Money is a token of cooperation: The biology of indirect exchanges

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Abstract: This article proposes a clear definition of money, as opposed to credit, by elaborating on the distinction between cooperation and altruism in biology. It argues that these fundamental concepts have been confused due to a sociocentric perspective on the meaning of cooperation. Money should be primarily seen as a store of value, meaning that it mediates interactions that are more constructive than reciprocal altruism. This situated definition explains the challenges typically encountered by monetary theorists, who emphasise either utility or symbolism. The case of Bitcoin, the first form of digital money, provides central empirical support. Indeed, the value of bitcoins does not come from any intrinsic utility nor does it come from an institution. It has simply emerged on the internet, a social environment akin to the ecological environment in which trade has evolved. Like Bitcoin and other cryptocurrencies, money emerges naturally to enable indirect exchanges. This cooperative potential is seized by processes of social reproduction that transform money into credit.

Keywords: game theory, evolutionary social psychology, economic anthropology, definition of morality, social evolution, Stag Hunt, history of money

1. Introduction

Ordering a coffee in Europe involves having the money to pay for it. The café wants money and the customer wants coffee in what should be a win–win situation. However, when the coffee arrives the customer often says 'thank you', and when he pays for it the waiter replies accordingly. We call it politeness and even goodness, but these words explain away what is a genuine puzzle: If both parties act out of self-interest, then why are they thanking each other? What do they feel grateful for?

This article essentially argues that our understanding of cooperation and money is encumbered by these kinds of feelings. We have a tendency to view our market relations as impersonal and individualistic. Even anthropologists have regarded the market economy as fundamentally different from what takes place in traditional societies [1, p. 55]. Yet the above situation suggests otherwise. Gifts have always served to cement important relationships of gratitude and debt or, in the words of Mauss, 'to put people under obligations' [2, p. 73]. In reality, altruism coexists with the issues of reciprocity and self-interest that money has come to encapsulate [3].

We should be able to achieve conceptual clarity through the biological study of sociality. However, as in the case of morality, the lack of good definitions goes largely unnoticed [4] [23]. One exception is Dawkins' proposal that money is 'a formal token of delayed reciprocal altruism' [5, p. 188]. This elegant definition explains the gratitude with which people buy coffee but becomes equally problematic: are we morally motivated to trade? Here, again, altruism is a form of cooperation and reciprocity the basis of morality; so, a café that does not accept dollars is possibly acting immorally and against their own interest.

There certainly are reasons to speak of both monetary and moral behaviour as sociocentric [6-9]. As anthropologists have noted, our different competing tribes all prescribe altruistic 'cooperation' and gift giving. However, a biological notion of cooperation should *describe* what is beneficial to the actor, irrespective of cultural context, and in relation to other possibilities such as that of accepting alternative tokens. These ecological interactions are more accurately understood in the framework of game theory [10]. In this article, I shall describe these games in a way that is more relevant to human life, though I have included a mathematical appendix.

2. Direct interactions

Consider two partners, A and B, who may be individuals or groups of coordinated individuals. Each partner can choose to act in a way that benefits the other, or choose not to act. In an economic context, this will involve transferring a good or providing a service. Benefit may therefore come in two fundamental contexts, basically, one in which mutual action does not bring the greatest benefit and one in which it does:

1) *Altruism*: each partner performs a costly action that benefits the other. If A does not act but B does, the benefit A receives is *greater* than if A did act. Therefore, partners have an incentive to cheat. For example, we can assume it is costly for A to give its fruit to B and vice versa; if they prefer each other's fruit, they can both benefit from an exchange. However, if A and B are hungry, each altruistic action is risky, because there is a short-term incentive to keep both fruits.

2) *Cooperation*: each partner performs an action (not necessarily costly) that benefits both. If A does not act but B does, the benefit A receives is *lesser* than if A did act. Therefore, partners have an incentive to work together (the etymological meaning of the term) and not doing so cannot be considered cheating. This often involves cases in which no benefit will emerge without coordinated action, for example, in hunting down big prey, sailing a ship, or specialising in growing different crops. The possible cost of acting without the other's cooperation is not comparable to the benefit the actor seeks with their action, which is more accurately referred to as an investment. It could even be the case that it is beneficial to act regardless of what the other does, such as when it is costly to keep the goods one aims to exchange.

