The transfer space

Friedrich, T.

Humboldt-Universitaet zu Berlin

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Abstract

Within the transfer space source and sink exchange material and energy to optimize their own productivity. Under certain conditions this optimization will lead to a productivity increase of the whole ensemble. The present day view that cooperation is the most productive interaction between organisms is an illusion. Whenever two not identically equipped parties meet with the potential to exchange substrates one party will become a source and the other a sink. This is realistically called exploitation. The outcome depends on the relation between fix cost, variable cost, productivity and affinity. Brute force and educational conditioning used by the sink take advantage of emotions to hide the real size of cost in exploitation. In case the transfer of substrates leads to increased productivity parts of the productivity might be reinvested to keep the exploited party. The lasting relationship is called wise exploitation. Wise exploitation may last for one or many generations depending on the use of breeding, brute force or education. All actions have to be viewed under thermodynamic considerations and the benefit must always exceed the cost to maintain a stable system. This hypothesis explains observations from catalytic networks to societies.

Key words: source, sink, wise exploitation, brute force, education, emotions, fix cost, variable cost, productivity, game theory, cooperation, prisoners´ dilemma, benefit, cost, transfer space, symbiosis

Introduction

Cooperation and prisoners´ dilemma

What is cooperation? Many definitions exist in the different fields of research. They all speak of joint interactions and working together of two parties for mutual benefits. But this kind of cooperation is hardly - if at all - observed. The reason is prisoners´ dilemma.

Axelrod and Hamilton (Axelrod, R. and Hamilton, W. D., 1981) use the following and generally accepted matrix to explain prisoners´ dilemma (Figure 1).

Figure 1

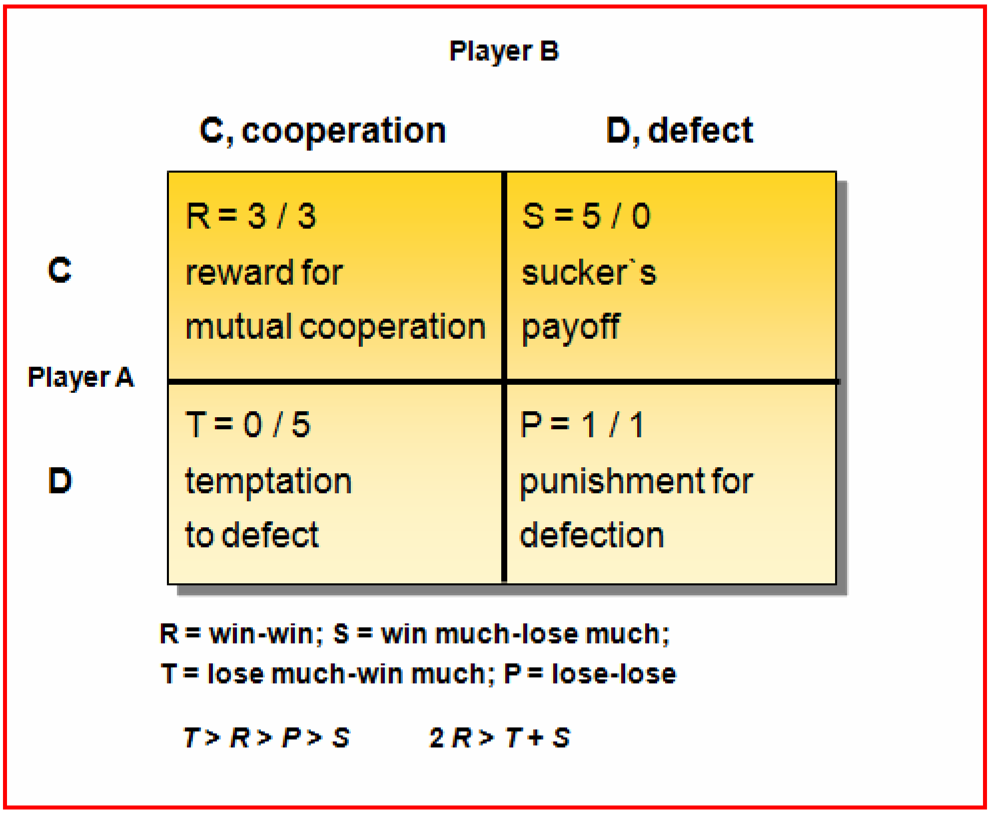

Figure 1. Prisoners´ dilemma, an example.

From arbitrary values they learn that successful exploitation (D) of a source may earn more for the individual than cooperation (D>C). The best productivity or fitness has the ensemble (Player A+B) if both parties cooperate (C+C>C+D>D+D). This is the prisoners´ dilemma – it would be better to cooperate, but the temptation to exploit someone or the danger of being exploited prevents cooperation. As defect is stable (D+D; a Nash equilibrium) it is puzzling to many authors why help between two organisms is observable. One reason is genetic relation – kin selection (Hamilton, W.D., 1964).

An unanswered question in this example is where does the productivity come from and why should the productivity in cooperation (C+C) be higher than in exploitation (C+D)? This view has evolved a little (Nowak, M. A., 2006). This author writes: "a cooperator is someone who pays a cost, c for another individual to receive a benefit, b. A defector has no cost and does not deal out benefits." To assume that something (a benefit) can only come from something else (a cost) is a step forward. However such behavior (giving) is difficult to understand. Giving is an altruistic action – it pays in terms of evolution only for offspring and other genetic relation. Complex evolutionary ideas are invented to transfer the genetically founded behavior altruism and kin selection to group selection with no genetic foundation ("A group of cooperators might be more successful than a group of defectors", same author). The question is not answered where this additional fitness (productivity) has its source. The answer to this question is important as we live under the law of mass and energy conservation - one of the most important empirical laws and philosophic meaningful concepts.

As the values are arbitrary other outcomes are possible and would be worth to be discussed. A general form should be helpful. Turner and Chao (Turner, P.E. and Chao. L., 1999) use an interesting general form to explain prisoners´ dilemma (Figure 2). They introduce a further simplification: one side will only give and one side will only take.

Figure 2

		Player B	
		C, cooperation	D, defect
Player A	C	R = 3 1	S = 0 $1\text{-}s_1$
	D	T = 5 $1+s_2$	P = 1 1-c

Individual: $1+s_2 > 1 > 1\text{-}c > 1\text{-}s_1$

Ensemble: $1+1 > 1+s_2 + 1\text{-}s_1 > 1\text{-}c + 1\text{-}c$

Figure 2. Prisoners´ dilemma, one side gives (giving is $-s_1$) and one side takes ($+s_2$).

