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The role of writing and recordkeeping in the cultural evolution of human cooperation

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ABSTRACT

Efforts to account for the emergence of large-scale cooperative human societies have focused on a range of cultural advances, from the advent of agriculture to the emergence of new forms of political regulation and social identification. Little attention has been accorded to the role of writing and recordkeeping in cultural evolution. Recent insights garnered here from behavioural economics, palaeography, grammatology, evolutionary psychology, and anthropology suggest that writing and recordkeeping helps to solve the problem of cooperation in large groups by transcending the severe limitations of our evolved psychology through the elaboration of four cooperative tools – (1) reciprocal behaviours, (2) reputation formation and maintenance, (3) social norms and norm enforcement, and (4) group identity and empathy.

1. Introduction

Our species' ability to cooperate in large groups of unrelated individuals is perhaps our most important survival strategy. Humans rely on food, resources, labour, and information from fellow group members and routinely share these things with others. We do this on a scale that ranges from small hunter–gatherer societies of fifty or so individuals to large modern agriculturalist societies and nation states comprising thousands or millions of individuals. Such societies require individuals routinely to bear costs for the benefit of genetically unrelated individuals in a wide variety of ways, ranging from the remittance of tribute or tax to more extreme forms of self-sacrifice as cannon fodder on the battlefield. Explaining the evolution of this level of cooperation presents a theoretical puzzle because co-operators in a population are vulnerable to exploitation by free-riders who reap the benefits of cooperation without paying the costs.

A major achievement of evolutionary theory over the last half century has been the development of rigorous models that can account for cooperative behaviours, for instance via reciprocity (Axelrod, 1984), kin selection and the extended phenotype (Hamilton, 1964; Dawkins, 1976), and multilevel selection (Michod, 1999). As we explain in Section 2, current theory can explain most of the cooperation observed in the small-scale societies that characterised much of our evolutionary history. However, large-scale human societies present some unique challenges for these theories, due to both the nature and scale of cooperation and the fact that large-scale societies first appeared and proliferated in the Holocene, too recently to be an outcome of genetic cognitive adaptations. Section 2 outlines how human evolved psychology promotes cooperation in small-groups but is powerless to address the challenges of cooperation in much larger societies. A number of cultural adaptations have been proposed to overcome the shortcomings of our innate psychological tools but little attention has been

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accorded to the role of writing and recordkeeping in the evolution of cooperation in large-scale societies, the main focus of the current study.

2. The limitations of evolved psychology in large-scale societies

Humans evolved in small hunter–gatherer bands facing a wide range of collective action problems such as how to bring down large game, how to support each other in times of hardship, how to coordinate defence against predators (enemy groups, large carnivores, etc.), how to raise children, and how to protect group resources from being plundered and monopolised by self-regarding individuals. Many such problems were overcome through the evolution of psychological mechanisms designed to promote prosociality or detect and punish defectors within the group.

Some of the mechanisms supporting ingroup prosociality are likely to have evolved out of kin detection systems prevalent in earlier hominid species, such as sensitivity to cues of genetic relatedness (e.g. based on smell or other indicators of phenotypic similarity) (Manson and Wragham, 1991; Daly and Wilson, 1999; Henrich and Henrich, 2007). However, for the benefits of cooperation to be exploited in foraging bands of more distantly related individuals, the payoffs of cooperation on a larger scale would have had to outweigh the costs whether calculated in terms of inclusive fitness at the level of organisms or demographic success at the level of cultural groups (or perhaps at multiple levels of selection). Humans possess an evolved psychology that allows them to achieve cooperation within small groups of non-kin using a range of mechanisms.

One such mechanism is reciprocal altruism. Whilst a one-off anonymous act of altruism will, by definition, have negative fitness consequences for the altruist and should therefore be selected against, cooperative or altruistic behaviour can be favoured when the probability of future interactions allows for acts to be reciprocated. Repeated interactions between the same individuals have been shown to favour a strategy of reciprocity or 'tit-for-tat' cooperation (Axelrod, 1984). The net fitness gain of such an exchange is highest when the altruist can provide a large benefit to the recipient with minimal cost to themselves. The opportunities for such repeated reciprocal exchange when hunting in small groups (e.g. sharing meat following a large kill) is thought to have driven the evolution of cooperation in humans and furnished us with a psychology that constantly tracks favours given and owed within our social circle (Haidt, 2012).