The above distinction leaves little room for ambiguity because it outlines the two economic games of Prisoner's Dilemma (P-D) and Stag Hunt (S-H), respectively (see the appendix). Some social evolution textbooks discuss it because organisms do not always associate at each other's expense, not least by reproducing sexually [11, ch. 3] [12, ch. 2]. In spite of this, the concepts of cooperation and altruism are confused throughout the literature. West et al. [13] recognised and tried to solve this problem, but ended up introducing more ambiguity (see e.g. Table 4). The

authors try to distinguish cooperation from 'mutual benefit', effectively, due to a global standard of biological value that makes reciprocal altruism 'not altruistic' (sic) but cooperative. More recently, Marshall [12] (see Table 2.3) disagrees. This tendency goes back to the celebrated work of Hamilton and Axelrod on the evolution of 'cooperation' [14], which focuses exclusively on the Prisoner's Dilemma. Cooperation here necessitates reciprocity, meaning reciprocal *altruism*. In this view, individuals engage inevitably with one another, eventually coming across 'cooperators' who punish those 'cheaters' who do not reciprocate. This evokes feelings that have more to do with Western morality and less with cooperation and trade.[1]

When we trade, we normally look for suitable partners first, and then we are glad to use our skills or give up our products in exchange for something else. We do not wish to stay unemployed or keep all the goods for ourselves so that a mechanism of enforcement becomes necessary. This is because we are investing or looking for an emergent benefit in cooperation with others. Similarly, two farmers who specialise in different fruits are not being altruistic when they exchange them directly. They also have negative incentives such as (i) they need to recover the costs of production, (ii) they will not receive their expected product unless they let go of their own, or (iii) not letting go would cost them more in terms of reputation. These interactions are modelled by the game of S-H, as shown in the appendix. Still, this reality coexists with feelings that by cooperating one is sacrificing for a particular other, doing 'what is right', and that one must be rewarded for it. This situation of psychological restriction is modelled by the P-D.

As I illustrate throughout, this sociocentric ambivalence explains why we confuse cooperation with altruism, money with credit, and ethics with morality. It is sociocentric because cooperation and trade do happen between people of different societies or who will not see each other again. When these interactions happen in the traditional intersubjective context of a society, however, they take a moral form. In this anthropological view of morality, one gives not so much

[1] Apart from these conceptual issues, the evidence points to the existence of markets in nature [15], including the classic example of vampire bats [16]. Like the present article, this approach emphasises the continuum between non-human and human behaviour by looking at economic activity as a situated phenomenon. This does not reject global notions of biological value (reproductive fitness) but criticises them as excessively abstract and therefore prone to an anthropocentric bias.

to get something in exchange but to secure partners through debt obligations.[2]

3. Indirect interactions

Morality has been extensively described as a system of indirect reciprocity [18,19]. As noted above, this does not necessarily mean that it is a system of indirect cooperation. I have made the corresponding distinction by calling the latter *ethics* [8]. This is not because it is ethical to always cooperate, but because it seems unethical to punish those who do not cooperate. In accordance with the distinction above, someone who does not cooperate cannot be called a cheater or a defector. They are, in fact, losing out; so it must be the case that they are somehow unable to cooperate, such as in the context of dispersion, mistrust or contingency that exists in nature. In this definition, partners are still being ethical by not cooperating, unlike those who do not return altruistic actions, who would be immoral.

Morality is thus more clearly viewed as a system of indirect altruism, one in which actors do not receive their respective benefit directly from the recipient but indirectly from someone else. In our reduction, B would remain the recipient of A's helpful action but A would be helped by C later on. This creates the problem of whether C will be helped by B, closing a cycle, otherwise B will have exploited the system. This is, essentially, the problem of how moral and monetary systems can evolve on their own, where the latter involves establishing the reliability of a token instead of a partner. That is, C will help A not because B is a reciprocal helper, but because A has given C a token that B will accept in exchange for help.