Using the same values as Axelrod and Hamilton we obtain the same result. Prisoners´ dilemma is P>S though 2R>T+S>P+P. In this new general form prisoners´ dilemma equals $1\text{-}s_1<1\text{-}c$. Cooperation (1=1) is doing better than exploitation ($1\text{-}s_1<1+s_2$). We could say: $1+1>1\text{-} s_1+1+s_2$.

The transfer space

What does the generalization (prisoners´ dilemma: $c<s_1$; cooperation is better than exploitation: $0>s_2\text{-}s_1 = s_2<s_1$) teach?

It seems there are three variables: s_1, s_2 and c and they are considered independent because the used values were arbitrary. Three independent variables may be best arranged in a three dimensional space (Figure 3).

The size comparison of these variables may teach something like in prisoners´ dilemma (not giving, $c<s_1$). The pair wise combinations of three variables are: $c<s_1$, $c>s_1$, $s_2<s_1$, $s_2>s_1$, $s_2>c$ and $s_2<c$.

Figure 3

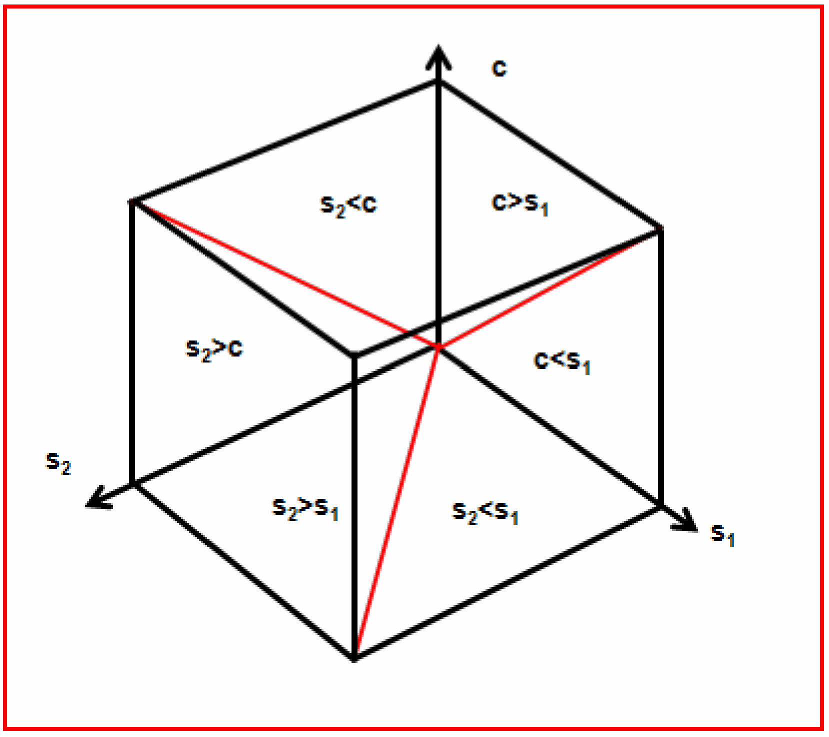

Figure 3. The transfer space formed by the variables c, s_1 and s_2. The origin of the transfer space is where the red lines meet; $c=s_1=s_2=0$. The red lines are $s_2=s_1$, $c=s_1$ and $s_2=c$.

What do the variables mean?

- The variable c is the loss if an exchange does not take place. This variable seems to be some kind of fix cost – always present. It is a fix cost for both sides. But this fix cost is not necessarily of the same size for player A and player B but will be connected by a factor or an equation.
- Although one substrate is exchanged the loss to one party is not necessarily identical with the gain to the other party ($s_2>s_1$, $s_2<s_1$)! The exchanged substrate will however couple s_1 and s_2.

- The variable s_1 is the loss of one party. It consists of the fix cost (the essence of a fix cost is the ubiquity; c), the variable cost that is connected to the lost substrate (S) and the loss in productivity (p) with this lost substrate.
- The variable s_2 is the gain of the other party. It consists of the fix cost (c), the variable cost that is connected to the gained substrate (S) and the gain in productivity (p) with this substrate.
- Productivity (p) is a saturation function. At high saturation the gain in productivity is small compared to low saturation for the same amount of substrate (S). At high saturation the productivity with this substrate may be less earning than the variable cost for this substrate.
- The substrate (S) is a variable cost with a linear dependence.
- $s_1=c+S+p$ and $s_2=c+S+p$. This helps to understand why there is "giving", "not giving", taking and "not taking" without genetically founded altruism involved.

➢ giving: $c>s_1$ equals $c>c+S+p$ or $0>S+p$
➢ not giving: $c<s_1$ equals $c<c+S+p$ or $0<S+p$
➢ taking: $s_2>c$ equals $c+S+p>c$ or $S+p>0$
➢ not taking: $s_2<c$ equals $c+S+p<c$ or $S+p<0$

As S is always a positive value, p must be a large negative value in the case of "giving" ($0>S+p$) and "not taking" ($S+p<0$).

Giving: A negative productivity loss is a relative productivity gain. Giving will increase the productivity! Giving will reduce variable costs that do not pay. Giving is a selfish act. It will increase the productivity via reducing the amount of substrate not earning the variable cost at high saturation. This idea is important for two reasons. Giving is reasonable and selfish, economically and thermodynamically founded. Giving is not a sacrifice. It is now independent of genetic relation.

Not taking: A negative productivity gain is a productivity loss. The second party will not take because a loss in productivity would be realized. Increasing the substrate (increase variable costs) at high saturation will decrease the relative productivity. This idea is important for two reasons. Not taking is not generous, it is reasonable. Not taking can prevent worsening of the productivity.

Giving (not) and taking (not): This 4 types of behavior meet in the three dimensional complex exchange space. The outcome of interactions depends on the physiological, emotional, informational and genetic condition of the parties.

- The saturable production function determines whether the transfer s_1 to s_2 will be productive ($s_2>s_1$) or consumptive ($s_2<s_1$). The effect is that the ensemble will be more or less productive than the sum of the single entities.
- The variables c, S and p will be of typical size for a species/population and vary slightly between individuals.

