Appendix II
Estimates of Significance (Games Compared)

ONE OF THE FIRST questions we asked at the beginning of our investigation concerned the relation between the payoffs of a Prisoner's Dilemma game and the associated pressures toward cooperation and defection. Such relations were found throughout to be in the expected direction, the most consistent relations being observed in sets of games differing with respect to only one payoff parameter. Thus our weakest hypothesis (Hypothesis 1) was by and large corroborated. Neither of the alternative strong hypotheses (H_3 and H_4) was consistently corroborated, therefore the question about the significance of observed differences in the frequency of cooperative choices observed in the several games must be raised. We wish to know what role the payoff structure plays in determining the value of C (as well as of several other variables), regardless of conditions under which the game is played and regardless of the population. We thus compare the values of these variables between all pairs of games and note the significance of the difference in each case.

Estimates of significance are shown in Table A.

We now rank order the games according to the magnitude of the observed values of the variables, ignoring differences which are not significant. The result is shown in Table B.

Now we apply the rank order correlation coefficient, comparing the observed rank order with those prescribed by our various hypotheses. The results are summarized in Table C.

TABLE A

Kolmogorov-Smirnov Two Sample Tests for thirteen of the variables. Roman numeral entries indicate significance at .01 level, the entry indicating the game in which the variable in question has the greater numerical value.

Games Compared

Variable	I II	I III	I IV	I V	I XI	I XII	II III	II IV	II V	II XI	II XII	III IV	III V	III XI	III XII	IV V	IV XI	IV XII	V XI	V XII	XI XII
CC	I	I	I	I	0	I	II	IV	II	XI	II	IV	III	XI	0	IV	XI	IV	XI	XII	XI
CD	II	0	IV	I	0	XII	II	0	II	II	0	IV	III	0	XII	IV	IV	0	XI	XII	XII
DC	II	0	IV	I	0	XII	II	0	II	II	0	IV	III	0	XII	IV	IV	0	0	XII	XII
DD	0	III	I	V	I	XII	III	II	V	II	XII	III	V	III	0	V	XI	XII	V	V	XII
C	I	I	I	I	0	I	II	IV	II	XI	II	IV	III	XI	0	IV	0	IV	XI	XII	XI
x	I	I	I	I	0	I	0	0	II	XI	II	IV	III	XI	III	IV	IV	IV	XI	XII	XI
y	I	I	I	I	0	I	II	0	II	XI	0	IV	III	XI	XII	IV	0	0	XI	XII	XI
z	0	I	IV	I	I	I	II	IV	II	0	II	IV	III	0	0	IV	IV	IV	XI	XII	0
w	II	I	IV	I	0	I	II	II	II	II	II	IV	III	XI	XII	IV	IV	IV	XI	XII	XI
ξ	I	I	I	I	0	I	0	IV	II	XI	II	IV	III	XI	III	IV	IV	IV	XI	XII	XI
η	I	I	I	I	0	I	II	IV	II	XI	II	IV	III	XI	III	IV	XI	IV	XI	XII	XI
ζ	II	I	IV	I	0	I	II	0	II	II	II	IV	III	XI	XII	IV	IV	IV	X	XII	XI
ω	II	I	IV	I	0	I	II	0	II	II	II	IV	III	XI	XII	IV	IV	IV	XI	XII	XI

TABLE B

Roman numerals indicate rank order of the games prescribed by the corresponding hypothesis except in the case of *DD* where the reverse order is prescribed. The entries indicate the actually observed rank order of the games with respect to each of the variables. Absence of differences significant on the .01 level are indicated by tied ranks.