Again, the literature on indirect interactions largely deals with the case of indirect

[2] This does not mean anthropologists are immune to the confusion. On the contrary, they often make an appeal to tradition, as if morality and symbolism were the only possible means of human association. Graeber [17] summarises it well: 'We are all communists with our closest friends, and feudal lords when dealing with small children' (p. 114). In other words, human existence is seen as a Prisoner's Dilemma where one can only either be fair or dominate others. Like some biologists, anthropologists and social theorists tend to view any hierarchical mode of social organisation (which can involve the cooperation of specialists or mutualists) as a system of reciprocal altruism. In the tradition of Marx, this means confusing production with exchange, or labour with capital. But the fact that people report being engaged in altruism (e.g. 'This is how we repay our mothers for the pain of having raised us', ibid., p. 114) does not entail that the interaction is biologically altruistic. Indeed, if there is so much evidence that human economies are based on gift giving, it is because the species can afford it. In this sense, it would be more accurate to say the topic is *credit* rather than debt.

reciprocity, which is the problem that B has an incentive to cheat by not forwarding *altruistic* help. There is little hope of closing the cycle between A, B and C because, unlike cooperative help, the cost of altruistic help is comparable to the benefit B has received (see the appendix). In order to solve this problem, complex mechanisms of monitoring and enforcement are usually conjectured [14,20]. However, these mechanisms are unlikely to appear in nature [21,22] and must assume that partners are living in close proximity. Consequently, they do not help solve the problem of how money evolves to mediate interactions among strangers. Rather, they help explain how an additional phenomenon of indirect exchange appears in an already cooperative, cohesive human society. This suggests a distinction between money as a biological phenomenon that arises naturally, and 'money' as a cultural, symbolic phenomenon that arises normatively.

3.1. Money

Indirect cooperative actions are analogous to three partners, instead of two, who embark on an unknown enterprise. Money can be understood as a beacon toward such cohesion, in a state of uncertainty about what each of them will contribute, and whether they will contribute at all. This particularly involves preparing for any contingency by investing in something that will attract co-operators. Money is therefore anything whose possession signals the ability and intention to cooperate. This signal is reliable when an individual or group has 'cooperated with themselves' in the absence of partners, for example, by making elaborate necklaces or gathering certain metals; or when it is otherwise known that obtaining those items necessitates such an investment, due to their proven uniqueness.

From the perspective of A and C, if B has secured this kind of item (*m*), it has effectively cooperated first. This means that B can expect a benefit from A, who cooperates because by exchanging its goods or services for *m*, A is investing into its own future need for C's cooperation; and C cooperates with A because it knows that B will be willing to cooperate to get *m* back and start another cycle. Even in the case of a personal item of a lesser demonstrable value, B would honestly want *m* back, at least due to the time and energy put into it. That is, A can exchange *m* with C in the knowledge that C can use *m* to get what it wants from B in the future. This closes the cycle and makes their partnership a self-reinforcing success. When all parties prefer *m* in this way, they continue to add credibility to this memory of past investment, whether they have obtained it themselves or from a partner.

3.2. Credit

Credit reverses the logic of money by mediating altruistic actions that presuppose group cohesion. It cannot easily evolve because a token in itself does not say anything about the group's or the bearer's reputation. However, morality prescribes these interactions and creates what is called a network effect. The cycle begins with A's altruistic action toward B, which establishes a personal relation between A as a creditor and B as a debtor. Now, B can give A a token *m* that defers the reciprocal action required by A. This makes C a debtor to A. Eventually, B ought to satisfy C's own requirement and close the cycle. However, this should also mean that *m* ceases to have a function as a record of B's indebtedness. (This point is important.)

My choice of the same term *m* serves to illustrate that, when B comes up with *m* (as an individual or institution) the personal quality of debt is transformed into a thing that attracts anyone's altruism (including B's!) As I discuss in the next sections, this reification can be facilitated by a physical reliance on money or by sheer imitation. The item continues to circulate primarily thanks to the norms that stimulate its use and create a network effect, namely: if partners ought to be altruistic and accept *m*, then they also have an incentive to *want it*. This encourages B to issue more credit in an odd mixture of duty and desire, compulsion and utility, requirement and expectation (see section 6). This normative process is supported by more altruism, especially by socialising a partner D who can provide additional resources. This is what makes *credit* a formal token of reciprocal altruism, yet one that eventually succumbs to the incentive to cheat that is inherent in the Prisoner's Dilemma.