Now we can give names to the different situations:

$c<s_1$ prisoners´ dilemma; avoided exploitation, not giving;
giving will decrease own productivity

$c>s_1$ tolerated exploitation, giving improves own productivity

$s_2<s_1$ consumptive exploitation, the system looses productivity

$s_2>s_1$ productive exploitation, the system gains productivity

$s_2>c$ cost efficient exploitation, taking will increase own productivity

$s_2<c$ costing exploitation, taking will decrease own productivity

1-1=0 cooperation, the starting point $c=s_1=s_2=0$

Discussion

I suggest a new way to look on two parties capable to exchange substrates. This idea is able to explain exchange related behavior on different levels of complexity (enzymes, organisms - many enzymes - and societies - many organisms) and suggests a source of productivity to fuel group selection without any genetically or else founded form of altruism. Here a purely selfish founded explanation is introduced. Let us first discuss important definitions. To do this we should for simplicity keep some of the variables zero.

- Cooperation, the entry point into the exchange space:

Cooperation is now formally the entry point into the transfer space. In cooperation nothing is exchanged (s_1=s_2=0) at no cost (c=0) but the two parties are able to exchange. What is usually implied using the word cooperation is a point of the coordinates $s_2 >> s_1$, $s_1 \sim 0$, $c \sim 0$. In this point productivity is generated from a small loss at negligible costs and parts of the gain are shared. This will be explained later and is called wise exploitation.

- Productive and consumptive exploitation; the plane s_2-s_1:

Giving and taking create or destroy productivity within the ensemble. The productivity gain $s_2 > s_1$ is the intrinsic power source for the system and is called productive exploitation. The transfer of one substrate from a saturated condition to an unsaturated condition is the reason for the increase in productivity (Figure 4). The increased productivity is realized in the sink. The sink controls the gain and this is the maximal reward. The ensemble of sink and source together has a better productivity then both parties alone. This is an advantage to the group but on the cost of the source. The productivity of the source will decrease and finally the source will be lost. The advantage to the sink and the group is gone. The sink will need new exploitable source from somewhere else.

The transfer from an unsaturated condition to a saturated condition will lead to a decrease in productivity ($s_2<s_1$) and is called consumptive exploitation (Figure 4). The smaller productivity is realized and controlled by the sink. A reward is still obtained but the catch to the sink is smaller than the loss to the source. But it is still an advantage to the sink. The ensemble of sink and source together has a smaller productivity then both parties alone. This is a disadvantage to the group and in addition on cost of the source. The productivity of the source and the group will decrease very fast and finally the source will be lost. The sink will need new exploitable source from somewhere else.

Figure 4

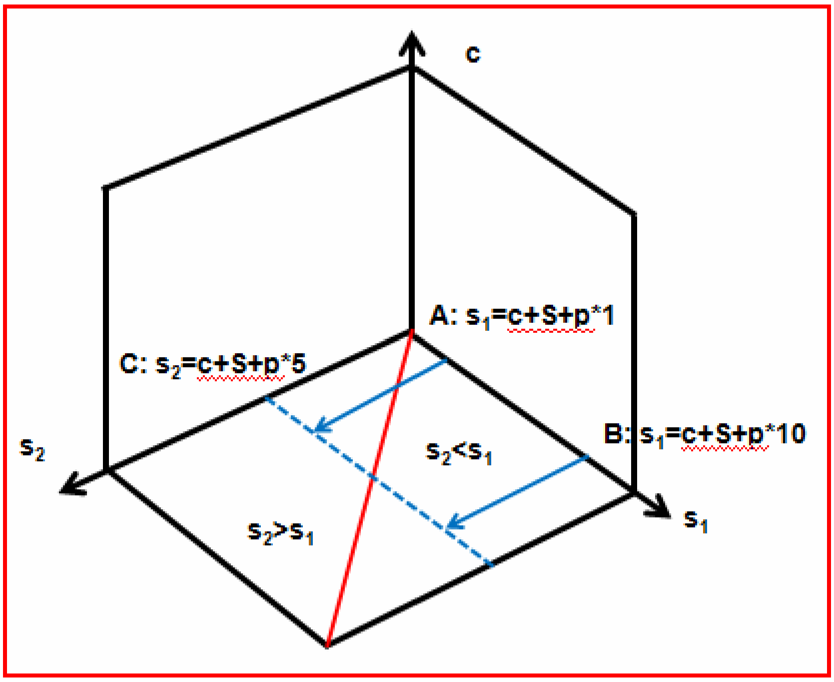

Figure 4. An example: In case A a source has a fix cost (c) and a variable substrate cost (S) and a certain productivity (p*1). In a second case (B) a different source has the same fix (c) and variable cost (S) as A, but a tenfold productivity (p*10). The same substrate (S) in both cases is transferred to the same sink. With the same

substrate the sink has a productivity of p*5 at identical fix and variable cost. The ensemble AC will have a fivefold increased productivity. The productivity of the ensemble BC however is cut by half. AC is a productive transfer ($s_2>s_1$), BC is a consumptive transfer ($s_2<s_1$).

- Brute force, the plane c-s_1:

In prisoners´ dilemma (avoided exploitation) nothing is transferred because not giving is cheaper ($c<s_1$). Only the fix cost (c) is lost. Brute force will increase the cost of “not giving”. The size relation will therefore change from $c<s_1$ to $c+bf>s_1$. Now the subdominant party will give to optimize own productivity. On one side bf is a risky investment. Both sides may be hurt seriously. But once bf is effective cheap threatening will make the subdominant party give. Threatening evokes an emotion called fear. Fear will hide the true cost of giving (s_1) (Figure 5). The intensity of brute force and fear correlate directly to the amount given.

