nature scienceupdate Thursday 23 December 1999

physics : Good news for losers

PHILIP BALL

If you feel that life always deals you a bad hand, take heart. Scientists in Australia have proved that two games guaranteed to give a player a steady string of losses can generate a sure-fire winning streak if played alternately.

This counter-intuitive behaviour of games of chance was discovered recently by physicist Juan Parrondo of the Universidad Complutense de Madrid in Spain, and has become known as Parrondo's paradox. Physicists have had an interest in simple games ever since the mathematician John von Neumann developed so-called game theory in the late 1920s. He showed that certain kinds of game involving bluffing, like some card games, have optimal strategies that guarantee the player the best outcome. Von Neumann's work on games turned out to be applicable to some situations in economics, social behaviour, and ecology.

Gregory Harmer and Derek Abbott of the University of Adelaide, Australia, now demonstrate in *Nature*[1] the bizarre consequences of Parrondo's paradox, with reference to two 'loser's' games. In Game A, a player gambles on a simple coin-tossing process in which the coin is loaded to guarantee that the probability of winning is less than 1 in 2. A win might, for example, correspond to an outcome of 'heads', whereas the coin is designed to fall with slightly greater probability as 'tails'. The player is then sure to suffer losses roughly proportional to the number of times the game is played.

Game B in Harmer and Abbott's scenario is more complicated, involving two biased coins. Which of them is tossed depends on how much money the player has. One of the coins gives a good probability of winning; but the game is set up so that the other coin, which usually gives a loss, is tossed more often. So the player is sure to lose out in the long term.

The researchers show that, as expected, each game played repeatedly generates a steady decrease in the player's capital. But what if the two games are alternated? You'd expect the player to be no better off. But it turns out that two rounds of Game A followed by two of Game B actually produce a steadily increasing capital. What is more, the same is true when the games are switched at random.

How can this be possible? Switching between the two games, explain the researchers, creates a ratchet-like accumulation of wins. Winning rounds, mainly thanks to the 'good' coin in Game B, carry the player's capital 'uphill'. Swapping to the other game then 'traps' the winnings there before subsequent repetitions of the same game can introduce the otherwise inevitable decline.

The researchers propose that Parrondo's paradox may operate in economics or social dynamics to extract benefits from ostensibly detrimental situations. For example, they suggest that if a society or an ecosystem suffers from declines in either the birth rate or the death rate, declines in both together might combine with favourable consequences. Testing the theory in the casino, however, might prove expensive.

1. Harmer, G.P. & Abbott, D. Game theory: Losing strategies can win by Parrondo's paradox *Nature* **402,** 864 (1999).