3.3. Money–credit

The concepts of money and credit overlap due to the influence of morality, which can itself be seen as a conflation of natural and social concepts, or as the confusion of social laws with natural laws that is characteristic of myth [8,23,24]. In this way, morality biases cooperation toward an ingroup with a shared identity, which typically means marrying other group members and sharing resources preferentially with them. This view not only accounts for such a well-known phenomenon in social psychology [25]; it also highlights that the concept of morality cannot logically refer to norms that are universal *and* discriminate against outsiders. Through this cognitive conflation, group members are somehow rationally required to cooperate, rather than

simply expected to cooperate. It affects groups of any size, from a family or clan to a large-scale society. Because these 'relatives' are valued primarily for their partnership, their non-cooperation is perceived as inflicting a cost comparable to the benefit of cooperation. This projection changes the type of interaction, as I illustrate in the appendix: Partners are in an intersubjective prisoner's dilemma where non-cooperation amounts to defection, and cooperation amounts to an altruistic action that risks a possible lack of reciprocity. This happens even if expectations of reciprocity are delayed indefinitely, which is often the case; partners can afford to prolong asymmetric relationships because their contributions are in fact cooperative (see footnote 2). The dilemma is also projected on potential partners, who are seen as either belonging to one's group or to a competing group. In other words, from a sociocentric perspective, nobody is free, everyone ought to be 'giving to us' as their creditors or 'allowing us to give to them' as their debtors, otherwise they are enemies (or gods).

This central feature of our nature probably dates to the beginnings of *homo sapiens*. It explains why humanity would evolve to consist of antagonistic cultures that restrict the cooperative ability of individuals to an exclusive subset of the species. As Cheal writes: 'it may not be winning or losing that is important so much as playing the game' [26, p. 139]. Consider the Kula ring of the Trobriand Islands, the famous example where primitive people exchange what Szabo [27] has called *collectibles*. These people realise that their bracelets and necklaces enable long-distance cooperative trades that would not otherwise be possible, but at the same time, strict customs require that these objects be altruistically given away. Thus, it is not enough that the objects circulate, as they do, as a result of their intrinsic, demonstrable value; they must also favour the particular lineage that originated them, who become creditors of those who hold them. This is done through the additional requirement that objects go back to their owners, the 'paradox of keeping while giving' [28]. This paradox may be contrasted with the more general 'paradox of the non-cooperating defector' to which I have alluded. Indeed, people are generally keen to give because it creates debt obligations, but they would not insist that debtors return exactly the same things that were given away. This happens due to the *monetary* nature of the Kula collectibles, which is probably why they are often held without knowing who their owners are [29].

Other societies are equally bound by 'spheres of exchange' that obey a traditional system of marriage and kinship [1, p. 59]. These reproductive systems can resist the 'impersonal' power of money, restricting it to short-term relations, or they can adopt it [6]. When systematic farming

began in Mesopotamia, precious metals were similarly kept in religious temples along with the surplus. They were used in external trade only by the powerful, and internally to represent personal credits and debts [17]. At the same time, money was finding a way through the back door, so to speak, along with the greater ambitions of civilisation [30,31]. Because of the moral need to channel resources toward the ingroup, it seems plausible that token-money (credit) could buy encounters with 'goddesses of fertility' and participation in ritual feasts from Sumer to Greece [17, p. 181] [32] [33, p. 282]. According to Plutarch, these tokens were given the shape of cumbersome sticks in order to discourage the pursuit of wealth. So, when Greek city-states proceeded to give them the more practical shape of coins, they often ended up buried with the dead. Coinage allowed for more explicit measures of taxation [34], but also more explicit accounts of the sexual services that could be bought [33, p. 134].

In sum, the evolution of money has been led by expanding societies that sought to harness its power. From Alexander's empire to that of the Romans, soldiers were systematically paid with newly minted coins, essentially, to attack foreign people and conquer new land [35]. These unethical actions were surely moral at the time, justified by a belief in various divinities; they served to integrate other societies by introducing a money that would progressively be debased in order to feed a greater reproductive system. This tendency has, of course, continued up to this day. Our planetary-scale nations rely on a system of pure credit, and their central banks resemble mint-temples both in appearance and functioning [32].