Figure 5

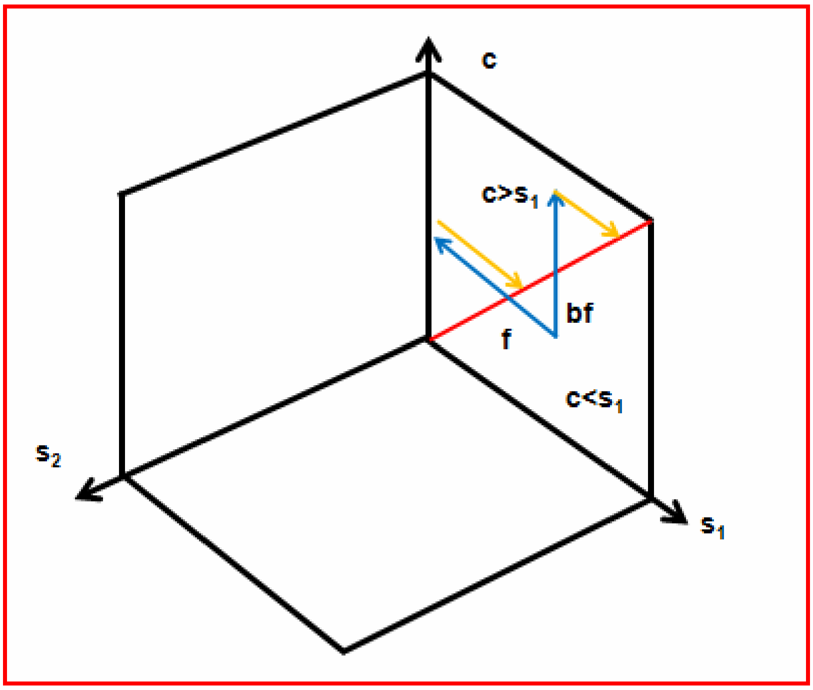

Figure 5. At first brute force (bf) will increase the fix cost (c) for the subdominant party (blue arrow). Giving is induced as variable costs no longer pay at that relationship between fix cost, variable cost and productivity (orange arrow). Later fear is sufficient. Fear (blue arrow, f) hides the true cost s_1 and induces giving (orange arrow) at lower fix costs. The red line separates $c>s_1$ and $c<s_1$.

- Education, the plane c-s_1:

Education is used in intelligent species. It is difficult to determine the true degree of saturation in a complex organism. Manifold, different and complex internal and external information has to be processed. Education is an investment by one party to influence the behavior of a second party. Education as external information is capable to change the perception of the relation between fix cost, variable cost and productivity. This changes the behavior of the source from not giving to giving. Emotions (hope, h) hide the true size of the loss (s_1). The role of emotions in cooperation related behavior has been addressed (Fessler and Haley, 2002). Alternatively the whole space is changed and the source judges the position of the border between $c<s_1$ and $c>s_1$ differently and will give (Figure 6). Giving will stop at $c=s_1$. The size of the difference $c<s_1$ determines how intensive education and hope have to be.

Figure 6

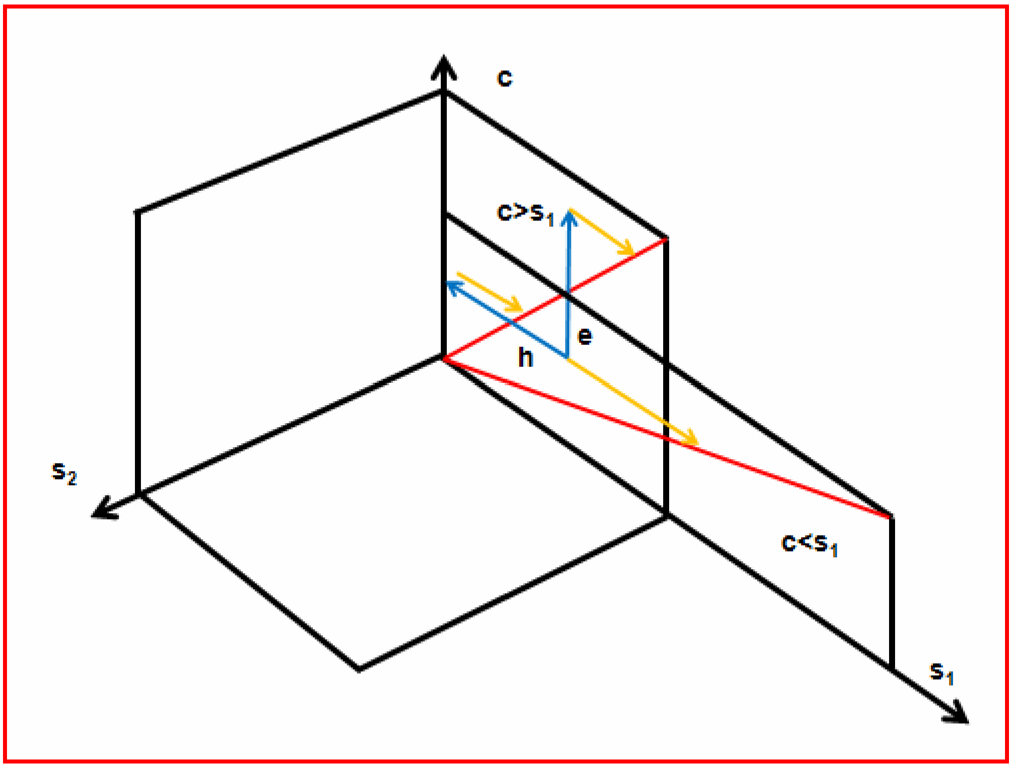

Figure 6. Education manipulates the perception of the fix cost (blue arrow, e) and giving is induced (orange arrow). Hope (blue arrow, h, educational conditioning of endogenous reward systems) is induced and hides the true cost (s_1) and giving is induced (orange arrow). Education can also change the perception of the whole exchange space and induce giving (long orange arrow) directly. The red lines separate $c>s_1$ and $c<s_1$.

- Brute force, the plane c-s_2:

In cost efficient exploitation ($s_2>c$) taking is cheap and effective for the dominant party but the subdominant party may not be willing to give because the status there is not saturated anymore. Brute (counter) force will increase the cost of taking. The size relation will therefore change from $s_2>c$ to $s_2<c+bf$. Now the dominant party will no longer take because the border to costing exploitation is exceeded. Also here bf is a risky investment. Both sides may be hurt seriously. But once bf is effective cheap threatening will make the dominant party recoil from taking. Threatening evokes an emotion called fear. Fear is an emotion and will hide the true gain of taking (s_2) (Figure 7).

