# The mutual gains from trade moderate the parent-offspring conflict

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*By combining basic concepts from economics and genetic economics, I elaborate a rationale for the mutual gains from the exchange of goods between siblings to moderate the famous parent-offspring conflict, an issue of interest for evolutionary psychology. The rationale also fills in the gaps of standard economic theory by justifying why trade (ultimately a cooperative endeavor) is made possible starting from egoistic utility-maximizers.*

By the end of the nineties, behavior genetics reached a consensus over three basic "laws" of genetic behavior (Turkheimer 2000):

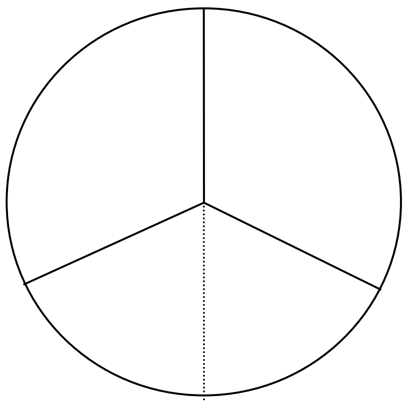
1. Genes are involved in all human behavior.
2. The family environment effect on an individual behavior is negligible.
3. The unique environment of an individual (possibly his or her peer group (Harris 1998)) explains the remaining chunk of behavior not accounted for the direct effects of genes or families.

Such laws did not evolve from identifying the individual genes related to any given behavioral trait. In fact, the laws emerged from statistical correlations after crunching numbers from the meta-analysis of proper genetic controlled studies of twins or adoptees. On the whole, the percentage of the behavior that can be directly attributed to the genes is 40–50 percent, the shared environment in the family a meager 0–10 percent, and the unique environment the remaining percentage (Pinker 2002).

The touchstone of genetic economics is the family. This is because an individual shares the genes with parents and siblings, but not with genetically unrelated individuals. As it happens, parental investment is scarce. The parents would desire to equitably split their investment among the children. This is because they are related to all their offspring by an equal factor, 50 percent. However, each child is related to himself or herself by a factor of 100 percent. For instance, in a family with two children and one pie, parents would desire to split the pie fifty-fifty if favor of each child. But each child would desire to split the pie in a ratio of two-thirds to one-third, as depicted below. After all, a child shares half his genes with the sibling but shares all his genes with himself (Hamilton 1964; Trivers 1974; 1985). Thus, there is genetic basis for a perennial conflict between the parents and the offspring. Not surprisingly, genetically unrelated individuals outside the family are thought to deserve no piece of the pie.

| | First Child | Second Child |
|---|---|---|
| Father | $\frac{1}{2}$ | $\frac{1}{2}$ |
| Mother | $\frac{1}{2}$ | $\frac{1}{2}$ |
| First Child | $\frac{2}{3}$ | $\frac{1}{3}$ |
| Second Child | $\frac{1}{3}$ | $\frac{2}{3}$ |

The genetic parent-offspring conflict



One particular case of interest is that of identical twins who share the same prenatal environment in the womb. Actually, sometimes one of the fetuses vanishes.

Vanishing twins are a relatively frequent event that occurs in up to one out of every eight multi fetus pregnancies (Landy and Keith 1998). Here, the possibility of fratricide exists. If that really occurs, a mere counting of genes cannot explain the fact. After all, why kill a sibling with whom one shares 100 percent genes? However, each fetus, like any living individual, is a survival machine blindly set by natural selection to preserve one's own genes (Dawkins 1976). Thus, nature must endow each fetus with a sort of utility function (Dawkins 1995). To a survival machine, another survival machine that is not its own child or another close relative is merely part of its environment. Furthermore, the other survival machine is inclined to hit back (Dawkins 1976). One fetus is selfish because it struggles for survival, sometimes at the expense of the other competitor. Of course, the utility function is a replication of an individual's own genome, and not the result of free will. From a neurological point of view, free will is an illusion (Harris 2012). And biology has a well-developed theory of exactly what utility is based on Darwin's concept of reproductive success (Trivers 2011).

The notion of a utility function applies to situations where one has to choose between the possible actions that could lead to different outcomes (Von Neumann and Morgenstern 1944). Individuals would choose the action that leads to the most desirable outcome, which has the highest utility. The utility function can be revealed from the workings of an individual's sensorimotor system, which has been shaped by natural selection to make choices between different actions (Kording *et al.* 2004). Once the particular details of a utility function are specified, the decision problem becomes one of solving an optimal control problem, thereby finding the actions that maximize the utility.

