Alternative Tournament Formats

Three alternative tournament formats are described below. The selection of these formats is limited to those using the pairwise scoring, which was previously reported. Specifically, we consider (*i*) a round-robin tournament with three groups of five entries, (*ii*) a second round-robin tournament with five groups of three entries, and (*iii*) a four-stage, single-elimination match-up tournament.

Round-robin Tournament with Three Groups of Five Entries

This tournament format considered all combinations of the fifteen original strategies placed into three groups, each with five entries. With computer simulation we examined all $\frac{15!}{5!\,5!\,5!} =$ 756,756 tournament combinations. Using the tournament scores reported in Table 2 for each entry we compute the total points earned in the first-stage, round-robin competition with four other entries. The entry with the most points (ties broken randomly) in each group moves on to the second (final) stage where each of the three group winners competes to determine the overall winner. The number of times each entry won the first and second stage was computed over all possible tournament combinations. The results of this simulation, which are reported in Table 3 and discussed in the body of the manuscript, are not repeated here.

Round-robin Tournament with Five Groups of Three Entries

Using five groups, each with three entries results in $\frac{15!}{3!\,3!\,3!\,3!\,3!} = 168,168,000$ unique tournament combinations. Examining this many combinations is tedious, even with computer simulation. Thus, we elected to produce a random sample of 100,000 tournament combinations. Similar to the three groups of five tournament format described above, the entry with the most points in each group in the first stage moved on to the second and final stage. As before, ties are broken randomly. Table S1a below shows the program number, name, and number of times the program won the first and final rounds in this round-robin tournament. Consistent with the results reported in Table 3 for the round-robin tournament with three groups of five entries, T&C won

the most tournaments, posting wins in 24.3% of all tournament combinations. While the top eight entries from previous analyses remained in the top eight, there were differences in the percentage of wins and in the rank order of wins, compared to the results for the three groups of five tournament format. Additionally, there is less variance in the winning percentages among the top eight strategies. Both of these results are due to having more groups, each with a smaller number of entries in the first stage, that allows more of the top strategies to move on to the second and final stage.

Four-stage Match-up Tournament

The final format considered is a single-elimination, match-up tournament. In this tournament design each entry was paired with one other entry in stage one, where the winner of this stage moved on to stage two. This process continued, with each winner moving on to the next stage, until a final winner was determined in the fourth and final stage. Note that this format works best when the number of entries, n, is an integer determined by $n = 2^s$, where s is the number of stages. Because we began with only 15 (rather than 16) entries, we gave each entry a 1 in 15 chance of getting a first-stage "bye". Thus, the fifteen original entries were reduced to eight at the end of stage 1. This design results in over 81 billion different tournament combinations. Rather than examine all possible combinations, we produced a random sample of 100,000 unique tournament combinations. The results of this simulation are summarized in Table S1b. The first column shows the program number and the second column shows the program name. Subsequent columns list the number and percentage of wins in each of the four stages.

Notice that even a relatively weak entry, like RAN, posted a number of first-stage wins. This is due in part to the 1 in 15 chance of receiving a first-stage bye. The results from this match-up design are substantially different from the previous round-robin tournaments. Here programs JO and FE won 58.6% and 23.1%, respectively, of the tournaments played. For JO this is explained as the program beats twelve of the other fourteen entries and ties the remaining two (FR, FE). Thus, in match-up competitions it only loses in tie-break situations. A similar explanation is offered for FE, which beats ten of the other entries, ties two and loses to only one entry, GR. T&C, which performed well in both of the alternative round-robin tournaments, posted the third

highest win percentage (10.1%) in the match-up format. TFT, which does not beat a single strategy (but does tie seven other entries) wins only five of the 100,000 simulated tournaments.

Table S1a. Analysis of Axelrod's First Tournament Using a Two-stage
Round-Robin Tournament with Five Groups of Three Entries

Program	Name	Stage 1 Wins		Stage 2 Wins	
		#	% Wins	#	% Wins
1	TFT	33,389	33.4%	15,839	15.8%
2	T&C	63,360	63.4%	24,277	24.3%
3	NY	42,204	42.2%	16,775	16.8%
4	GR	48,673	48.7%	17,556	17.6%
5	SH	42,084	42.1%	7,570	7.6%
6	S&R	64,303	64.3%	13,697	13.7%
7	FR	35,335	35.3%	1,917	1.9%
8	DA	31,895	31.9%	845	0.8%
9	GR	40,790	40.8%	847	0.8%
10	DO	33,105	33.1%	525	0.5%
11	FE	19,654	19.7%	133	0.1%
12	JO	12,097	12.1%	19	0.0%
13	TU	19,872	19.9%	-	0.0%
14	NA	6,629	6.6%	-	0.0%
15	RAN	6,610	6.6%	-	0.0%

Table S1b. Analysis of Axelrod's First Tournament Using a Two-stage Round-Robin Tournament with Three Groups of Five Entries

Program	Name	1st Stage		2nd Stage		3rd Stage		Final Stage	
		#	p(Win)	#	p(Win)	#	p(Win)	#	p(Win)
1	TFT	30,055	30.1%	6,297	6.3%	657	0.7%	5	0.0%
2	T&C	86,699	86.7%	65,568	65.6%	37,192	37.2%	10,126	10.1%
3	NY	30,142	30.1%	5,249	5.2%	435	0.4%	4	0.0%
4	GR	63,270	63.3%	31,073	31.1%	9,975	10.0%	1,194	1.2%
5	SH	46,695	46.7%	13,628	13.6%	1,763	1.8%	25	0.0%
6	S&R	76,694	76.7%	48,100	48.1%	20,381	20.4%	2,867	2.9%
7	FR	63,244	63.2%	31,854	31.9%	12,073	12.1%	4,087	4.1%
8	DA	50,040	50.0%	15,408	15.4%	1,938	1.9%	23	0.0%
9	GR	39,886	39.9%	7,694	7.7%	354	0.4%	-	0.0%
10	DO	49,995	50.0%	16,496	16.5%	2,655	2.7%	18	0.0%
11	FE	83,273	83.3%	61,969	62.0%	40,391	40.4%	23,054	23.1%
12	JO	93,392	93.4%	83,799	83.8%	71,652	71.7%	58,597	58.6%
13	TU	46,651	46.7%	10,565	10.6%	517	0.5%	-	0.0%
14	NA	26,740	26.7%	2,051	2.1%	17	0.0%	-	0.0%
15	RAN	13,224	13.2%	249	0.2%	-	0.0%	-	0.0%
		800,000		400,000		200,000		100,000	100.0%