ES generation, but it is also *the cause that drives generation*. We make two assumptions: (1) organisms sometimes generate random structures in the environment (pheromones, leaf piles, etc.) as part of their everyday activity; and (2) organisms can track their physical or cognitive effort (i.e., they get tired), and they have a bias to reduce tiredness. The term "tiredness" indicates the "felt" quality of the feedback, which allows tracking of cost using affect – that is, without using a separate computational module.

Some of the randomly generated structures in the world are now encountered by the agents, and in some random cases, these structures make tasks easier for the organisms (following pheromones reduces travel time, avoiding leaf-piles reduce foraging effort). In other words, these structures *shorten paths in the task environment* (see Kirsh 1996). Given the postulated bias to avoid tiredness, these paths get preference, and they are reinforced. Since more structure generation leads to more of these paths, structure generation behaviour is also reinforced. We have implemented this model using both genetic algorithms (evolutionary learning) and the Q-Learning algorithm. The latter implementation shows that reactive agents can learn, *within their lifetime*, to add ESs systematically to their world to lower cognitive load (Chandrasekharan & Stewart 2004). Such within-lifetime learning to reduce cognitive load has recently been shown in homing pigeons. They follow railways and highways to reach their target, even taking exits (Guilford et al. 2004).

The tiredness model explains the process underlying the generation of two of the three ES types possible (structures for oneself, structures for oneself and others, structures exclusively for others). It only partially explains the third. The second type is explained by appealing to the similarity of systems: if a structure provides congeniality for me, it will provide congeniality for other systems like me. The similarity of agents led to them forming structures that were useful for everyone, even though they were just concerned about reducing their own tiredness.

A similar learning system could explain the first of Lea & Webley's (L&W's) puzzles: the origin of money. The tiredness approach is suited to modeling money because, given a barter system, money lowers both physical and cognitive effort, as it helps lower the number of physical transactions, and reduces the computational complexity of tracking branching transactions (agent X has Good B and she wants Good A, but agent Y, who has Good A, doesn't want Good B. Agent X now needs to find an efficient and guaranteed path from her Good B to Good A.). With multiple goods, the branching transaction problem becomes extremely complex, particularly with added constraints like perishability, security, and so forth. Money can be seen as an epistemic structure that emerged to shorten such complex paths in the barter environment, by providing a common structure that can connect any path, reducing both cognitive and physical load.

Applying our model of ES generation to such a view of money, given any barter environment with sufficient cognitive load and transaction costs, and agents that seek to lower their tiredness, a commodity that is in demand by most agents (salt, sugar, spice, gold, etc.) would be used to connect branching paths efficiently. The commodity would acquire this money role the same way pheromones acquired an epistemic role in our simulation. In this view, money emerges not because of evolutionary or genetic advantages, but because of a central survival advantage – the lowering of energy utilization. To test this hypothesis, we are currently designing a network-based barter experiment and a parallel simulation model.

What about L&W's second puzzle: the tendency to acquire money? In the model above, this could be explained by including dopamine as a second reinforcement factor, acting in tandem with tiredness. So, once the use of money is learned by agents in a barter environment, a dopamine-based system takes over. This system "extends" the use of money as a path-connecter – to a tendency to acquire money. Schultz (1992; reported by Braver & Cohen 2000) has shown that dopamine responds initially to a rewarding event, but with training this response "migrates" to predictive cues. This behaviour, where learning chains backwards in time to identify (and reinforce) successively earlier predicators of reward, has been modeled by Montague et al. (1996) using a temporal difference learning algorithm (similar to Q Learning). Such a dopamine-based model would explain the tendency to acquire money (and the pleasure it provides) as an adaptive extension of money's role in lowering tiredness.

Besides cognitive load, two other factors could drive this migration. One, epistemic structures like money significantly expand the space of actions possible (see Kirsh 1996). Being the connector of all possible paths in a trading system, money expands the action space of agents exponentially. Two, epistemic structures make a system more robust, by raising task-success in noisy and high processing load environments (see Chandrasekharan 2005). These two advantages, combined with lowered energy use, make the tendency to acquire money a highly adaptive response.