4. The origins of money

The holding of money signals ability and willingness to invest in the future. This is why money tends to receive divine status or promote political interests. Money is a proof of uniqueness and reproductive fitness. Obtaining or holding it must require energy, because only this way can it be preferred by other biological individuals or groups who are investing energy for cooperative exchanges. Even if it has been obtained by chance, or stolen, any such party can only hold money if it is fit enough to preserve it as well as forgo the resources that money can be exchanged for.

All of the three main characteristics of money can be derived from this grounded definition. Firstly, money is a good store of value because it registers a previous investment that signals the willingness and ability for cooperative exchanges. Money becomes a good medium of exchange because it is a store of value that parties seek to possess. And money is a good unit of account

because people want to keep it as well as exchange it, which means that they must divide it well. This measure of investment in the light of natural limitations (the scarcity of energy and resources) is the so-called thingness of money.

Economists in the tradition of classical liberalism mistake the thingness of money for the notion of utility or saleability in an attempt to reduce money to a commodity. Commodities certainly signal a previous investment because, like copper or coffee, they must be produced or extracted. However, money does not need to be a commodity, or come from a commodity, because an item can fulfil such signalling function without it being a resource (see Bitcoin below). As Szabo [27] has noted, humans are prone to collect seemingly purposeless items that can function as tokens. Collectibles have been traded and used as records of past favours (even as mnemonics of stories and gossip) presumably because they can be trusted by human groups living very far away and experiencing great economic uncertainty. The basic component of such an intergroup trust is biological. Namely, only a successful group would be able to produce such elaborate items and offer them in exchange. In an economy of pretend givers, where the memory of past interactions can be faint, any reliable proof of the intention to cooperate would have been valued and circulated. As shown in section 3.1, the proof is in the degree of investment naturally required to produce these items, which would readily incentivise cooperators to accept them.

The word *money* comes from the latin *moneta*.[3] In roman mythology, moneta was a title given to the goddess of memory (identified with the Greek goddess Mnemosyne). Moneta was also an epithet of the goddess Juno, the protectress of funds in whose temple the mint of Ancient Rome was located. The words Juno and moneta are etymologically associated with the meanings of *remind*, *warn*, *the one*, *unique,* all of which suggest the idea of a reliable memory or record. Money performs this signalling function naturally, without the need for norms. This means that money always has a social function, in spite of its institutional use by the Romans and others. That is, money has a relationship to everyone else in the sense of human beings who would voluntarily give their property in exchange for it, not 'everyone else' meaning members of a society or country. This genuine social function remains elusive today due to the monetary monopoly of states throughout the 20th century.

[3] Graeber [17] supports an account of money as credit through his knowledge of ancient history and etymology. He cites the word *pay*, meaning to pacify or appease (p. 96). Ironically, he does not cite the word *money*.

4.1. Bitcoin

Created in 2009 by Satoshi Nakamoto, Bitcoin is commonly called a decentralised digital currency. However, according to the present definition of money, Bitcoin is simply the first form of digital money, as opposed to credit that has been issued digitally. Both digital credit and digital money are accounting ledgers that are stored in networks of computers. In the case of credit, the network is centralised, meaning that the authenticity of the ledger is set by a single authority, typically, a government that decides what credit belongs to whom and how much of it can there be in circulation. By contrast, the authenticity of the Bitcoin ledger is decided by a cooperative process called proof-of-work [36]. Any computer that is connected to the internet is free to participate in the process by adhering to a certain protocol. The protocol rewards those 'mining' computers with new coins at a decreasing rate that mimics the scarcity of gold. At root, however, the proof-of-work is a mathematical solution to the problem of coordinating different computers on the internet, in the same way as money in general is a solution to the problem of coordinating different people in nature.

As discussed in section 3.3, the Trobrianders and their Kula ring are a classic puzzle in economic anthropology. These primitive people travel long distances across the ocean in order to give what, in the words of Malinowski, were 'worthless trinkets'. Malinowski concluded that this was a political system of exchange motivated by reciprocity [37]. However, politics requires a means of enforcement that is simply not available to the Trobrianders, as it is not available in the wild of the internet. Szabo makes a convincing case that the collectibles used in this network, through which the men establish important bonds, are a form of what he calls proto-money [27]. In his view, these objects acquire value by circulating, but this emphasises the function of exchange. These elaborate, unique objects have an immediate potential for circulation. They are exchanged in a ceremonial act in which the proud donor talks down to the recipient [29]. And they go back to their owners not because the Trobrianders obey some law of 'inalienable possessions' [28] but because the owners are 'giving-for-keeping' [38] a valuable object.

