HEALTH

The Doping Game: Payoffs That Make Cheaters Into Losers

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***Editors note**: This story is part of a Feature "The Doping Dilemma" from the April 2008 issue of* Scientific American.

Why do cyclists cheat? The game theory analysis of doping in cycling (below), which is closely modeled on the game of prisoner's dilemma, shows why cheating by doping is rational, based solely on the incentives and expected values of the payoffs built into current competition. (The expected value is the value of a successful outcome multiplied by the probability of achieving that outcome.) The payoffs assumed are not unrealistic,

"low" in the matrices correspond to the standard names of strategies in prisoner's dilemma. It is also assumed that if competitors are playing "on a level playing field" (all are cheating, or all are rule-abiding), their winnings will total $1 million each, without further adjustment for a doping advantage.

—Peter Brown, Staff Editor

Game Assumptions: Current Competition

Value of winning the Tour de France: $10 million

Likelihood that a doping rider will win the Tour de France against nondoping competitors: 100%

Value of cycling professionally for a year, when the playing field is level: $1 million

Cost of getting caught cheating (penalties and lost income): $1 million

Likelihood of getting caught cheating: 10%

Cost of getting cut from a team (forgone earnings and loss of status): $1 million

50%

Case I: My opponent abides by the rules (he "cooperates"). I have two options:		**Case 2:** My opponent cheats by doping (he "defects"). Again, I have two options:	
High Payoff		Sucker Payoff	
I abide by the rules (I "cooperate," too). The playing field is level.		I abide by the rules (I "cooperate"). I can earn the average winnings for a competitive racer only if my opponent gets caught cheating and is disqualified.	
Value of competing for one year:	**$1 million**	Expected value of competing for one year: $1 million*10%=	**$0.1million**
Since I am not cheating, I expect no penalties:	**$0**	Expected cost of getting cut from a team: $1 million*50%=	**-$0.5million**
Total expected High Payoff:	**$1 million**	Total expected Sucker Payoff:	**$0.4million**
–		–	
Temptation Payoff		Low Payoff	
I cheat by doping (I "defect").		I also cheat by doping (I "defect"). The playing field is level.	
Expected value of winning the Tour de France (if I do not get caught cheating): $10 million*90%=	**$9.0million**	Expected value of competing for one year (if I do not get caught): $1 million*90%	**$0.9million**
Expected penalty for cheating (if I do get caught): $1 million*10%=	**-$0.1million**	Expected penalty for cheating (if I do get caught): $1 million*10%=	**-$0.1million**
Total expected Temptation Payoff:	**$8.9 million**	Total expected Low Payoff:	**$0.8million**
Because $8.9 million is greater than $1		My incentive in Case II is also to cheat.	

Game Assumptions: After Reforms

New, higher cost of getting caught cheating (penalties and lost income): $5 million

New, higher likelihood of getting caught cheating: 90%

Consequent new, lower likelihood that a non-doping rider will get cut from a team for being noncompetitive: 10%

Case I:	Case 2:
My opponent abides by the rules (he	My opponent cheats by doping (he

I have two options:		Again, I have two options:	
High Payoff		Sucker Payoff	
I abide by the rules (I "cooperate," too). The playing field is level.		I abide by the rules (I "cooperate"). I can earn the average winnings for a competitive racer only if my opponent gets caught cheating and is disqualified.	
Value of competing for one year:	**$1 million**	Expected value of competing for one year: $1 million*90%=	**$0.9million**
Since I am not cheating, I expect no penalties:	**$0**	Expected cost of getting cut from a team: $1 million*10%=	**-$0.1million**
Total expected High Payoff:	**$1 million**	Total expected Sucker Payoff:	**$0.8million**
–		–	
Temptation Payoff		Low Payoff	
I cheat by doping (I "defect").		I also cheat by doping (I "defect"). The playing field is level.	
Expected value of winning the Tour de France (if I do not get caught cheating): $10 million*10%=	**$1.0million**	Expected value of competing for one year (if I do not get caught): $1 million*10%	**$0.1million**
Expected penalty for cheating (if I do get caught): $5 million*90%=	**-$4.5million**	Expected penalty for cheating (if I do get caught): $5 million*90%=	**-$4.5million**
Total expected Temptation Payoff:	**$-3.5 million**	Total expected Low Payoff:	**-$4.4million**
Because earning $1 million is better than losing $3.5 million, my incentive in Case I has changed to abiding by the rules.		My incentive in Case II has also changed to playing by the rules.	

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