Chi-square for within-subjects: McNemar's test

For a binary dependent variable, there is a form of the chi-square test for within-subjects designs called McNemar's chi-square. As with the paired t-test or the within-subjects ANOVA, the McNemar test is used whenever the same individuals are measured (or surveyed) twice, matched on some variable (e.g., yoked by age), participants are paired in some way (e.g., twins or married couples), or responses on two measures are used (e.g., favorability toward gun control compared to favorability toward abolishing the second amendment).

For instance, we might examine the favorability of voters for gun control legislation in April and in June.

		June: No	June: Yes	
April	No	80	100	180
	Yes	10	110	120
		90	210	300

To compute McNemar's, the following formula is used:

$$McNemar's\ \chi^2 = \frac{(c-b)^2}{c+b}$$

c, b, and d come from labeling the cells in the table as below.

		June: No	June: Yes
April	No	a	b
	Yes	c	d

$$= \frac{(10-100)^2}{100+10}$$
$$= \frac{(90)^2}{110}$$
$$= 73.63$$

df in this test is 1, the critical value is 3.84 (from the chi-square table), and because calculated value of 73.63 exceeds this value, there is a significant difference in April and June responses.

For repeated variables with 3 or more options (e.g., yes, no, undecided), the Cochran's Q test, which I will not detail here, can be used.

SPSS Menus Steps for McNemar's test

1. Analyze→ Descriptive statistics → Crosstabs

2. Move over the two variables to the row and column boxes (I used rows for the pretest and columns for the posttest)

3. Click on Statistics and check McNemar, then click Continue.

4. Click on Cells and then check Row and Column under Percentages, then click Continue.

5. Click OK.

SPSS Output for McNemar's test

April Favor gun legislation in April * June Favor gun legislation in June Crosstabulation

			June Favor gun legislation in June		
			1 no	2 yes	Total
April Favor gun legislation in April	1 no	Count	80	100	180
		% within April Favor gun legislation in April	44.4%	55.6%	100.0%
		% within June Favor gun legislation in June	88.9%	47.6%	60.0%
	2 yes	Count	10	110	120
		% within April Favor gun legislation in April	8.3%	91.7%	100.0%
		% within June Favor gun legislation in June	11.1%	52.4%	40.0%
Total		Count	90	210	300
		% within April Favor gun legislation in April	30.0%	70.0%	100.0%
		% within June Favor gun legislation in June	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	Exact Sig. (2-sided)
McNemar Test		.000[a]
N of Valid Cases	300	

a. Binomial distribution used.

(Note that SPSS does not give the value of the McNemar chi-square, just its p-value (Exact Sig.). Also, in the repeated mesures case, it makes more sense to use the marginal total percentages rather than the percentages within particular cells.)

Example write-up. Voter favorability toward the gun control measure changed significantly over the two-month period ($p < .001$). Voters were more likely to favor the gun control legislation in June (70%) than in April (40%) when they were first polled.