Variable	H_{1a}			H_{1b}			H_{1c}			H_2		H_3							H_4						
	I	XI	III	IV	III	V	II	XII	III	IV	XI	I	IV	II	XI	XII	III	V	II	IV	I	XII	XI	III	V
CC	1.5	1.5	3	1	2	3	1	2.5	2.5	2	1	1.5	3	4	1.5	5.5	5.5	7	4	3	1.5	5.5	1.5	5.5	7
CD	2	2	2	1	2	3	1.5	1.5	3	1	2	5	2	2	5	2	5	7	2	2	5	2	5	5	7
DC	2	2	2	1	2	3	1.5	1.5	3	1	2	5	2	2	5	2	5	7	2	2	5	2	5	5	7
DD	2	3	1	3	2	1	3	1.5	1.5	2	1	4.5	7	4.5	6	2.5	2.5	1	4.5	7	4.5	2.5	6	2.5	1
C	1.5	1.5	3	1	2	3	1	2.5	2.5	1.5	1.5	2	2	4	2	5.5	5.5	7	4	2	2	5.5	2	5.5	7
x	1.5	1.5	3	1	2	3	1.5	3	1.5	2	1	1.5	3	4.5	1.5	6	4.5	7	4.5	3	1.5	6	1.5	4.5	7
y	1.5	1.5	3	1	2	3	1.5	1.5	3	1.5	1.5	1.5	4	4	1.5	4	6	7	4	4	1.5	4	1.5	6	7
z	1	2.5	2.5	1	2	3	1	2.5	2.5	1	2	2.5	1	2.5	5	5	5	7	2.5	1	2.5	5	5	5	7
w	1.5	1.5	3	1	2	3	1	2	3	1	2	3.5	2	1	3.5	5	6	7	1	2	3.5	5	3.5	6	7
ξ	1.5	1.5	3	1	2	3	1.5	3	1.5	1.5	1.5	2	2	4.5	2	6	4.5	7	4.5	2	2	6	2	4.5	7
η	1.5	1.5	3	1	2	3	1	3	2	2	1	1.5	3	4	1.5	6	5	7	4	3	1.5	6	1.5	5	7
ζ	1.5	1.5	3	1	2	3	1	2	3	1	2	3.5	1.5	1.5	3.5	5	6	7	1.5	1.5	3.5	5	3.5	6	7
ω	1.5	1.5	3	1	2	3	1	2	3	1	2	3.5	1.5	1.5	3.5	5	6	7	1.5	1.5	3.5	5	3.5	6	7

Notes:

H_{1a}: cooperation increases as R increases.
H_{1b}: cooperation decreases as T increases.
H_{1c}: cooperation increases as P decreases (being negative, becomes numerically smaller).

H_2 : $(\partial C/\partial r_1) > 0$
H_3: $(\partial C/\partial r_1) > 0$; $(\partial C/\partial r_2) > 0$
H_4: $(\partial C/\partial r_1) > 0$; $(\partial C/\partial r_2) < 0$

TABLE C

Kendall Rank Correlation Coefficient τ and associated a priori probability of observed rank order under the null hypothesis $p(H_0)$, i.e., where each game is assigned each of the relevant rank orders with equal probability.

Variable	H_{1a}	$p(H_0)$	H_{1b}	$p(H_0)$	H_{1c}	$p(H_0)$	H_2	$p(H_0)$	H_3	$p(H_0)$	H_4	$p(H_0)$
CC	.82	.154	1.00	.077	.82	.154	−1.00	.333	.73	.015	.34	.191
CD	0	.231	1.00	.077	.82	.154	1.00	.333	.39	.191	.73	.035
DC	0	.231	1.00	.077	.82	.154	1.00	.333	.39	.191	.73	.035
DD	.33	.154	1.00	.077	.82	.154	1.00	.333	.65	.035	.60	.068
C	.82	.154	1.00	.077	.82	.154	0	.333	.79	.015	.48	.119
x	.82	.154	1.00	.077	0	.231	−1.00	.333	.65	.035	.25	.281
y	.82	.154	1.00	.077	.82	.154	0	.333	.69	.035	.37	.191
z	.82	.154	1.00	.077	.82	.154	1.00	.333	.79	.015	.79	.015
w	.82	.154	1.00	.077	1.00	.077	1.00	.333	.69	.035	.88	.005
ξ	.82	.154	1.00	.077	0	.231	0	.333	.69	.035	.37	.191
η	.82	.154	1.00	.077	.33	.154	−1.00	.333	.69	.035	.29	.281
ζ	.82	.154	1.00	.077	1.00	.077	1.00	.333	.75	.015	.85	.005
ω	.82	.154	1.00	.077	1.00	.077	1.00	.333	.75	.015	.85	.005

From Table C we see that the only hypothesis perfectly corroborated by all variables is H_{1b}, which asserts that cooperation decreases as T increases. It should be kept in mind, however, that the numerical range of T (2 – 50) was greater than that of the other payoff parameters. We conjecture, further, that H_3 has somewhat of an edge over H_4, as has been guessed.

We see also that the variables which agree best with our strong hypotheses H_3 and H_4 are z, w, ζ, and ω, that is, the contingent probabilities of responding cooperatively following *noncooperation* (one's own or the other's). From this we conjecture that the nonpersistence of the defecting response is a more important symptom of the degree of cooperation than the persistence of the cooperative response reflected in CC, x, y, ξ, and η.