Chapter 20—Nonparametric and Resampling Tests

20.1 Amygdala lesions and fear responses (Kapp, Frysinger, Gallagher, & Hazelton, 1979):

a) Analysis using the Mann-Whitney test:

Again we rank the data without regard to group and sum the ranks in each group.

Lesion	15	14	15	8	7	22	36	19	14	18	17
Rank	14.5	12.5	14.5	7	6	19	20	18	12.5	17	16
Control	9	4	9	10	6	6	4	5	9		
Rank	9	1.5	9	11	4.5	4.5	1.5	3	9		

The test run the traditional way

$Ws = 53 \qquad Ws' = 2\overline{W} - Ws = 189 - 53 = 136$

$W_{.025}(9,11) = 68 > 53$ $\;Ws < W's$ so use Ws in Appendix E. Double the probability level for a two-tailed test.

Using *R* for both the standard test and a randomization test. Code also covers Ex20.1 and 20.2

```
### Wilcoxon on Ex20.1 and Ex20.2
groups <- rep(c(1,2), c(11, 9) )
dv <- c(15, 14, 15, 8, 7, 22, 36, 19, 14, 18, 17, 9, 4, 9, 10, 6, 6, 4, 5, 9)
result1 <- wilcox.test(dv ~ groups, alternative = "two.sided")
result2 <- wilcox.test(dv ~ groups, alternative = "greater")
result3 <- wilcox.test(dv ~ groups, alternative = "less")
print("The Wilcoxon test produces \n")
print(result1)
print(result2)
print(result3)
dvr <- rank(dv)    #Rank the raw scores from low to high
W <- sum(dvr[groups == 2])       # This is the sum of the ranks in Group 2
cat(" Wilcoxon's W = ", W)
nreps = 10000
sums <- numeric(nreps)  #Place to store sums
for (i in 1:nreps) {
  temp <- sample(dvr, length(dv), replace = FALSE)
  sums[i] <- sum(temp[groups == 2])
}
```

```
prob <- 1 - (length(sums[sums >= W])/nreps)
cat("The probability of a value of W equal to the one that we obtained is =
\n",prob)
```

```
            Wilcoxon rank sum test with continuity correction
            Tw0-tailed test
      data:  dv by groups
      W = 91, p-value = 0.001782
      alternative hypothesis: true location shift is not equal to 0
```

b) Reject the null hypothesis and conclude that subjects in the Lesion group take longer to learn the task, as the theory predicted.

20.3 Hypothesis formation in psychiatric residents (Nurcombe & Fitzhenry-Coor, 1979):

Before	8	4	2	2	4	8	3	1	3	9
After	7	9	3	6	3	10	6	7	8	7
Diff.	-1	+5	+1	+4	-1	+2	+3	+6	+5	-2
Rank	2	8.5	2	7	2	4.5	6	10	8.5	4.5
Signed		8.5	2	7		4.5	6	10	8.5	
Rank	-2				-2					-4.5

Nonparametric Tests

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between Beforedv and After equals 0.	Related-Samples Wilcoxon Signed Rank Test	.052	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

b) We cannot conclude that we have evidence supporting the hypothesis that there is a reliable increase in hypothesis generation and testing over time. (Here is a case in which alternative methods of breaking ties could lead to different conclusions.)

Here you might discuss how we could go about deciding how to break ties, putting the emphasis on *a priori* decisions.

20.5 Independence of first-born children:

First	12	18	13	17	8	15	16	5	8	12
Second	10	12	15	13	9	12	13	8	10	8
Diff.	2	6	-2	4	-1	3	3	-3	-2	4
Rank	4	17.5	4	11	1	8	8	8	4	11
Signed	4	17.5		11		8	8			11
Rank			-4		-1			-8	-4	

Data Cont.:

First	13	5	14	20	19	17	2	5	15	18
Second	8	9	8	10	14	11	7	7	13	12
Diff.	5	-4	6	10	5	6	-5	-2	2	6
Rank	14	11	17.5	20	14	17.5	14	4	4	17.5
Signed	14		17.5	20	14	17.5			4	17.5
Rank		-11					-14	-4		