Of course, one of the key features of bitcoins, as a form of cash, is that claiming them back is futile (due to the extreme difficulty of modifying the ledger against the consensus of the network). Yet the owner of a Kula valuable would equally sever his relationships by actually claiming it back, and as I mentioned, it is often unknown who the owner is [29]. In the spirit of Malinowski, Szabo subscribes to the biological confusion (section 2) by assuming that these

partners are engaged in an individualistic system of reciprocal altruism [27]. He also speaks of insurances and the division of labour as instances of 'cooperation' in a Prisoner's Dilemma. But those who *really* have to deal with a risk of defection do not have time and resources to make the kind of investments required by the Kula, an insurance fund, or specialised labour. And if they do have time and resources, then there is no reason to suppose that they must be caught in a game of 'cooperate' or defect.

Similarly, Krawisz [39] has likened the Bitcoin proof-of-work to an altruistic consensus. However, this mechanism incentivises partnering computers to make a joint decision on the state of the Bitcoin ledger; it does not incentivise them to make independent decisions, which is what the so-called 'temptation' payoff represents in a Prisoner's Dilemma (see the appendix). There is little benefit in 'suckering' the others by detaching from the network and leading one's version of the ledger. On the contrary, the proof-of-work is the reliable signal for a successful Stag Hunt (i.e., the so-called payoff-dominant equilibrium of the game) that brings all players the greatest benefit. Some research explores this signalling mechanism in the light of biology [40,41]. Krawisz insight is also biological, but it is restricted to the signalling of handicap as a means to ensure reciprocal altruism [42]. This costlier mechanism applies to competitive situations that do not correspond to the reality of the Bitcoin protocol.

5. The origins of credit

Network effects can sustain the illusion of credit even when it has no monetary basis, such as in the case of fiat 'money' today. Thus, unlike money, credit is primarily a medium of exchange. Credit imitates money by turning a personal creditor–debtor relation into a thing that can be transferred, or even one that ought to be transferred. Only then does credit acquire the property of being a store of value, albeit one dependent on norms and the altruism of others. Because of this weakness, and the ease with which people are made to feel indebted in a society (to kin, god or flag), credit must also be a bad unit of account. That is, if one wants *m* mainly to give it away, then one will have a lesser incentive to accurately divide it. This is reminiscent of Gresham's Law, which reminds us that 'bad money drives out good money' [35]. Credit can be seen as a money that people do not want as much, because it is a bad store of value, prone to economic miscalculation and inflation.

Credit can have a long life because the norms of exchange that sustain it are strong.

However, it mainly survives thanks to a parasitic reliance on the value of money. Throughout history, credit has used money as a basis, notably precious metals stored in temples or otherwise used for coinage [35]. Rulers have made credit from gold, silver or copper not as a whim; but because in an uncertain world, people cannot reasonably accept absolutely anything as valuable, just as their minds cannot be absolutely embedded in a single normative context. This is particularly true of the military expansions of Ancient Greece and Rome, which needed strong money to create new markets in a context of lawlessness. It is also true of prehistoric times when the possibilities for bringing together separate human groups were minimal. In these situations of distrustful encounters, a strong monetary basis is key. This was the case of collectibles, which were probably the first form of money [27]. Objects such as cowrie shells, glass beads, and wampum have all served the same function. The adoption and devaluation of wampum by European colonists, in particular, is a good example of how money emerges and is subsequently transformed into credit due to the demands of a more ambitious society [35].