Figure 7

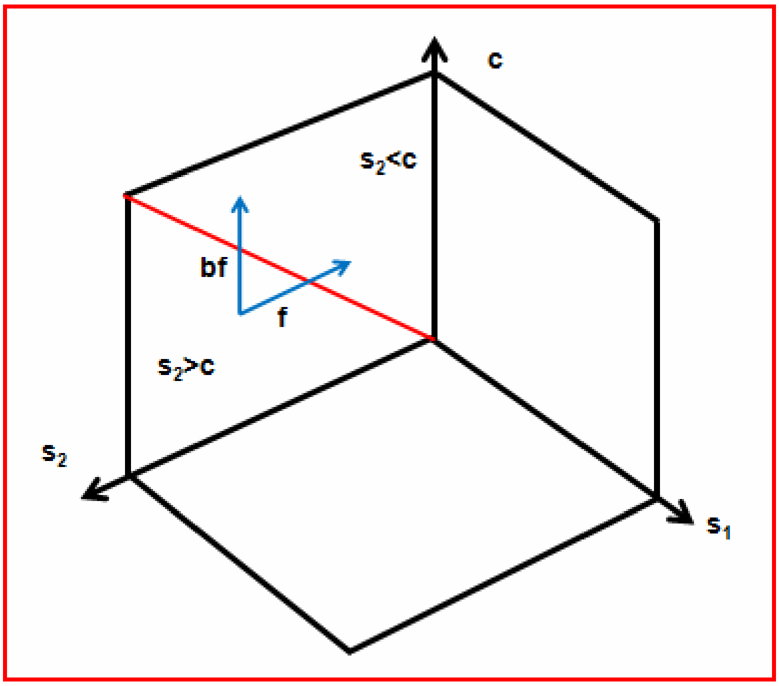

Figure 7. At first brute force (bf) will increase the fix cost (c) for the dominant party (blue arrow). Not taking is induced at that relationship between cost and productivity

(costing exploitation). Later fear (f) is sufficient. Fear (f) hides the true gain s_2. The red line separates $s_2>c$ and $s_2<c$. In the described case giving back could be a result as the border $s_2=c$ is exceeded.

A fight could be interpreted as a test which party is nearer to the border of giving/not giving – taking/not taking. Or: Who is more and who is less saturated? The minimal intensity of the counterforce is determined by the distance to the border $s_2=c$. But it should be clear that in every production function the most left point is zero. At a high saturation there may be low productivity but there is also endurance. s_1 or $s_2=c+S+p$ could also be interpreted as a space with many different positions.

- Education, the plane c-s_2:

Usually the exploiting party (sink) will educate the exploited party (source) to tolerate exploitation. This may lead to exhaustion of the exploited party and a decrease of productivity of the whole ensemble. Ensembles with low productivity will be defeated by ensembles with high productivity. The highest productivity will be reached at optimal distribution of material and energy between both parties so that both are combined maximal productive. Therefore, it could be in the interest of the exploiting party to restrain from complete exploitation of the exploited party.

Education as investment could originate in the dominant party but also within the subdominant party to change the behavior of the dominant party. The dominant party is changed from “taking” to “not taking”. The deception of the size of the fix cost (c) is changed by education (e). Emotions (hope, h) hide here the size of s_2, the possible gain and reward. A second effect of education is that the exchange space is deformed and the addressed party judges the position of the border between $s_2>c$ and $s_2<c$ differently and will not take (Figure 8). Not taking

will stop at $c=s_2$. The size of the difference $s_2>c$ determines how intensive education and hope (emotions) have to be to avoid taking.

Figure 8

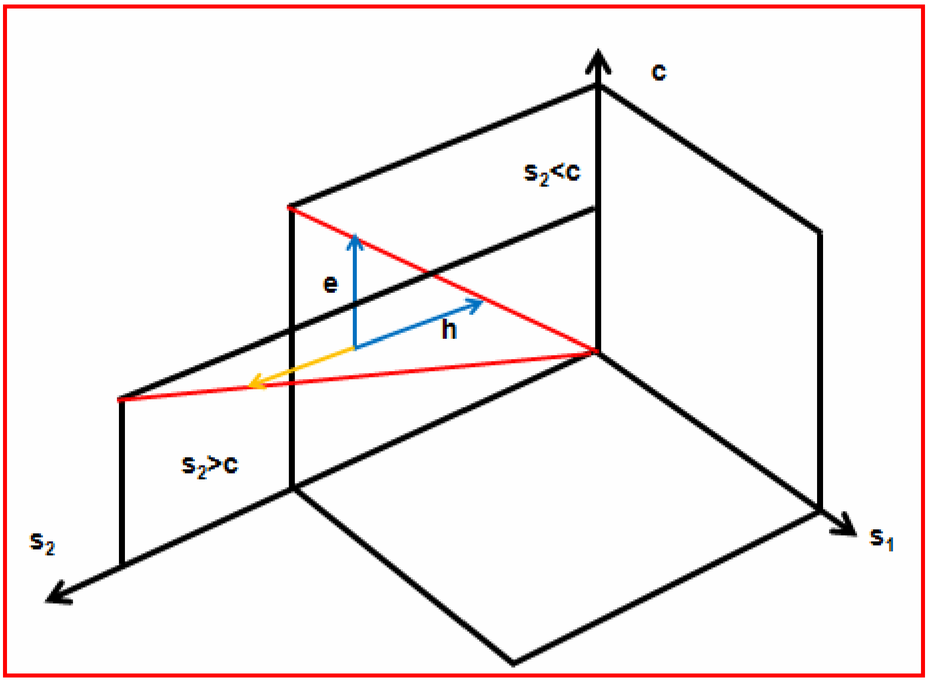

Figure 8. Education manipulates the perception of the fix cost (blue arrow, e). Hope (h, emotions, blue arrow; an educational conditioning of the endogenous reward system) is induced and hides the true gain. Education can also change the whole judgment of the exchange space and the perception of the own position within that space (from $s_2>c$ to $s_2<c$). In this case giving back would be induced in the sink (orange arrow).

- Exploitation

As long as the source is in $c>s_1$ the source will selfish give to increase own productivity – in case a sink will take. This is an advantage through increased productivity to all sides: source, sink and the ensemble. If taking by the sink is larger than the additional productivity through giving the source will approach $c=s_1$. As soon as the source enters $c<s_1$ further taking would decrease productivity of the source and therefore giving by the source will selfish end. The exploited party is at first lost to prisoners´ dilemma. A source also may be right from the very beginning of the contact in prisoners´ dilemma. If the sink wants to take now two possibilities exist.

Exploitation with brute force, (s_2-s_1-bf>0) or (s_2-s_1-bf<0):
Brute force (bf) is an investment of the exploiting party to induce giving. Fear (f) hides the true size of s_1 but is imaginary and therefore not added.
Exploitation with education, (s_2-s_1-e>0) or (s_2-s_1-e<0):
Education (e) is an investment of the exploiting party to induce giving. Hope (h, a complex of conditioned emotions. The reward exists only in the brain.) is virtual and therefore not added.

The use of brute force and education changes the behavior of the exploited party from not giving to giving. But this behavior is harmful and not reasonable. The productivity of the source will further decrease and then the source will be lost completely (physically) through extinction or consumption. Why can it be evolutionary stable to take in prisoners´ dilemma? How can the loss of the exploited party be avoided?