Both the twins or in fact, their sensorimotor systems, maximize utility in the womb environment. However, as the resources are limited in the womb, the environment is one of a two-person, zero sum game. Obviously, a "theory of mind" is absent from the sensorimotor system. Thus, the maximum that nature can accomplish is to endow each fetus with strategies that randomize the choice over all the possible actions. Notwithstanding this fact, the minimax theorem guarantees that even in such a constrained situation an optimal mixed strategy for each player exists (Von Neumann 1928). One such possible optimal may be for one fetus to kill the other in some situations.

The third law of genetic behavior makes sense once an individual who has a utility function meets peers outside the family environment and struggles to find a niche. This niche is where it is most likely for the individual to reach the highest status. Utility-function equipped individuals do not necessarily kill parents or sibs in the presence of the parent-offspring conflict mentioned above, owing to the counting of genes. Parents and sibs are on their "Do Not Kill" list, to use the words of robot Bender Rodriguez of *Futurama*. However, genetically unrelated peers outside the family are considered as subhuman. Thus, it should first be explained why peers are not murdered in the first encounter. It could be possible that before engaging in the quest for status, a certain degree of cooperation must have already evolved between the peers.

The emergence of cooperation can be rationalized as follows. Utility-maximizing individuals in the face of critically scarce resources find themselves in a Hobbesian trap, which is a ubiquitous case of violent conflict (Schelling 1960; Glover 1999; Daly and Wilson 1988). Each individual desires to remove the obstacle represented by its competitor. And each individual recognizes that the other individual also desires the same. Thus, mutually distrustful individuals each have an incentive to inflict a preemptive strike to avoid being invaded for gain. As a result, violence thrives and cooperation cannot flourish. Life ends up, in the words of Hobbes, as "nasty, brutish and short."

An alternative credible defense, which can be announced to potential adversaries, is as follows: "I will not attack first, but if I am attacked and survive then I will strike back" (Pinker 2002). Then, the Hobbesian trap can be removed by the *lex talionis*: "an eye for an eye, a tooth for a tooth" (Daly and Wilson 1988). This is the Hammurabi's code, one of the first written codes of law in recorded history, which serves as a basis for all the laws of the classical antiquity including those of the Roman Empire. This is also the golden rule of Confucius: "Do unto others as you would have them do unto you." Thus, the *lex talionis* is the basis of modern law. Interestingly, a computationally distilled version of the *lex talionis* is the celebrated "tit for tat" strategy of game theory (Axelrod 1984).

Subsequently, a step that may evolve for individuals is to vest authority in a sovereign third person or assembly (Hobbes' Leviathan). The most effective general violence-reduction technique invented is adjudication by an armed authority (Pinker 2002). As the state evolves, its monopoly of violence is justified to remove the Hobbesian trap by enforcing the *lex talionis*. A similar arrangement is likely to have evolved even in prehistoric times. This is because trade (which, as I will describe, is made possible only after cooperation has taken place) may explain the *Homo sapiens*' success accompanied by the displacement of the Neanderthals (Horan *et al.* 2005).

However, the state must also justify its existence by being credible. This can be illustrated by the ultimatum games. In the face of the conflict between the two children depicted above, where each demands $\frac{2}{3}$ of the pie, if the parents (essentially, the "state") assign the property right of the pie to the first child, this child will offer $\frac{1}{3}$ for the second. If the second child rejects the offer both will get nothing. The dominant strategy for the second child is to accept any piece, which is greater than zero. However, though this arrangement is rational for both, what is at stake is more profound. The state is founded under the premise of removing the Hobbesian trap by enforcing the *lex talionis*. The parents' role is similar to that of the state on such a matter. (But hopefully not on the monopoly of violence in the household.) This can be grasped by the ubiquitous advice that parents give to their offspring: "Do unto others as you would have them do unto you." Since the parents want to offer $\frac{1}{2}$ of the pie to each child, which is considered unfair by both, the "state" morality in the present case does not equate the genetic preferences of each child. The credibility of the state is then undermined and the rational offer is rejected. Thus, the conflict is ignited.

The children may become involved with crime following the lack of credibility in the third party, which monopolizes morality. Here, a prisoner's dilemma of game theory can arise. For instance, imagine that the children, who are partners in a crime, are questioned in separate rooms. Each prisoner has a choice of confessing to the crime, and thereby implicating the other, or denying the crime. If only one prisoner confesses to the crime he will go free and the other will spend 6 months in jail. If both deny the crime they will be held for 1 month. However, if both confess to the crime they will be held for 3 months. The negative utilities are depicted below.

| | | Second Child | |
|---|---|---|---|
| | | Confess | Deny |
| First Child | Confess | –3, –3 | 0, –6 |
| | Deny | –6, 0 | –1, –1 |

The prisoner's dilemma for the siblings

The solution to this canonical game is the strategy (confess, confess). However, it is not Pareto-efficient because the strategy (deny, deny) makes both the players better off. If each child could trust the other, they could coordinate their actions and decide that both would deny. However, such cooperation is not Nash-equilibrium of this one-shot game. The dominant strategy for both is to confess.

