Emotions Help Solve the Prisoner's Dilemma

Behavioural Finance Working Group Conference
Fairness, Trust and Emotions in Finance

1–2 July 2010

Behavioural Finance Working Group
Cass Business School
London

Martin Sewell
mvs25@cam.ac.uk
University of Cambridge

Abstract

Many philosophies treat emotions as the polar opposite of logic, and an economist would judge emotions as irrational. Taking an evolutionary perspective informs us that emotion is no less rational than any other behaviour, and likely evolved to maximize lifetime utility. Frank (1988) argues that emotions evolved to enable us to sacrifice a short-term benefit for a longer-term gain. Frank's work is interpreted via a bottom-up evolutionary approach within the framework of the prisoner's dilemma. Emotions help solve the prisoner's dilemma by enabling us to cooperate. Emotions allow us to selectively lower our discount rate, and to be effective must be both visible and credible. Credible emotions are achieved by their manifestation in both the iterated prisoner's dilemma (where they help us cooperate) and the non-repeated prisoner's dilemma (where they appear irrational).

This paper seeks to explicate the evolution of emotions. The work extends Frank (1988)[1], who argues that emotions evolved to enable us to sacrifice a short-term benefit for a longer-term gain, by taking a bottom-up evolutionary approach.

Evolutionary biology informs us that, from a gene eye's view, only selfish behaviour is possible (Dawkins 1976), and even humans cannot transcend their genes (Moxon 2010). This does not preclude us from acting against our interests in the short term, so long as there is a likelihood of a greater payback later.

[1] In contrast to the psychologists making a contribution to economics such as Kahneman and Tversky, Robert H. Frank is an economist making a contribution to psychology.

This is known as *reciprocal altruism* (Trivers 1971). So, the key dilemma an individual faces is when to behave selfishly in the immediate term, and when to risk cooperating in the hope of engaging in reciprocal altruism.

This evolved behavioural conundrum is a classic problem in game theory known as the *prisoner's dilemma*. The payoff matrix for the prisoner's dilemma is depicted in Figure 1. In addition to being the most famous game in game

		Red Player	
		Cooperate	Defect
Blue Player	Cooperate	win (Red) win (Blue)	win much (Red) lose much (Blue)
	Defect	lose much (Red) win much (Blue)	lose (Red) lose (Blue)

Figure 1: The prisoner's dilemma

theory, the prisoner's dilemma is of great practical importance across many disciplines, e.g. economics, politics, sociology and biology. There are many examples in human interaction as well as interactions in nature in general that have the same payoff matrix. Prisoner's dilemmas occur in nature whenever an individual's self-interest is opposed to group interest. In 1950, puzzles with a similar structure to the prisoner's dilemma were developed by RAND Corporation scientists Merrill Flood and Melvin Dresher, then Princeton mathematician Albert W. Tucker formalized the game with prison sentence payoffs (Poundstone 1993). Formally, the prisoner's dilemma is a non-zero-sum game in which the unique Nash equilibrium is not a Pareto-optimal solution. Although the participants are better off as a whole if both players cooperate, economic theory informs us that the rational choice is for both players to always defect. The game demonstrates the benefits of mutual trust: the prisoner's dilemma ceases to be a dilemma if the players trust each other—mutual trust leads to the win-win situation.

When two players play the prisoner's dilemma more than once in succession and they remember the previous actions of their opponent and can change their strategy accordingly, this is known as an *iterated prisoner's dilemma*. Only when the players play the iterated prisoner's dilemma an unknown number of times can cooperation be an equilibrium. In this case, the incentive to defect can be overcome by the threat of punishment. Most of the prisoner's dilemmas in nature are iterated. In 1979 Robert Axelrod of the University of Michigan hosted an iterated prisoner's dilemma tournament, and experts in game theory were invited to submit programs (Axelrod 1990). To his considerable surprise, the winner was the simplest of all the programs he received, TIT FOR TAT, submitted by Anatol Rapoport. The strategy was simple: cooperate on the first move and then respond with whatever action the opposing player used on their previous move. Tit for tat is a very stable strategy, does best when opposing another responsive strategy, and in Axelrod's survival of the fittest tournament tit for tat again evolved as the winner. Perhaps surprisingly, human behaviour aside, there are few examples of tit for tat in nature.