- Productive wise exploitation with brute force (s_2-s_1-bf>0):

Brute force between different species: In two different species the transfer of the substrate to the sink may lead to a higher productivity of the ensemble so that the investment (bf) is overcompensated. This leads to productive wise exploitation with brute force (s_2-s_1-bf>0). In primitive organisms fear will be absent anyhow. Brute force in enzymes is a higher affinity. The ensemble with such a behavior will succeed against other not so productive ensembles of different species. However, the source will suffer a decrease in fitness and therefore vanish. The ensemble may succeed against competing groups on the short run but it will only survive on the long run if parts of the gain are also used to breed the source. An example would be the leafcutter ant with the fungus grown in their garden. The fungus is partly eaten alive (bf) but also bred (br). Gracing and hunting use brute force but usually no breeding of the source is observed. This leads only to predator-prey type stability. If the transfer is consumptive (s_2-s_1-bf<0) the dominant party needs continuous influx of exploitable individuals also.

Brute force within the same species: Naturally emerging asymmetries (male/female; young/old, strong/weak) may serve the same purpose as breeding. With every new generation the consumed sources are replaced resulting in a higher productivity of the ensemble of e.g. strong and weak. The increased productivity (s_2-s_1-bf>0) comes from the species internal transfer. This could be called self-exploitation. Every species produces surplus offspring. This surplus is consumed by disasters, diseases, predators and starvation. In self exploitation part of the surplus is transformed into e.g. more muscles or larger fat reserves or more offspring of the dominant animal. This may lead to a better survival or better competitiveness of the whole group against other groups.

- Productive wise exploitation with education (s_2-s_1-e>0):

The transfer of the substrate to the exploiting party may lead to a higher productivity of the ensemble so that the investment education (e) is overcompensated. This leads to productive wise exploitation with education to hope (s_2-s_1-e>0). In this case the ensemble with such a behavior will succeed against other not so productive ensembles. However, the subdominant party will suffer a decrease in fitness in c<s_1. The ensemble may succeed against competing groups on the short run but it will only survive on the long run if parts of the gain are also used to stabilize the exploited party. If the transfer is consumptive (s_2-s_1-e<0) the dominant party needs continuous influx of exploitable individuals also. This behavior is not self sustainable and will only continue as long as no better competitors arise and the influx is constant. The long term physical loss of the exploited party can be counteracted through breeding.

- Productive wise exploitation with breeding (s_2-s_1-br>0):

All organisms depend on an energy and substrate source. If the source is consumed completely the organism can no longer survive. Taking from a source will decrease the productivity of the source and finally consume the source. The source must be replaced if the sink will use the source further. Two possibilities exist.

First: New sources must be found. This will only be the case when the source is produced somewhere else unhindered and unconsumed and a surplus leaks to the place where it will be consumed. Or the energy reserves are big enough to carry the sink there. This situation reminds of a predator-prey relationship in biology. This is the case (consumptive or productive exploitation) as long as breeding is absent.

Second: The sink uses parts of the gain to replace the consumed source through breeding. Though the source is consumed, new source will replace the loss. This is called wise exploitation: s_2-s_1-br>0, the essence of farming. The productivity gain (s_2-s_1>0, productive exploitation) is so big that besides a reward a reinvestment (br) into the stability of the source can be made. Due to the reinvestment farming is not as much earning as complete exploitation but will last longer.

- Productive wise exploitation, the plane s2-s1:

When s_2>>s_1 there will be so much productivity generated that besides a reward for the exploiting party parts of the gain may be reinvested to stabilize the source. This is called productive wise exploitation (a special case of productive exploitation, Figure 9). Due to the reinvestment wise exploitation is earning less than productive exploitation in the same spot but it will last longer. The productivity gain to the system is no miraculous violation of mass and energy conservation. The gain is a result of the transfer of a substrate from a flat part of a production function (saturated, source) to the steep part of another production function (not saturated, sink).

Figure 9

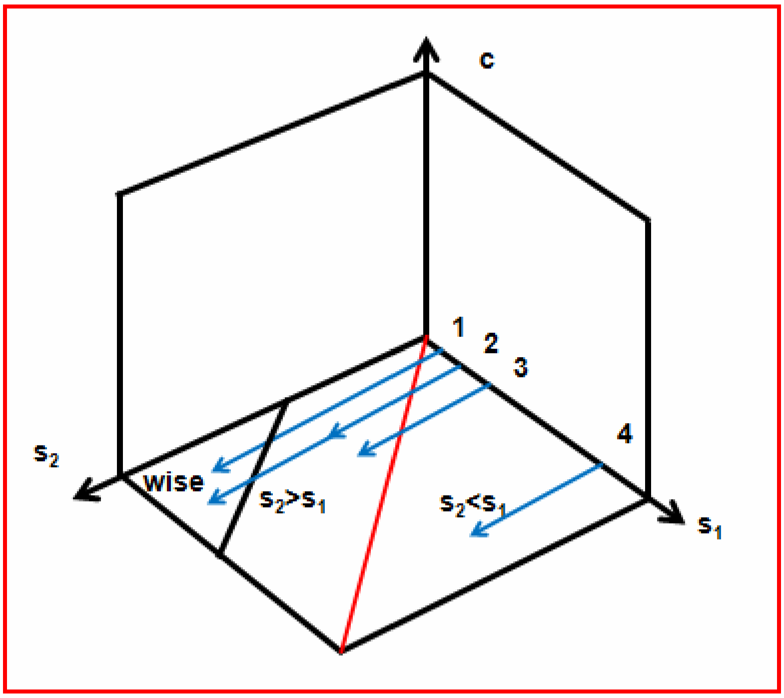

Figure 9. At small fix and variable costs and high productivity (low saturation) in the sink and low productivity (high saturation) in the source the region of wise exploitation is in reach (blue arrow, 1). This region is also in reach by adding smaller amounts from several sources (2) or by inventions to increase the leverage. At higher costs only the region of productive exploitation (3) can be reached. But a reward will always be gained and the ensemble is more productive than the single parties. The size of the reward and the size of the necessary investment determine when wise exploitation will be reached. Finally at very high cost (or low costs and high productivity; $s_1=c+S+p$) only consumptive exploitation is reached. A reward is still earned but here the productivity of the ensemble is below the productivity of both parties. In 3 and 4 the source must come from somewhere else to maintain the system. The red line separates $s_2>s_1$ from $s_2<s_1$.

