

## McNemar Test

- ▶ McNemar's test is a statistical test used on paired nominal data.
- ▶ It is applied to  $2 \times 2$  contingency tables with a dichotomous trait, with matched pairs of subjects, to determine whether the row and column marginal frequencies are equal (that is, whether there is "marginal homogeneity").

# McNemar Test

- ▶ Binary Outcomes (Success and Failure)
- ▶ Before and After
- ▶ Is there is a significant difference between "Before" and "After" in terms of success rates

## McNemar Test

- ▶ The test is applied to a  $2 \times 2$  contingency table, which tabulates the outcomes of two tests on a sample of  $n$  subjects, as follows.

	Test 2 positive	Test 2 negative	Row total
Test 1 positive	$a$	$b$	$a + b$
Test 1 negative	$c$	$d$	$c + d$
Column total	$a + c$	$b + d$	$n$

## McNemar Test

- ▶ The null hypothesis of marginal homogeneity states that the two marginal probabilities for each outcome are the same, i.e.

$$p_a + p_b = p_a + p_c$$

and

$$p_c + p_d = p_b + p_d.$$

- ▶ Thus the null and alternative hypotheses are

$$H_0 : p_b = p_c \quad (1)$$

$$H_1 : p_b \neq p_c \quad (2)$$

# McNemar Test

- ▶ The McNemar test statistic is:

$$\chi^2 = \frac{(b - c)^2}{b + c}.$$

# McNemar Test

`mcnemar.test()`

- ▶ Agresti (1990), p. 350.
- ▶ Presidential Approval Ratings.
- ▶ Approval of the President's performance in office in two surveys, one month apart, for a random sample of 1600 voting-age Americans.

## McNemar Test

- ▶ In the first example, a researcher attempts to determine if a drug has an effect on a particular disease.
- ▶ Counts of individuals are given in the table, with the diagnosis (disease: present or absent) before treatment given in the rows, and the diagnosis after treatment in the columns.
- ▶ The test requires the same subjects to be included in the before-and-after measurements (matched pairs).

# McNemar Test

	<b>After: present</b>	<b>After: absent</b>	Row total
<b>Before: present</b>	101	121	222
<b>Before: absent</b>	59	33	92
Column total	160	154	314



## McNemar Test

- ▶ In this example, the null hypothesis of "marginal homogeneity" would mean there was no effect of the treatment.
- ▶ From the above data, the McNemar test statistic:

$$\chi^2 = \frac{(121 - 59)^2}{121 + 59}$$

has the value 21.35, which is extremely unlikely to form the distribution implied by the null hypothesis ( $P < 0.001$ ).

- ▶ Thus the test provides strong evidence to reject the null hypothesis of no treatment effect.

```
mcnemar.test()
```

```
Effect <-  
matrix(c(101,121,59,33),  
       nrow = 2,  
       dimnames = list(  
         "Before" = c("Present", "Absent"),  
         "After" = c("Present", "Absent")))
```