Crime would be perennial problem, given that distrust cannot be completely eliminated by the state. Thus, the two children are likely to repeatedly find themselves in the same situation of the prisoner's dilemma. Outside the family environment, the dilemma would also be the norm among the children and their peers. However, given the fact that the game is repeated with an unknown date to end, cooperation can emerge out of genetically selfish acts. Interestingly, the solution comes again from the *lex talionis*. Using tit for tat, the strategy (deny, deny), which means cooperation, can become attainable for both the children and even for the children playing against their peers.

Obviously, the values chosen above for the prisoner's dilemma faced by the siblings are arbitrary. In the given example, $0 > -1 > -3 > -6$ or $T = 0 > R = -1 > P = -3 > S = -6$. The game continues to be a prisoner's dilemma for any values as long as $T > R > P > S$. This condition ensures that the payoffs will lead to individual self-interest, which is an evolutionary stable strategy. This is because players who deviate from the strategy can never make inroads against a population of defectors (Maynard Smith 1982). A second condition, $R > (T + S)/2$ (in the particular case above $-1 > -3$), is also implied. For instance, if both the players get locked into an alternation of cooperation and defection, the second condition guarantees that each will do worse than if they had cooperated with each other on each play from the very beginning.

| | | Second Child | |
|---|---|---|---|
| | | Confess (defect) | Deny (cooperate) |
| First Child | Confess (defect) | P, P | T, S |
| | Deny (cooperate) | S, T | R, R |

The generalized prisoner's dilemma for the siblings

Tit for tat is an evolutionary stable strategy if and only if a probability $w$ of the two players meeting in the future is sufficiently large, such that $w$ is strictly greater than the larger of the numbers $(T - R)/(T - P)$ and $(T - R)/(R - S)$ (Axelrod 1984). The number $(T - R)/(T - P)$ represents the relative payoff for being nasty and getting away with it as opposed to being nasty and getting caught. And $(T - R)/(R - S)$ is the incremental difference in what one receives for being nasty and getting away with it when compared with the incremental amount one receives for being nice without being duped in (Casti 1996). Computing these quantities for the two players, who are genetically related (Hamilton's inclusive fitness), is more likely to foster cooperation than the computation done by selfish peers. Kin selection (helping one's relatives) is good for cooperation to emerge. Then, the children may recalculate the payoff matrix depicted above in terms of inclusive fitness, which results in reversing one or both of the inequalities $T > R$ and $P > S$. Clustering is another mechanism through which cooperation can emerge. A cluster of tit for tat individuals can become viable even when the majority of the players are being nasty by defecting at every encounter. And clustering may be associated with the kinship. Thus, genetic relatedness is key for cooperation to prevail at large. It should be noted that not defecting is a kind of altruism. This is because an altruistic individual foregoes gains that might have been made.