Breeding, brute force and education are different forms of wise exploitation. Breeding (s_2-s_1-br>0) is a long lasting investment of the exploiting party into the exploited party. This is driven by the gain from the transfer of the substrate to a better production function. Breeding will last many generations although wise exploitation is less earning than productive exploitation in the same spot. Pure productive exploitation will consume the source push trough against direct competitors and disappear when there is no source anymore. If both strategies are not in permanent contact and only in indirect competition reinvesting strategies win. In intelligent species exploitation will be detected very fast and avoided. On the short run - only within one lifetime - brute force and education prevent the loss of the exploited party, too. The loss here is to be understood as entering prisoners´ dilemma (not giving).

- Productive wise exploitation within the complete exchange space:

The three variables s_1, s_2 and c shape the exchange space. Within this space we observe self-ordering. If $c>s_1$ giving will be no problem as giving will improve the productivity of the source. To give in avoided exploitation (prisoners´ dilemma, $c<s_1$) would decrease the productivity of the source and is therefore not reasonable and will lead to exhaustion if induced by brute force or education. On the other side taking will only be observed if $s_2>c$ (cost efficient exploitation). Costing exploitation ($s_2<c$) would lead to a decrease in productivity of the sink.

Additional consequences are to be discussed:

1. Taking not and giving deliberately are observed with high fix costs and high saturation. This is rare and will not lead to wise exploitation due to the high fix costs (Figure 10,1). The outcome of $s_2<c$ and $c>s_1$ depends on the degree of saturation and on specific affinities.
2. Once giving deliberately ($c>s_1$) and taking ($s_2>c$) are combined the productivity of the source and the ensemble will increase very

much. But taking will not end if saturation ($s_2<c$) is not reached for the sink. The source will cross the border ($c=s_1$) and then move on to prisoners´ dilemma ($c<s_1$).

3. Taking from prisoners´ dilemma (giving not) is attractive as fix costs are very low ($c<s_1$) (Figure 10). Only the use of brute force and education is able to realize this. The productivity of the ensemble will end when the source is consumed without breeding. But until then the ensemble is more productive.
4. The subspace s_2-s_1-br-2c>0 (or s_2-s_1-br-2c-bf>0) is producing the surplus and long term stability to fuel co-evolution (Figure 10).
5. There is another subspace of stability in the transfer space. This subspace is called "true symbiosis" and is under strict control of the saturated source. The source can stop giving at ($c=s_1$). The sink is then no longer able to take.
6. Wise exploitation is under the control of the sink, true symbiosis is under the control of the source.
7. Matrix and Vector calculations would be an appropriate treatment.

Figure 10

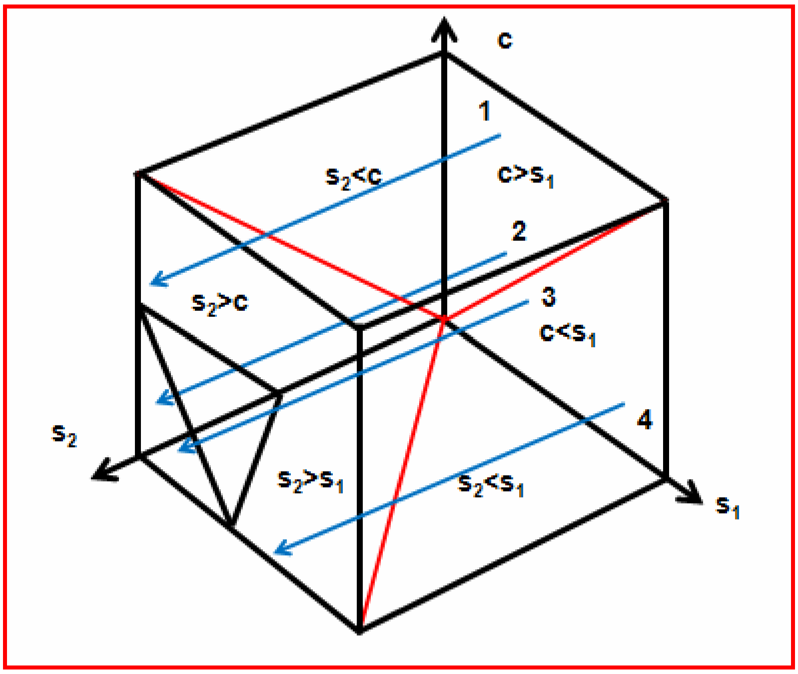

Figure 10. In this example the transformation s_1 to s_2 is very effective (high productive in s_2), the blue arrows are very long. High fix costs will lead to the behavior of giving deliberately, but even at high productivity the transfer will not reach the corner of wise exploitation as 2c has to be paid (arrow 1). At small fix and variable costs wise exploitation is in reach (2: s_2-s_1-br-2c>0; 3: s_2-s_1-br-2c-bf or s_2-s_1-br-2c-e>0). Giving will be deliberately in 2. Education and brute force have to be used to induce giving in 3 and 4. At higher costs only the region of productive exploitation (4: s_2-s_1-2c-bf>0 or s_2-s_1-2c-e>0) will be in reach. Consumptive exploitation is not discussed here.

In general the final benefit (b) to cost (c) ratio for organisms and societies must be larger than zero (b/c>0) to lead to stability and growth. The benefit could be interpreted as the productivity (p) per used substrate (variable cost, S). The cost (c) is the total cost (fix cost).

- The external energy source

All actions of life depend on the external energy from the sun (a few exceptions exist). The suns energy is collected by plants and handed over from consumers of different levels to man in the food chain. The loss of energy in each step is about 90%. The empirical law of mass and energy conservation is strictly obeyed on all levels! On each level of the food chain the residual 10% are handed over via consumption of generated surplus in form of offspring or offspring related products. Only two offspring will survive under stable conditions. The rest is consumed and transformed into productivity of the next trophic level. Man is the final stage of the food chain (usually). If man invests all collected energy and material in offspring, density dependent problems will arise (disease, aggression, starvation). Man can also transform the material and energy into other activities (manufacture, art, science, etc). But energy and material can be spent only once for physical activity. Productivity will result either in offspring or in economic productivity or a mixture with less offspring and suboptimal economic productivity. The transformation process leads to a decrease in fertility as recently published (Myrskylä, M., Kohler, H.-P., Billari, F.C., 2009). The transformation process comes to saturation at an offspring level between three and two as expected. A speed limit is reached when all energy determined to produce offspring is converted to economic activity.