Hypothesis Test Summary

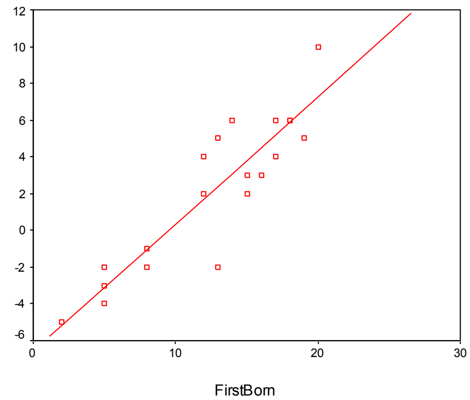
	Null Hypothesis	Test	Sig.	Decision
1	The median of differences between First and Second equals 0.	Related-Samples Wilcoxon Signed Rank Test	.027	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

b) We can reject the null hypothesis and conclude that first-born children are more independent than their second-born siblings.

Here is a good example of where we would use a “matched sample” test even though the same children do not perform in both conditions (nor could they). We are assuming that brothers and sisters are more similar to each other than they are to other children. Thus if the first-born is particularly independent, we would guess that the second-born has a higher than chance expectation of being more independent. They share a common environment.

20.7 Data in Exercise 20.7 plotted as a function of the first-born's score:



The scatterplot shows that the difference between the pairs is heavily dependent upon the score of the first-born.

20.9 The Wilcoxon matched-pairs signed-ranks test tests the null hypothesis that paired scores were drawn from identical populations or from symmetric populations with the same mean (and median). The corresponding *t* test tests the null hypothesis that the paired scores were drawn from populations with the same mean and assumes normality.

> This is an illustration of the argument that you buy things with assumptions. By making the more stringent assumptions of a *t* test, we buy greater specificity in our conclusions. However if those assumptions are false, we may have used an inappropriate test.

20.11 Rejection of the null hypothesis by a *t* test is a more specific statement than rejection using the appropriate distribution-free test because, by making assumptions about normality and homogeneity of variance, the *t* test refers specifically to population means—although it is also dependent on those assumptions.

of students among the three professors.

20.13   Truancy and home situation of delinquent adolescents:

Analysis using the Kruskall-Wallis one-way analysis of variance:

Natural Home		**Foster Home**		**Group Home**	
Score	Rank	Score	Rank	Score	Rank
15	18	16	19	10	9
18	22	14	16	13	13.5
19	24.5	20	26	14	16
14	16	22	27	11	10
5	4.5	19	24.5	7	6.5

8	8	5	4.5	3	2
12	11.5	17	20	4	3
13	13.5	18	22	18	22
7	6.5	12	11.5	2	1
R_i	124.5		170.5		83

$N = 27$
$n = 9$

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Days is the same across categories of Home.	Independent-Samples Kruskal-Wallis Test	.034	Reject the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

We can reject the null hypothesis and conclude the placement of these adolescents has an effect on truancy rates.

This analysis doesn't directly answer the question the psychologist wanted answered, because he wanted to show that the group home was better than the others. He might follow this up with Mann-Whitney tests serving in the role of multiple comparison procedures, applying a Bonferroni correction (although it might be difficult to find the necessary critical values.) Alternatively, he could just run a single Mann-Whitney between the group home and the combined data of the other two placements.

20.15 The study in Exercise 20.14 has the advantage over the one in Exercise 20.15 in that it eliminates the influence of individual differences (differences in overall level of truancy from one person to another).

20.17 One way to represent how effectively lesions to the amygdala interfere with fear responses is to report the percentage of lesioned animals who take longer to learn an avoidance task than any (or the median) control animal. In our case, the median number of trials to learn the avoidance was 6 trials for the control group. 100% of the lesioned group took more trials than this. Another way to represent the effect is to say that only 2 out of the 11 subjects in the lesioned group learned the task in fewer trials than the worst subject in the control group.

20.19 As a test of Bleuler’s (1911) hypothesis that schizophrenia relates to a lack of connections in cortical locations dealing with memory, Suddath et al. (1990) compared the volume of the left hippocampus in 15 schizophrenic individuals and their monozygotic twin brothers. For these cases, the normal twins differed from their schizophrenic twin by a mean of .199 units, with larger volumes favoring the normal twin. A randomization test on this difference showed a probability value of .0031 on the hypothesis that twins did not differ in hippocampal volume. This study strongly supports the hypothesis that hippocampal volume is related to schizophrenia.