In addition to direct reciprocity, in which individuals track the behaviour of those individuals they have themselves interacted with, cooperation can also be promoted via indirect reciprocity, whereby individuals have access to information about the cooperativeness of potential interaction partners (Nowak and Sigmund, 1998). Whereas in non-human primates antisocial behaviour would have to be directly witnessed in order to be detected and punished, the evolution of language made it possible for humans to acquire information about the behaviour of others indirectly, through gossip. Reputation management thus became crucially important to an individual's reproductive fitness, producing among other things a hypersensitivity to being observed by others (Bateson et al., 2006). Human reputational concerns promote cooperation by providing new information about potential partners and by changing incentives to defect by attaching a reputation benefit to cooperation and a reputation cost to defection.

Human cooperation is also normative. Like much of human behaviour, the decision to cooperate in a given situation is not pre-programmed in our genes, but is acquired from those around us. Social learning allows individuals to adjust their behaviour in the light of information about the local environment that has accumulated over previous generations – information that is stable but not so stable as to have been genetically selected (Henrich and McElreath, 2003). Human social learning includes social behaviours dictating how we interact with one another and allows for the establishment of cooperative social norms. Experimental economic games show that most of us are conditional co-operators, tailoring cooperation to the level of cooperation we see around us (Keser and van Winden, 2000; Brandts and Schram, 2001; Fischbacher et al., 2001; Fehr and Fischbacher, 2004). Whilst a few free-riders can undermine cooperative norms and lead to a break-down of cooperation, there is growing evidence that moral reasoning in humans is highly sensitive to issues of fairness (Haidt, 2012) and that in any small community there will be at least some individuals who are willing to punish wrong-doing even at a cost to self, a behaviour known in behavioural economics as 'punitive altruism' or 'prosocial punishment' (Fehr and Gächter, 2002). Cooperative social norms, together with the threat of punishment for norm violations is a key mechanism by which cooperation can be maintained in human groups.

Cooperation also involves human group psychology. Reputational information and/or shared social norms will predict cooperative behaviour most reliably within one's local group. What is more, neighbouring groups can compete for resources either directly via warfare or indirectly via competition. As a result, human psychology has become highly attuned to group membership and signals of group identity as a way of determining how far to extend trust (Brewer, 2007). Even trivial and arbitrary differences between groups are enough to trigger ingroup favouritism (Billig and Tajfel, 1973). There is also reason to think that many striking cultural characteristics of small-scale societies may have evolved via a process of cultural group selection (Henrich, 2004) to exploit this psychology for the benefit of groups. For example, a series of studies have shown that synchronised movement (a recurrent feature of collective rituals across the ethnographic record) increases cooperation within groups (Wiltermuth and Heath, 2009; Reddish et al., in press; Wiltermuth, 2012). Numerous other mechanisms promoting social cohesion have been proposed, including the sharing of food, laughter, and music (Morley, 2012). Dysphoric initiations have been linked to particularly high levels of prosociality within groups, such as military units or ancestor cults, and a variety of mechanisms have been advanced to account for this including costly signalling (Sosis, 2000, 2003; Sosis and Alcorta, 2003), dissonance reduction (Aronson and Mills, 1959), and identity fusion (Swann et al., 2012). As the list of potential mechanisms associated with cohesion and cooperation in small groups grows longer it has been suggested

that rather than seeing each mechanism as a distinct cognitive adaptation it might be better to view the entire cluster as a uniquely human 'socio-cognitive niche' whereby simpler versions of each mechanism in non-human primates came to interact in hominin evolution so as to create an 'adaptive complex' (Whiten and Erdal, 2012).

All these mechanisms may work admirably in groups that are small enough that each individual can keep track of group membership and the behaviour of all or most of the other group members and blow the whistle on free-riders, cheats, and defectors. But what happens when societies become so large that many social interactions occur between strangers? Under the cloak of anonymity there would now be much greater opportunity to transgress while eluding detection or for one's transgressions to go unreported.

