. Based on an observational study in which she ate Cheerios with the opportunity to use both hands, Greta currently uses her right hand to eat Cheerios 37% of the time (a 95% confidence interval is 0.25 to 0.49). At eight months, she used her right hand 52% of the time (a 95% confidence interval is 0.39 to 0.65). The observed difference in proportions is not statistically significant (two-sided p-value from a z test is 0.10). The observed data is consistent with the assumptions of a binomial setting. Greta has not yet shown signs of which hand will ultimately be dominant.

Introduction

Greta Larget is a nine month old baby girl, and is the third of my three children. Greta will eventually develop a dominant hand, but informal observation seems to indicate that she uses both hands about equal amounts of time. Most children begin to develop a dominant hand around age one, but there are exceptions (Spock and Rothenberg 1992, page 305).

The population proportion of right-handedness is about 90%, but it also tends to run in families (Spock and Rothenberg 1992, page 305). My wife and I are both right-handed as are my two older children. Our extended family is predominately right-handed, although two family members are left-handed (my brother and my wife's mother). The proportion of right-handers among Greta's closest relatives is close to 90%. On this basis, one might expect that there is about a 90% chance that Greta will eventually be right-handed.

The purpose of this paper is to see if Greta has exhibited a preference for one hand at age 9 months and to see if her handedness has changed since she was 8 months old. To examine this question, I observed Greta eating Cheerios over a period of several days and noted which hand she used to pick up a Cheerio off her highchair tray to feed herself.

Methods

Greta eats several handfuls of Cheerios each day as part of her breakfast. She sits in a highchair with a large plastic tray. At the beginning of a meal in which I was observing which hand Greta used to eat, I placed a single Cheerio in the center of her tray where she could easily reach it with either hand and noted which hand she used to pick up the Cheerio. I repeated this until she had picked up ten Cheerios on each day and then let her continue to eat her breakfast normally. I observed Greta on six consecutive days shortly after she turned eight months old and again for six consecutive days shortly after she turned nine months old. The number of times Greta used her right hand is displayed in Table 1.

Table 1: **Daily counts of the number of Cheerios out of ten which Greta picked up with her right hand at two different ages.**

Day	1	2	3	4	5	6
Age 8 months	6	2	4	6	7	6
Age 9 months	3	3	3	5	5	3

To justify the use of textbook formulae for confidence intervals and hypothesis tests for proportions and differences in proportions, we should check that the data is consistent with the binomial setting. One could imagine that Greta might tend to use the same hand several times in a row before switching to the other, which would invalidate the assumption of independence between trials.

To test this, I divided each observation period into two parts of five Cheerios each. There were a total of 24 counts which could be modeled by a binomial distribution with $n = 5$, assuming that her handedness did not change from age eight to nine months and that each time she picked up a Cheerio, she used a hand independently of what she had used before. Table 2 shows the observed

and expected counts. Outcomes at each end of the distribution have been grouped together so that the chi-square test is appropriate.

Table 2: **Combined counts of the number of Cheerios out of five which Greta picked up with her right hand in 24 time periods.** The expected counts are 24 times the binomial probabilities with $n = 5$ and $p = 0.417$, the overall proportion of time Greta used her right hand.

Count	0 or 1	2	3	4 or 5
Observed	6	7	9	2
Expected	6.5	8.1	6.4	3.0

The chi-square test statistic,

$$\chi^2 = \sum \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

(Brase and Brase 1997, page 537) is 1.51 and has 2 degrees of freedom (4 cells - one estimated parameter - 1, Rice 1995, page 313). The p-value from a table is more than 0.1 (Brase and Brase 1997 page A9). Statistical software gives the p-value as 0.47 (S-PLUS 2000). The data appears to fit a binomial distribution, so it may be reasonable to model the sequence of observations of which hand Greta uses to pick up a Cheerio as independent. We note, however, that there could be dependencies between trials that this test would not detect because of the small sample size.

Results and Discussion

At age 9 months, Greta used her right hand only about 37% of the time. A 95% confidence interval for the proportion of time she uses her right hand at age nine months is

$$\frac{19}{60} \pm 1.96 \sqrt{\frac{(19/60)(41/60)}{60}}$$

or from 0.25 to 0.49 (Brase and Brase 1997, page 377). At age 8 months, Greta used her right hand about 52% of the time (a 95% confidence interval is from 39 to 65 percent). The observed change of 15%, however, can be explained by sample randomness,

$$z = \frac{(19/60) - (31/60)}{\sqrt{\frac{(50/120)(70/120)}{60} + \frac{(50/120)(70/120)}{60}}} = -1.65$$

with a two-sided p-value = 0.099 (Brase and Brase 1997, page 498).

At this stage in her development, Greta is still using both hands with fairly high frequency. Although she used her left hand more than her right hand in the study, it is not at all certain that she will eventually become left-handed. Spock and Rothenberg report the following summary of scientific opinion on the development of handedness (1992, page 305). Scientists believe that handedness is an inborn trait that will sooner or later become evident. Some children show an early preference for one hand that seems permanent while others may use one hand predominantly for many months before switching. Greta appears to be in the group of children who do not show a strong preference for either hand at an early age. I wait with interest to see how Greta's inborn handedness will emerge in the coming months.

References

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Appendix

The complete data is displayed here, with 0 and 1 representing use of the left and right hand, respectively.

Eight months										
Day one	0	1	1	0	1	0	0	1	1	1
Day two	0	0	0	0	0	1	0	1	0	0
Day three	1	0	0	1	0	0	0	1	0	1
Day four	1	0	0	0	0	1	1	1	1	1
Day five	0	0	1	1	1	1	1	0	1	1
Day six	1	0	1	1	0	1	1	0	0	1

Nine months										
Day one	1	0	0	0	0	1	0	1	0	0
Day two	1	0	1	0	1	0	0	0	0	0
Day three	0	0	1	0	0	1	0	0	1	0
Day four	1	1	0	1	0	1	0	0	0	1
Day five	1	1	0	0	0	0	0	1	1	1
Day six	0	0	0	0	0	0	1	1	1	0