It is informative to consider tit for tat in the context of group selection. Wilson and Wilson (2007) summarized *group selection* with their famous quote: 'Selfishness beats altruism within groups. Altruistic groups beat selfish groups. Everything else is commentary.' Group selection is possible in theory, but in practice very unlikely, because it requires that all four of the following conditions are met: 1) groups have generation times as short as individuals; 2) groups are fairly inbred; 3) there is relatively little migration between groups; and 4) the whole group has as high a chance of going extinct as the individuals within it (Ridley (1997), p. 179). Recently, David Sloan Wilson and Elliot Sober have argued that the case against group selection has been overstated, and introduced multilevel selection (Wilson and Sober 1994). For a contemporary survey on levels of selection in evolution, see Keller (1999). Tit for tat loses to an always defect strategy in a one-on-one game (within group), but succeeds in a round robin tournament because pairs of tit for tat players do better than mixed pairs or pairs of always defect (between group).

When studying an aspect of human behaviour, such as emotions, it is instructive to take an *evolutionary psychology* perspective (e.g. Buss (2008)). *Homo sapiens* originated about 200,000 years ago, and natural selection is a slow process, so human beings today are better equipped to solve the problems faced by our ancestors. The environment to which a species is adapted is known as the *environment of evolutionary adaptedness* which, for modern man, is the Pleistocene (which lasted from 1.8 million to 12,000 years before the present) where we lived in hunter-gatherer tribes on the African savannah. From a gene's eye view, evolution is survivorship bias, so our minds have adapted to ensuring that we propagate our genes in an environment that dealt with predators, food acquisition, interpersonal aggression, diseases, mate choice, child rearing, etc. For example, in the present we are more afraid of snakes and spiders than cars, despite the fact that cars cause more deaths and injuries than creatures in developed countries. In short, evolutionary psychology informs us that our minds today are adapted to maximize gene replication in the Pleistocene. Although many of the details concerning what we believe about evolutionary psychology may well be wrong, the central thesis—that our minds are the product of evolution—remains very strong, due to the lack of any credible alternative hypothesis. Pertinent to our work here is group size. There is both greater safety and improved efficiency with task sharing in numbers, so human beings have always tended to live in groups. The size of social groups was likely to have been constrained by the information-processing capacities of the brain, with 150 people being a good average.

Returning to the prisoner's dilemma, we consider the scenarios in which we may be motivated to cooperate, rather than defect. Consider the concept of time. No one takes the future quite as seriously as the present: people generally prefer to have benefits today rather than in the future. *Time discounting* pertains to how large a premium an individual will place on receiving a reward nearer in time relative to a more remote reward. If one is hoping for a future reward, such as a reproductive opportunity with a potential partner, there is a risk that the expected future reward will not, in fact, be available. For example, the prospective partner may find another mate, or worse, you could die before receiving the reward. There is also the opportunity cost to consider, the time spent waiting for a delayed reward may be time wasted. It seems reasonable to assume that the risk that the reward will not be available decreases as one approaches the time that the reward is expected, and such a scenario gives rise to a *hyperbolic discount function* (Sozou 1998). In practice, although the *exponential discounting* assumption is the most commonly used in economics (as the exponential function is the only discount function that provides time-consistent preferences), there is more empirical evidence for hyperbolic discounting (Frederick, Loewenstein and O'Donoghue 2002). Taking an evolutionary psychology perspective amplifies the magnitude and frequency of occasions that warrant a high discount rate, and also those that warrant a low discount rate. On the one hand the hostile environment of the Pleistocene would have increased the number of instances when it made sense to care only about the immediate future, such as fleeing from an imminent danger. On the other hand living in small groups would have provided greater opportunities for repeated transactions with the same individuals. The tit for tat strategy involves lowering the discount rate, and it could be that emotions help solve the impulse control problem by allowing us to lower our discount rate in selected instances.

Frank (1988) frames the prisoner's dilemma addressed here as a *commitment problem*, as it arises when it is in a person's long-term interest to make a binding commitment, but the short-term rational response is to defect. For example, romantic love is an emotion that keeps couples together, when a more immediate and apparently rational response might be to leave a partner as soon as a more attractive partner became available. In the longer term, the ultimate goal of reproduction will be better served if love lasts long enough for the male to help rear any offspring. Love enables a man to convince a prospective or present female partner of his reliability (women are attracted to men of high ranking in the male dominance hierarchy but also seek reliability in long-term partners), and allows a woman to convince herself that it is worth the risk of banking on the reliability of her male partner. In both cases, love is both a deception and a self-deception (the latter being necessary to convincingly achieve the former), as love is a temporary feeling which is merely instrumental to an individual's true motivation, that of sex.