Pure credit has its expression in fiat money, which acquires value by decree. These eminently normative tokens are favoured by strong government or the availability of resources. In their absence, the tokens fall out of favour through episodes of inflation. Fiat systems have thus appeared and disappeared at previous times in history [43]. Modern fiat money dominates the world economy thanks to the marriage of banking and state. It originated in 17th Century England when goldsmith bankers began to lend their customers' deposits of precious metals as notes payable to bearer [44]. This means turning a debt obligation (a relationship with the depositor) into a thing that can be loaned and exchanged in the form of impersonal notes, just as the gold itself can. Kim refers to it as the fraudulent promotion of a legal hybridity between rights *in personam* and rights *in rem*, or as a double-ownership scheme [44]. However, the tendency to make credit out of money is simply inherent in human societies and cannot be blamed on a single party (as section 3.2 shows, B can only produce credit together with A and C). In the English case, the scheme was supported by the ability of goldsmiths to honour demands of payment through what is called fractional reserve banking. It was also supported by law, in a novel legal context of individual rights 'against all the world' [45]. Through nationalisation, England finally divorced these bankers' debts from any personal connotations, along with a liberal notion of 'individual' that was political, as opposed to biological. Thus, current monetary theorists refer to all money as credit, and to credit as a claim against 'everyone in society'; meaning an undetermined group of

individuals who are trillions of dollars in debt.

6. Psychology and culture

Today banks continue to create credit in the form of numbers that they treat as property they can lend. This is a virtual experience of utility that resembles the way drugs create an experience of achievement. Lea & Webley [46] explore this behaviour by speaking of money as combining the qualities of a tool and a drug. Other theorists seem to agree. Orrel & Clupatý [47], for instance, ascribe a certain compulsion to the symbolic quantification of value, in a similar way as Kim [48] regards all property as a metaphysical fiction. Ever since the beginnings of civilisation, at least, there has been a duality of usefulness and compulsion, as money was stored in temples that were centres of duty but also of ritual excesses. However, the concept of money need not conform to such an anthropocentric view. Living organisms happen to own the resources that they control against the possible interference of others, which they achieve particularly by dispersing [49]. By controlling money in the same way, human animals own *potential* resources.

Thus, money is a kind of property upon which we project godlike illusions of credit and power over others; and this is because we have always believed in gods of all kinds, not because gods exist or the value of property is metaphysical. We believe in those things because others do, which they do in turn because others do, and there is a clear utility in it. This is the moral essence of institutions, that is, any pattern of behaviour resulting from a linguistic declaration such as 'you are now husband and wife', 'this land is now part of France', or indeed 'this piece of paper is money'. Not coincidentally, there are two main narratives on the origins of money, which are sometimes called chartalism versus metallism [17,50]. Essentially, chartalism contends that indirect exchanges are an institutional product. In this view, all people are dependent on a society and their behaviour determined by declarations such as that something is money. This narrative captures my argument that even a number on an accounting ledger can be money, but it fails to explain how a particular ledger could be preferable to another (in the absence of coercion). On the other hand, metallism contends the exact opposite: institutions in general are the product of rational individuals who can, in the case of money, see the utility of goods for purposes of exchange. This narrative captures the rationality inherent in the coordination games I have discussed, but cannot explain the arbitrariness or even aesthetic nature of money.

I have called these opposing views *narratives* because they are not scientific theories. Both

adopt a cultural perspective that emphasises the symbolic function of ‘money’ as a standard of account for a society. Chartalism has recently claimed scientific status through the work of Graeber, who relies on anthropological evidence that barter, as seen by the metallists, has never existed [17]. Graeber focuses on attacking the myth of barter without explaining why it is so widespread. Indeed, for Graeber, as for Marx, money alienates individuals from their communities through the illusion that owning it frees them from debt. Money seems to appear first in such individualistic form in Ancient Rome, along with the systematic ownership of slaves. So, Graeber concludes, money is the reflection of a mistaken idea of human relations. This narrative has its own problems with the arguments coming from the other side. Of course, ‘money’ cannot be an almighty declaration that bears no relation to its particular embodiment. No matter how powerful legal systems may be, there is a reason they back their accounts with assets.

Through the validity of their respective arguments, both approaches remind us of the science of biology. Like other social beings, humans are neither completely bound by our relations to others nor completely independent of them. Today a foreigner could peacefully buy a coffee with bitcoins, and there is no way to extract such monetary property from these organisms without their individual consent. How are we to explain this social phenomenon? These partners are not reproducing a pattern of behaviour set by a political authority, one that has issued some form of credit. They are also not interested in obtaining these coins due to some intrinsic utility. Yet their interaction is not an illusion. It is a biological game in which they cooperate, in the same way as they can cooperate to resolve any disputes.