Recent research has proposed a range of new mechanisms, over and above those provided by our evolved psychology and ancient hunter–gatherer norms and rituals, which had to be established in order for large-scale societies to emerge and persist. For example, along with the growth of large empires encompassing large populations across wide regions, there emerged new kinds of religions in which moralising gods are attributed the power to detect and punish transgressions (Shariff and Norenzayan, 2011; Gervais and Norenzayan, 2012; Norenzayan and Gervais, 2012). Belief in such gods is thought not only to restore the effects of surveillance even in an anonymous crowd but perhaps to have been bolstered by 'credibility enhancing displays' such as monumental architecture or burdensome rituals that demonstrate the conviction of adherents and motivate transmission of their creeds (Henrich, 2009; Henrich and Gil-White, 2001). These new kinds of religions also produced increasingly standardised bodies of teaching and practice via highly repetitive preaching and ritual (Whitehouse, 2000). This meant that simple emblems (such as styles of dress or body markings) could be used to convey a mass of socially strategic information about a stranger's beliefs and habits, acting as a sort of portable reputation in an anonymous market place (Whitehouse, 2004).

The transformation of face-to-face communities into much larger societies in which interactions with strangers were commonplace began to occur some ten thousand years ago among complex hunter gatherers and gradually led to the rise of the great bronze age civilizations of the Levant and Mesopotamia (Whitehouse and Hodder, 2010; Whitehouse et al., 2012). Similar processes have occurred independently only a handful of times in human history. In some of these cases, the process has gone further producing much larger polities, capable of extending cooperation from tens of thousands to hundreds of thousands or even tens of millions of citizens bound together in so-called 'mega-empires' (e.g. Archaemenid Empire (550–330 BCE), Maurya Empire (322–185 BCE), Han dynasty (206 BCE–220 CE), Roman Empire (27 BCE–284 CE)) (Turchin, in press). This scale of expansion has invariably involved the extensive application of writing and recordkeeping systems. In what follows we show how writing and recordkeeping builds on existing psychological mechanisms to allow large-scale cooperation. In order to sustain sufficient religious and normative homogeneity and coercive control across ethnically diverse populations there needed to be more robust methods of fixing norms, doctrinal orthodoxy, regulating the economy, enforcing the law, and extending systems of governance.

3. Writing and recordkeeping and the problem of cooperation in large groups

Literacy is often described as a cause of increases in group size and social complexity (Tylor, 1865; Morgan, 1877; Childe, 1936; Gelb, 1963; Diringer, 1968; Lévi-Strauss, 1973; Goody, 1987; Daniels, 1996; Schmandt-Besserat, 1996). Many social theorists rank the behavioural innovation of literacy next to the advent of agriculture as one of the most consequential changes that humans have experienced during the Holocene (Smith, 2009; Wells, 2012). The large-scale samples of ethnographic data that are available support the association between literacy and large, complex groups. Citing data from 186 societies, which comprise the standard cross-cultural sample, Basu et al. (2009a) find that the association between empirical proxies for literacy and group size is positive and non-linear with a monotonically increasing mean once group size reaches 200 or more persons ($p < 0.01$).

Despite the theoretical and empirical associations between literacy and large, complex groups, theories of the role of literacy in the evolution of socio-political complexity remain controversial. Some (e.g. Street, 1984, 1993) argue that literacy must be studied as both a concrete object and as a social product of particular political and ideological settings, while others view the social and cognitive effects of literacy as largely invariant (e.g. Goody, 1977, 1987, 2000). The former approach is not sufficient for a comprehensive study of the role of literacy in socio-political evolution because it has not been systematic, choosing instead to rely on carefully selected case studies that focus on the regions or historical periods with which individual researchers are familiar. In addition, an exclusive focus on the micro-level social and political settings in which literate behaviours are enacted risks overlooking common selection pressures and shared solutions to universal cooperative problems (Houston, 2004).

The latter approach fails to acknowledge adequately that literacy has been found to serve a huge variety of social functions cross-culturally and historically (e.g. elite display, divinatory records, transactional histories) (Halverson, 1992; Whitehouse, 2000). More ambitious theoretical accounts of the relationship between literacy and social complexity (e.g. Goody and Watt, 1963; Goody, 1977, 1986; Donald, 1991; Trigger, 2004) submit comparative historical, archaeological, and ethnographic data for several important functions of literacy, but do not provide a broad theoretical framework for understanding why writing is likely to have been key to allowing human populations to increase in size.

Recent insights into human evolution garnered from behavioural economics, palaeography, grammatology, evolutionary psychology, and anthropology suggest that writing and recordkeeping helps to solve the problem of cooperation in large groups by transcending the severe limitations of human evolutionary psychology through the elaboration of four cooperative

tools – reciprocal behaviours, reputation formation and maintenance, social norms and norm enforcement, group identity and empathy.