We've established that there are times when we wish to cooperate by playing tit for tat, and mentioned that we do so via emotions, so we focus now on *how*, what is the optimal strategy? During the Pleistocene, living in small groups led to the type of conversation that helped our ancestors, such as information about food sources, dangers or (most importantly) other people—tips and recommendations. Gossip was of great importance from an evolutionary perspective, see Dunbar (1996). As we spent most of our lives among people whom we would repeatedly interact with, our reputation in the Pleistocene would have been more important than it is today. When one wishes to cooperate by playing tit for tat, it is in one's interest to find partners who will cooperate, so it is in an individual's interest for others to believe that they will cooperate, and to appear vengeful if their partner defects. Those with a good reputation can solve even the non-repeated prisoner's dilemma. In order to maintain reciprocal cooperation, the emotions that we must exhibit are being *nice* so that we cooperate in the first instance, a feeling of *well-being* following mutual cooperation, *guilt* when we defect without provocation, *gratitude* when our partner cooperates and *anger* when our partner unfairly defects. In other words, we should appear honest and fair. Emotions are signals to others, and if they are to have the desired effect, must be both *visible* and *credible.* The best way of convincing someone else that you really are feeling a particular emotion is to genuinely experience that emotion. For example, in order to *appear* angry, it is helpful to actually *be* angry. To appear credible, emotions must at least partially be insulated from direct control, so are exhibited on a dispositional basis, and *in general*, not merely when they suit us. For example, me may tip at a restaurant even if we never expect to return—this is the price one pays for maintaining an honest disposition.

Furthermore, Hamilton's rule of kin selection (Hamilton 1964a,b) asserts that individuals have evolved to display non-reciprocal altruism towards other individuals in proportion to their genetic-relatedness. During the Pleistocene individuals would have likely been related to most of the people whom they came into contact with, so it is possible that our minds are adapted to engaging in non-reciprocal altruism to a greater degree than would be optimal in today's mega-societies in the developed world.

Many philosophies treat emotions as the polar opposite of logic, and an economist would judge emotions as irrational. Taking an evolutionary perspective informed us that emotion is no less rational than any other behaviour, and likely evolved to maximize lifetime utility. In short, emotions help solve the prisoner's dilemma by enabling us to cooperate. Emotions allow us to selectively lower our discount rate, and to be effective must be both visible and credible. Credible emotions are achieved by their manifestation in both the iterated prisoner's dilemma (where they help us cooperate) and the non-repeated prisoner's dilemma (where they appear irrational).

References

AXELROD, Robert, 1990. *The Evolution of Co-Operation.* London: Penguin. First published 1984, New York: Basic Books.

BUSS, David M., 2008. *Evolutionary Psychology: The New Science of the Mind.* Third ed. Boston, MA: Pearson Higher Education.

DAWKINS, Richard, 1976. *The Selfish Gene.* Oxford: Oxford University Press.

DUNBAR, Robin, 1996. *Grooming, Gossip, and the Evolution of Language.* London: Faber and Faber.

FRANK, Robert H., 1988. *Passions Within Reasons: The Strategic Role of the Emotions.* New York: Norton.

FREDERICK, Shane, George LOEWENSTEIN, and Ted O'DONOGHUE, 2002. Time discounting and time preference: A critical review. *Journal of Economic Literature*, **40**(2), 351–401.

HAMILTON, W. D., 1964a. The genetical evolution of social behaviour. I. *Journal of Theoretical Biology*, **7**(1), 1–16.

HAMILTON, W. D., 1964b. The genetical evolution of social behaviour. II. *Journal of Theoretical Biology*, **7**(1), 17–52.

KELLER, Laurent, ed., 1999. *Levels of Selection in Evolution.* Monographs in Behavior and Ecology. Princeton, NJ: Princeton University Press.

MOXON, Steve, 2010. Culture *is* biology: Why we cannot 'transcend' our genes—or ourselves. *Politics and Culture*, **1**.

POUNDSTONE, William, 1993. *Prisoner's Dilemma.* New York: Anchor Books.

RIDLEY, Matt, 1997. *The Origins of Virtue.* London: Penguin. First published 1996, London: Viking.

SOZOU, Peter D., 1998. On hyperbolic discounting and uncertain hazard rates. *Proceedings of the Royal Society B: Biological Sciences*, **265**(1409), 2015–2020.

TRIVERS, Robert L., 1971. The evolution of reciprocal altruism. *The Quarterly Review of Biology*, **46**(1), 35–57.

WILSON, David Sloan, and Elliott SOBER, 1994. Reintroducing group selection to the human behavioral sciences. *Behavioral and Brain Sciences*, **17**(4), 585–608.

WILSON, David Sloan, and Edward O. WILSON, 2007. Rethinking the theoretical foundation of sociobiology. *The Quarterly Review of Biology*, **82**(4), 327–348.