Now that internet money has been made a reality, there are hundreds of digital coins vying for users. Some coins are more like money, some less, as governments and social media giants begin to produce their own. Even in the case of a single cryptocurrency, there are issues of governance over the protocol that mirror traditional moral issues, such as whether the ‘money’ should be for the many or for the few [51]. In this case, however, there is no government that decides which policy everyone should obey for the next four years in an exercise of altruism. The currency simply splits into two (in what is called a ‘fork’) and each team goes their own way like the crews of two different ships. This is the ecological basis of cooperation.

7. Conclusion

The tendency to confuse cooperation with altruism needs to be overcome if morality and money are to be understood scientifically. When someone exchanges a coffee for something else, they are not actually being altruistic but cooperative. Any associated feelings of altruism belong in the moral, symbolic context of a society, not in the real context of trade. Thus, a token issued for rewarding altruistic actions (credit) cannot be logically called the same as a token wanted by people who are voluntarily looking to cooperate. The former kind of token follows the actions, whereas the latter necessarily precedes them.

Any system of exchange that relies on credit is vulnerable to deception and exploitation. Because altruistic actions are morally prescribed, there is a clear demand for credit, but also a clear incentive to issue it. In order to increase trust in the system, credit is given a monetary basis that adds to its conceptual confusion with money. It is hard to adopt an objective perspective on these concepts, away from what is commonly called 'society' and from the fact that language itself is sociocentric [23]. From the family to the nation-state, ingroups are all linguistic in nature, epistemically confusing, and charged with negative feelings [8, 24]. The word 'money' is equally shrouded in daunting mystery, but conceptual precision is important in science.

Financial discourse in general is now being challenged by technologies that disrupt the domestic setting in which it evolved. Consider the term *cryptocurrency*. The word *currency* refers to a medium of exchange issued within a legal context (from Middle English: *curraunt*, 'in circulation'). But Bitcoin is not a currency because it exists *de facto* in the lawlessness of the internet, nor does cryptography alone provide its monetary qualities. Instead, bitcoins should be termed *digital money*, in the same way as many commodities and collectibles (e.g. precious metals, cigarettes, salt, teeth, beads and shells) are seen as tangible money.

Human societies endure on the basis of abstract beliefs and kinship systems that recruit cooperative partners. Credit has fuelled their exponential, competitive growth at the expense of the sustainable, intelligent growth that results from money alone. This is not to condemn what has probably been an inexorable process of social evolution. However, now we are in a more conscious position. Morality and credit are fictional forms of value that concern only a subset of the species. On the other hand, money is ethical, because as a real form of value, it enables all human beings to cooperate.

Appendix: Cooperation in game theory

The first box below represents a game of Stag Hunt where player A chooses one of the two row actions and player B chooses one of the column actions. The letters C and NC stand for cooperation and non-cooperation. The numbers are an example of the so-called 'payoffs' (I prefer to call them gains) each player receives depending on their respective choice. In the second game, a Prisoner's Dilemma, the highest gains are additive, which incentivises players to defect (D):

	C	NC
C	2,2	-1,1
NC	1,-1	0,0

	ND	D
ND	1,1	-2,2
D	2,-2	0,0

Interactions can also be sequential, so that if the first mover chooses to help, it runs the risk of not being helped back. The terms 'cooperation' and 'defection' are commonly used to refer to what I have called non-defection (ND) and non-cooperation (NC). This is because they are defined in terms of absolute payoffs, in the case of P-D: 'reward' (1), 'temptation' (2), 'punishment' (0) and 'sucker' (-2). This P-D-centric terminology is also commonly used for S-H.

The boxes below represent a generic view of these games. They display only what player A gains, assuming symmetry. The term *b'* represents the non-additive value gained from a cooperative exchange, compared to the additive value *b* that may be received in either case. Hence, the Stag Hunt is defined by $b' > b$ whereas in the Prisoner's Dilemma $b > b'$:

	C	NC
C	*b'*	*-c*
NC	*b*	0

	ND	D
ND	*b'*	*-b*
D	*b*	0

As section 2 explains, the cost *c* of cooperating without B may not be positive. Correspondingly, a non-cooperative A may receive a benefit *b* from B's cooperation (e.g. a farmer's surplus), but this benefit is not comparable to the greater qualitative benefit *b'* that is derived from fulfilling the exchange. By contrast, altruistic players risk losing *b* in a P-D.

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