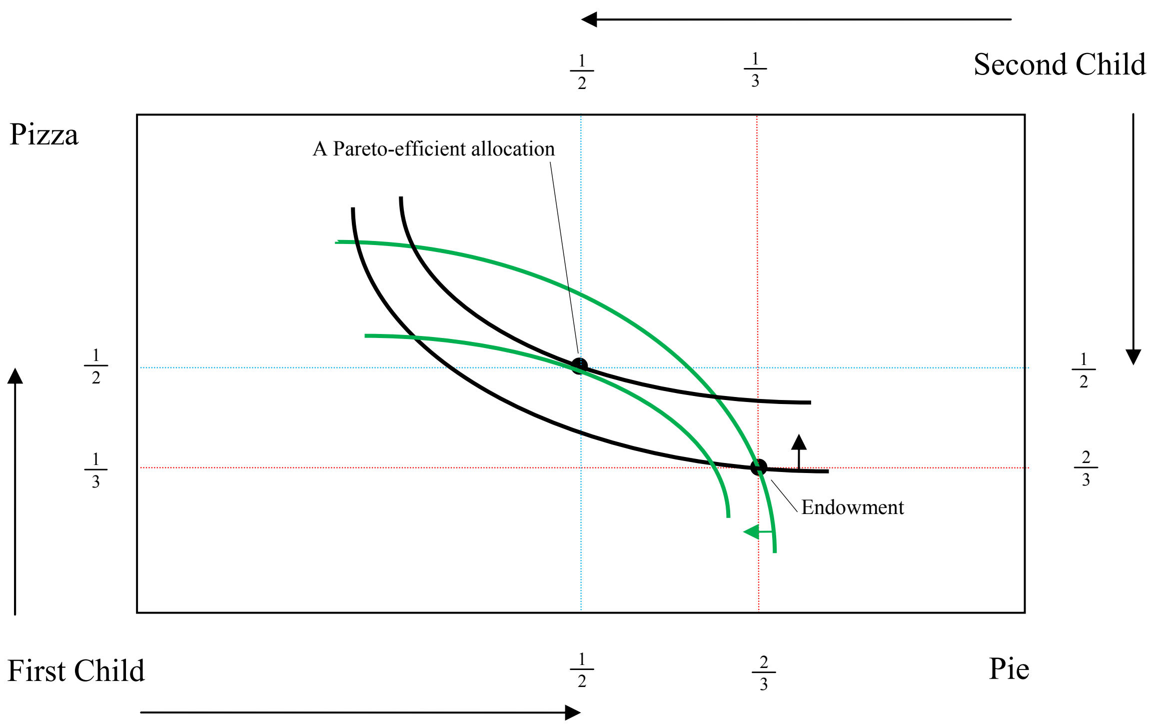
By relying on the gains potentially made possible from trade, parental investment abates. Parents may then wish to increase their parental investment, and this can moderate the parent-offspring conflict. Because the family environment effect on an individual child behavior is negligible and because each parent has an inclusive fitness term on his or her utility function, children somewhat drive resource allocation in the household. The children can be offered not only pie but also pizza. As a result, their preferences become defined toward both the goods. Since they can now cooperate, the children may try exchanging the goods to reach a utility that is now higher than the utility that could accrue from killing each other. If the outcome of the exchange turns out to be mutually beneficial trade can evolve, which further reinforces cooperation. Thus, trade, favored by the arrival of cooperation, helps to expand the "moral circle" (Singer 1981): killing of relatives is no longer the only alternative, killing of peers is no longer the only alternative, killing of foreigners is no longer the only alternative, and so on.

At first, both the children are likely to show an "endowment effect." This is because both kids value the goods they possess more highly than the same goods when they do not possess. The endowment effect merely shows respect for one's private property in the absence of a legal institution ensuring third-party contract enforcement (Gintis 2007). However, as the state has already evolved, trade can now ensue. The parents may be secure that their offspring will exchange pieces of pie and pizza. The set is one of pure exchange, with no production and just endowments of the two goods: pie and pizza for each child. Maximization of consumption of wherever goods it happens to be available can then be considered as the other argument of the utility function along with the inclusive fitness term. But survival (through the consumption of resources) and reproduction (trough decisions based on inclusive fitness) are eventually considered (Da Silva 2013). The preferences over the quantity of the two goods (a consumption bundle) can be represented by indifference curves. These consist of all bundles that leave one consumer indifferent to a given bundle because the joint utility accruing from each bundle is the same. Bundles located above the indifference curve bring higher utility. Thus, such bundles are preferred. Two consumers and two goods can be depicted in an Edgeworth box that shows their endowments and utility functions. An Edgeworth box for the two children considering convex monotonic indifference curves is shown below.

As for the pie, the parents can initially endow their first child to fulfill his will: $\frac{2}{3}$ for him, and $\frac{1}{3}$ for his sibling. At the same time, to balance their decision the parents fulfill the will of the second child and offer $\frac{2}{3}$ of pizza for him, and $\frac{1}{3}$ for the first child. By exploiting the gains from trade, the two children may end up at the fifty-fifty allocation genetically preferred by both parents. And this outcome is also efficient.

Indeed, at the point of endowment in the Edgeworth box both the children can be better off if they exchange pieces of pie and pizza. These points lay above both the indifference curves. Thus, the trade can increase the utility of both the children. All the gains from the trade are exhausted when the two indifference curves become tangent. This is the Pareto-efficient allocation where there is no way to make a child better off without making the other worse off.

Cooperation is implied as both the children trade in the Edgeworth box. This is because at the Pareto efficient allocation, each child is on his highest possible indifference curve *given the indifference curve of the other*. Of course, the fact that a Pareto-efficient allocation exactly matches the allocation genetically preferred by the parents (fifty-fifty of both goods) depends on certain technicalities, such as the particular shape of the well-behaved indifference curves considered, a similar bargaining power of the siblings, absence of strategic behavior from both parties, and so on. Nevertheless, the given example illustrates that at least one Pareto-efficient allocation resulting from the trade is possible, which can remove the parent-offspring conflict. To summarize, as scarcity abates in the family environment with regards to the boost in the parental investment, the gains from trade can moderate the parent-offspring conflict. Thus, it becomes possible to have an allocation that is both Pareto-efficient and matches the genetic preferences of the parents.




Edgeworth box for the two children, pie, and pizza

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