3.1. Reciprocity

Reciprocity poses several unique computational problems for humans in large groups. First, reciprocal acts in large groups are more numerous and heterogeneous, requiring the tracking of thousands of interactions involving diverse goods and services (Trivers, 1971). Second, when compared to other species, highly social and long-lived species such as our own must track interactions over much longer time scales (Melis and Semmann, 2010), which poses additional computational problems when the number of transactions is increased. Third, interactants in large groups must be able to identify and store data pertaining to each exchange, each of which requires the computation of many distinct cost/benefit ratios and complex forms of reciprocity (Boyd and Richerson, 2006). These cost/benefit ratios must be constantly adjusted over time to reflect the increased cost of performing a costly act without receiving a benefit in return (Trivers, 1971). Finally, all of this additional transactional data must be stored and readily recalled at a high-fidelity to serve as a guide for future behaviour.

Human evolutionary psychology provides several tools for initiating and maintaining reciprocal exchange within small groups. When compared with other species, humans possess a more complex memory, higher levels of information processing, more advanced predictive powers, highly accurate systems for identifying a relatively small number of individuals, precise numerical discrimination, etc. (Axelrod and Hamilton, 1981; Fehr and Fischbacher, 2004). Despite these advantages, human cognition imposes severe limits on our capacities for the creation, learning, and retention of information both as individuals and groups (Dunbar, 1998). Experimental (Basu et al., 2009b), palaeographic (Goody, 1977; Postgate et al., 1995; Goody, 2000; Trigger, 2004; Basu and Waymire, 2006), grammatological (Sampson, 1985; Daniels, 1996; Coulmas, 2009; McCauley, 2011), and observational evidence suggests that writing and recordkeeping systems evolved that transcend the limits of our evolved cognition and help to solve the problem of cooperation in large groups by elaborating human cooperative systems of reciprocal exchange. In particular, formalised writing and recordkeeping systems are shown to elaborate the scale, scope, and complexity of human reciprocal behaviour.

Writing and recordkeeping systems function in several ways to elaborate the systems of reciprocal exchange available to humans through their evolved psychology, thereby mitigating the computational problems posed by large group living. First, writing and recordkeeping systems facilitate the construction of external mnemonic devices for the tracking of large numbers of heterogeneous interactions, which reduces computational problems posed by increases in reciprocal behaviours. This function of writing and recordkeeping systems makes possible the massive scale of modern, complex exchange companies. For example, the NASDAQ OMX Group trades ca. 2 billion shares a day, lists over 3000 companies, and supports exchange operations across 50 countries. Writing and recordkeeping systems served analogous functions in ancient Egypt and Mesopotamia, where they were employed primarily to record transactional histories, convey messages, and organise administrative projects (Postgate et al., 1995; Trigger, 2004). Second, writing and recordkeeping systems provide permanent or long-lasting (Sampson, 1985; Daniels, 1996; Goody, 2000; Coulmas, 2009; McCauley, 2011) and, at times, verifiable (Ijiri, 1975; Goody, 1977; Basu and Waymire, 2006) records of the variable success of a given reciprocal exchange. Finally, writing and recordkeeping systems allow transactional data to be readily recalled at a high-fidelity and serves as a guide for future reciprocal behaviours.

Recent experimental data supports the argument that external mnemonic and tracking systems function can help to overcome cognitive constraints on reciprocal exchange between interactants. Basu et al. (2009b) carried out an iterated multi-dyad trust game in which one investor was paired anonymously with a number of trustees. They found that increases in the number of interactions, which increases the cognitive load for the interactant, increases the probability that an interactant will choose to make use of a recordkeeping technology. In addition to the multi-dyad trust game, a comparatively simplistic single-dyad trust game was conducted. In this game, a single investor was paired with a single trustee. As in the multi-dyad trust game, the investor was given 10 units of experimental currency and initiated 10 periods of interaction. Again, one condition provided the optional use of a reputational technology, while the second did not. Compared with the multi-dyad trust game in which 78% of the interactants kept records, the single-dyad trust game prompted only 50% of the interactants to use the recordkeeping technology.