Money and the autonomy instinct

Siegfried Dewitte

Marketing Research Center, K.U.Leuven, Naamsestraat 69, Leuven, 3000 Belgium.

siegfried.dewitte@econ.kuleuven.be

http://www.econ.kuleuven.be/siegfried.dewitte

Abstract: Applying the reciprocity instinct to monetary transactions implies that the reaction to monetary debt and monetary credit are similar. However, evidence suggests an asymmetry. I suggest that the "autonomy instinct" fits better with human behavior towards money. I show that people value autonomy, and I show how money can serve this instinct.

I concur with Lea & Webley's (L&W's) analysis that human behavior towards money is consistent with Drug Theory rather than with Tool Theory. I also concur with their claim that this implies that money should hinge on a pre-existing instinct. I do not concur with L&W's claim that money mainly parasitizes on humans' reciprocity instinct.

Applying the reciprocity instinct to monetary transactions requires two cognitive tools: a sensitivity to what others owe you (cf. cheater detection module; Tooby & Cosmides 1992) and a sensitivity to what you owe others (cf. the reputation concern; Axelrod 1984). The function of both is to bridge the time lag between the two transaction phases (i.e., giving and receiving) that define an exchange situation. L&W claim that money fills the gap between giving and receiving. Money removes the temporary imbalance between giver and receiver and the negative affect related to that imbalance.

It is critical to L&W's claim that people are willing to fill the time lag between the two transactions with money in *both* directions. They should be motivated not only to get the money they deserve but also to pay the money they owe. Credit cards should be equally as aversive as prepay cards. However, common intuition and recent findings suggest that people do not want to pay their debts as quickly as possible to get rid of the feelings of obligation. People are willing to live on credit and use simple heuristics to decide how much they can borrow (Soman & Cheema 2002). Credit cards are very popular (turnover in Europe in 2004: €617.3 billion), whereas prepaid cards remain marginal and often remain tied to one retailer (e.g., B+S Card Service GmbH 2005), although there is no practical reason why people would not be willing to prepay their expenses. There just seems to be no demand for such a product, although prepay cards would be an efficient way to self-regulate expenses (Trope & Fishbach 2000). Further, there is evidence that living on credit does not hurt when durables are involved (Prelec &

Loewenstein 1998). Finally, the mental accounting framework (Shefrin & Thaler 1988) does not fit nicely with the reciprocity principle: People borrow money even when they have money available on different (mental) accounts. By borrowing, they increase the amount they owe without increasing what others owe them. Borrowing increases the imbalance between giver and receiver, which is inconsistent with a reciprocity instinct.

My claim is that money either (1) parasitizes *only* on the receiving part of the reciprocity instinct (cf. cheater detection) or (2) parasitizes on another instinct. A candidate alternative instinct is the need for autonomy (Deci & Ryan 1985). I first present a series of human behaviors that suggest the existence of this instinct. I proceed by explaining how money might hinge on this instinct. I finish by reviewing several money phenomena that fit better with the autonomy instinct than with the reciprocity instinct.

The value of autonomy can be inferred from several human behaviors. I here define autonomy as independence from social influence. Autonomy reduces the likelihood that others can exploit the agent for their own benefits, and therefore increases survival. Is there evidence that such an instinct exists? Brehm (1966) showed that people are willing to forgo their favorite option in order to establish that they are in charge. Bown et al. (2003) showed that people prefer options that allow further freedom of choice. People also prefer a larger option set for its own sake (Suzuki 1997). Iyengar and Lepper (2000) replicated this finding but added that people are less likely to come back to the same choice situation, which suggests that choice has a cost. Together, these findings support the notion that people are willing to incur costs to preserve their freedom of choice.

How might money serve this instinct? Money may provide a buffer against dependency. In times of scarcity, poor people have to sell their labor or their bodies to survive. Rich people manage to acquire the means and the labor they need to survive. As a result, people might value money for its own sake, even in times of plenty when they cannot spend all the money they possess.