Interpretation

Enzymes

Enzymes are biological catalysts. Their production function is a saturation curve. The behavior is predictable by thermodynamics and reaction kinetics. In a test tube their activity and productivity depends on external physical and chemical parameters (pH, temperature, substrate concentration, product concentration etc) and intrinsic features (substrate affinity, specificity, etc). Source and sink in the test tube depends purely on thermodynamics. If a system of identical enzymes is not well mixed there may be local substrate concentration differences and therefore productivity differences. The combination of local substrate depletion (S+p>0) with potential high productivity and local substrate surplus (S+p<0) with low productivity will lead to a higher overall activity after mixing. After mixing differences in productivity are due to differences in intrinsic features. Enzymes never give beyond the border to prisoners´ dilemma ($c=s_1$; 0=S+p) in a well mixed solution. A thermodynamic view of economy has already been developed. (Eric Smith and Duncan K. Foley, 2005) Enzymes are important active building blocks of organisms.

Organisms

Cells and organisms are partially closed and not identically equipped. The enzymes in their bodies are in different states of saturation. This

different degree of saturation leads to different behavior. Only hungry animals grace or hunt. Many enzymes in their bodies are not saturated. Saturated animals will not grace or hunt because their enzymes are saturated.
Brute force is a fact in animal societies. (Clutton-Brock, T.H., 2009 and Clutton-Brock, T.H. and Parker, G.A., 1995). Animals respond to brute force from other animals. They will not feed or mate and leave the opportunity to dominant animals. Brute force is an investment by the dominant animal and will not be used all the time as fear will be induced. Fear makes the subdominant animal obey. Brute force in intra species conflicts is generally observed and therefore evolutionary stable. What is the reason?
Dominance is a result of mutual aggression and fight. Dominant animals have been successful in such conflicts. Therefore, their genes must be fitter. They are more productive (e.g. more muscles, faster reactions). Taking away food from weaker animals will only increase the productivity of the ensemble if: s_2-s_1-bf>0. This seems to be the case because we observe many species with this behavior. Why is that so? The consequence of the law of energy and mass conservation is that mass and energy stay either within one species/population or are transferred to another species/population. Weak animals are either consumed partially or completely by another species (e.g. pathogen, predator) or they are “consumed” by their own species. This seems to be of advantage to ensembles with brute force as investment. Material and energy stay in the same species/population.

Organisms of different degree of complexity take care for their offspring – others not. Infanticide and cannibalism is observed (Bluffer Hrdy, S., 1979) – this is a surprise. Altruism is not generally observed and it is not dependent on complexity. Could there be another reason for genetically founded altruism? Highly productive organisms produce much offspring. They do not take care but sow the offspring. It would be expected that high productivity is connected to low saturation. Organisms with scare offspring invest the productivity not completely into the production of progeny. Therefore they are saturated. In saturation the productivity of the ensemble of progeny and parent will become higher if material and energy is transferred from the saturated partner (parent, source) to the unsaturated partner (offspring, sink). Not genetic tradition but economics makes parental care under saturated condition a successful behavior. Now we can interpret infanticide differently. The flow of material and energy is reversed when the probability of a successful investment due to a dangerous environment (stress) has become too low.

Societies

Man seems to behave completely unexpected. Enzymes behave rational controlled by thermodynamics - man does not. Man does not have all information necessary and big parts of information given to him (cultural tradition, personal information by others) are systematically aimed to manipulate and disguise him. Education and emotional conditioning is able to modify the behavior in a way that individual harm is the outcome. The group may have an advance. Emotions are a product of man´s evolutionary history. They summarize complex situation and are prone to be manipulated.

The degree of saturation is difficult to determine in complex multidimensional systems. On the background of different genetic equipment two parties with the potential to exchange goods meet. Both sides give and take, do not give and do not take. The fix cost, the variable cost and the productivity is different on both sides. Information of

different quality (wrong by accident, deliberately wrong, partially right, right) is processed on the background of different educational conditioning and prejudgments. In addition the costs and productivity and the informational content change within time and in dependence of former decisions. The result is a complex, multidimensional, constantly changing space. The outcome of exchange decisions is partly rational and seems partly irrational with severe consequences for the individual and the group. A rational decision to give (optimize own productivity) may be wrong because the information was intentional wrong to induce giving. Suffering of the source (biologically or personally) will give a reward to the sink and may foster the productivity of the group. Economic growth seems to be a transfer of material and energy from reproduction to production. The success of a group may relay on the suffering of individuals. But suffering of the source will not guarantee the productive success of the group – it may only serve the consumptive well being of the sink. As always in evolution - success is a feature of the successful - the timescale has to be observed.
Emotions could be a byproduct of evolution. Emotions (fear, love, pride, hate, contempt, etc) reduce the fix cost in the induction of giving/not taking. A reduction of fix cost will increase the productivity of this group.
The transfer space helps to understand the effect of brute force, education (motivation) and emotions in general but also subvention or corruption can be understood.

Summary

A saturated source with high fix cost and low productivity will give voluntarily to a not saturated sink to reduce not earning variable costs and optimize own productivity. The transfer of a substrate from a saturated production function to an unsaturated production function leads to a productivity increase of the ensemble. This is called productive exploitation. The collective advantage may help that the ensemble will prevail against competitors. The productivity gain however is controlled by the sink. The source will give voluntarily until prisoners´ dilemma is reached.

The asymmetry of the beginning and the control of the gain enables the sink to exploit the source further to completeness using brute force or education not to detect prisoners´ dilemma. The sink will use the gain to exploit new sources as long as they are available. When all sources are completely exploited the system will collapse. Stability here is dependent on the continuous influx of new exploitable sources. This reminds of a predator-prey system in biology.

A lasting, self sustaining stability is reached when the gain from the transfer is big enough to pay besides a reward to the sink the necessary reinvestment into the stability of the source. The source is preserved through breeding. This is called wise exploitation. The system will prevail against the exploiting system on the long run but not in direct confrontation.

Saturation is a rare event in the real world! A source having a lower saturation than the sink will not give (prisoners´ dilemma). Here brute force or education to not detect the loss may be used from the beginning to change the behavior from “not giving” to “giving”. Starting in prisoners´ dilemma is attractive as the fix costs are low. The price is paid by the source. Productive and consumptive exploiting systems as well as sustainable systems in combination with breeding may originate here also. The reward in productive wise exploitation is larger than in wise exploitation with breeding. Sustainable systems will only prevail in indirect competition. A saturated sink with high fix cost and low productivity will not take deliberately. The sink will only take when it pays. Game theory seems to be only a flat piece of a whole exchange space.

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