I sketch four observations suggesting that money might be a drug fitting the autonomy instinct rather than the reciprocity instinct. (1) Parents are allowed to give money to their offspring, but not vice versa. Although parent-offspring relationships become reciprocal later in life and are reciprocal in the long run (e.g., when children care for the elderly), this monetary asymmetry survives adulthood. Gaining autonomy from parents is an important step in life, which suggests that the monetary asymmetry between parents and offspring is related to the autonomy instinct. (2) Intrinsic saving motives (Wärneryd 1999) do not make much sense from a reciprocity perspective because they reduce reciprocity. Money that is not spent is removed from the social dependency network and does not build reputation in a reciprocal interaction. However, intrinsic saving motives do make sense from an autonomy perspective. Saving leads to accumulation, which increases independence. (3) Borrowing money from third parties while owning money is difficult to understand from a reciprocity perspective. In fact, borrowing increases the amount you owe others (which is aversive if reciprocity underlies behavior towards money), without increasing what others owe you. However, borrowing from third parties *distributes* social dependency and hence increases average autonomy. (4) According to the autonomy instinct, money should function as a signal of some hidden intrinsic quality of the owner. Money may signal that the owner managed to become independent from the environment. According to the reciprocity instinct, however, accumulated money should raise concern of cheating. Money reflects that the owner received more money than he gave away. Probably both evaluative reactions to wealth exist, but I found evidence only for the first one (Christopher et al. 2005).

To conclude, I submit that human's behavior in the context of money fits better with an autonomy instinct than with a reciprocity instinct. Money might reduce interpersonal dependency rather than organize interpersonal dependency.

Individual differences, affective and social factors

Adrian Furnham

Department of Psychology, University College London, London, WC1 OAP, United Kingdom.

a.furnham@ucl.ac.uk

Abstract: The target article overestimates the power of money as a motive/incentive in order to justify trying to provide a biological theory. A great deal of the article is spent trying to force-fit other explanations into this course categorization. Lea & Webley's (L&W's) account seems to ignore systematic, individual differences, as well as the literature on many negative affective associations of money and behavioural economics, which is a cognitive account of money motivation.

The authors are to be congratulated on an interesting, innovative, and thoughtful paper on a woefully neglected topic. The understanding of how people think about and use money seems at once the concern of all disciplines and of none. Economists have been consistently wrong in asserting that money is the measure of all things but is itself unable to be measured. The everyday meaning and use of money may be a neglected topic in the behavioural sciences but that situation is thankfully changing (Furnham & Argyle 1998).

Perhaps the first point to be addressed and one that is completely overlooked in the target article is the extent to which money is a powerful motivator, particularly at work. Although both psychologists and lay persons hold the view that money is indeed a powerful motivator, the psychological research is far more sceptical about the power of money as a work incentive. Important experimental (Deci et al. 1999) and popular (Kohn 1993) literatures have demonstrated that money has paradoxical and negative effects on work motivation. In the old Herzbergian terminology, money is a hygiene factor, not a motivating factor: it prevents dissatisfaction rather than causing satisfaction. Money, in short, is over-rated as an incentive. It seems not be a powerful incentive, instinct, or motivator except under specific circumstances.

Indeed, Lea & Webley (L&W) overlook the literature which suggests that social comparison in terms of money earned is a much more important source of satisfaction and motivation than absolutes earned (Furnham & Arygle 1998). It is unclear how either Tool Theory or Drug Theory copes with that. Moreover, the literature on what people are willing to trade-off money for (e.g., time) seems at odds with either theory.

Further, there is a literature on the affective associations on money – that is, on what people associate with money (see Furnham & Argyle 1998). For money to be a positive cognitive drug one would imagine that nearly all associations would be positive. The results suggest precisely the opposite: Money is a major source of anxiety, worry, and depression for many – hardly an incentive.

It seems that L&W want to start with a powerful motive so that they can offer a novel biological or evolutionary psychological explanation and theory that parsimoniously explains the processes and mechanisms for money motivation better than all the other theories. But what is the nature of those theories? Are they any better than simple metaphors? The authors seem happy to dismiss Tool Theory as such but want to supplement it with Drug Theory. The ideas are novel but I believe the authors fail on three counts.

First, half of the target article is dedicated to showing how all the other theories in areas as diverse as classic psychoanalysis, economics, and developmental psychology can be fully accounted for by either the tool or drug metaphor. So we get many sections (Depth psychology; Cognitive development) in which, after a short description, the authors suggest that the area fits into one or other metaphor. This is woefully overplayed and often not well argued. Depth psychology is categorized as a