These experimental findings accord with what economists have long recognised as one of the essential causal factors in the formation of large, successful economies – impersonal exchange (Smith, 1976 [1776]). These experimental findings also accord with the palaeographic record of ancient southern Mesopotamia, which was home to one of the most ancient independent emergences of writing. Early Mesopotamian writing systems were restricted to the functional domain of administrative recordkeeping, basic bookkeeping, and business records (e.g. livestock quantities, lists of workers and their respective rations) before they were employed to send messages or record sequences of events (Nissen et al., 1993; Daniels, 1996; Coulmas, 2003; Bagley, 2004; Cooper, 2004). For example, the 'numeric-ideographic' tablets of ca. 3200 B.C. Uruk were portable, permanent, contained representations of commodities (Nissen et al., 1993; Cooper, 2004), and performed several of the functions that receipts and bank statements function in modern, complex economies.

This evidence suggests that writing and recordkeeping systems evolved that transcend the limits of our evolved cognition and help to solve the challenge of cooperation in large groups by elaborating human cognitive systems of reciprocal exchange. Writing and recordkeeping systems elaborate systems of reciprocal exchange by functioning as (1) external mnemonic

devices for the tracking of large numbers of heterogeneous interactions and (2) permanent or long-lasting transactional records.

3.2. Reputation formation and maintenance

Several criteria must be met for cooperation based on reciprocal behaviours to persist. Interactants must be able to recognise previous interactants, interact repeatedly, and recall the relevant outcomes of previous exchange (Axelrod and Hamilton, 1981). While simple tracking systems allow interactants to store information about individual transactions, large numbers of transactions quickly overwhelm the human cognitive ability to store and readily retrieve relevant information pertaining to a given interactant. Reputation extends and simplifies the information that results from simple transactional tracking by functioning to (a) aggregate the results of several interactions, (b) assign a reputational value or score to an identifiable potential interactant, (c) employ this reputational value to regulate cooperative behaviour, and (d) selectively share this information with others (McElreath, 2003). While reputation formation and maintenance serve an essential function in enabling reciprocal behaviours, this cooperative tool begins to break down in large group living. In large groups the number of potential interactants and actual interactants increases dramatically, requiring interactants to identify, store, and recall larger amounts of transactional knowledge. In addition, the degree to which a given exchange with a given interactant is deemed positive or negative must be negotiated through a much larger web of social relations. Interactions with kin, for example, impose very different criteria for reciprocal exchange than interactions with non-kin (Hamilton, 1964; Henrich, 2004).

While our evolutionary psychology provides humans with several tools for formulating and maintaining reputational images within small groups (Trivers, 1971), these capacities quickly degrade in conjunction with increases in group size and complexity (Dunbar, 1998). Larger, more anonymous groups present fewer reputational inhibitors to free-riding, especially if co-operators produce non-excludable public benefits (Hardin, 1968; Fehr and Fischbacher, 2004; Melis and Semmann, 2010). Without the reputational concerns connected to free-riding that are found in small groups, reciprocal behaviours and complex forms of cooperation quickly disintegrate. Observational, palaeographic (Goody, 1977; Cooper, 1989; Daniels, 1996; Bagley, 2004; Smith, 2009; Woods, 2010), and empirical evidence (Basu et al., 2009b) suggest that writing and recordkeeping systems evolved that transcend the limits of our evolved cognitive capacities for reputation formation and maintenance. These systems function as external identification devices and reputational recordkeeping systems, thereby mitigating some of the computational and cooperative problems posed by large group living.

As external identification devices, writing and recordkeeping systems function to efficiently and accurately identify interactants, decreasing the anonymity of individuals in large groups and providing a means of detecting and tracking transgressors. Large, modern societies are rife with external identification systems. For example, drivers' number plates and licenses function to impose an identity on an otherwise anonymous driver. These external identification devices allow transit authorities, who pre-emptively punish drivers who do not display valid identification information, an efficient mechanism by which to detect and track large numbers of potentially reckless or otherwise non-cooperative drivers. The large, complex freeway system in Los Angeles County, California, for example, plays host to tens of millions of drivers on a daily basis, each of whom can be identified and monitored via this functional application of writing and recordkeeping systems. Similarly, national insurance or social security numbers, addresses, passports, birth certificates, phone numbers, and, most obviously, name badges and employee identification cards function to impose an identity on an otherwise anonymous member of a large community. This functional application of writing and recordkeeping accords with historical evidence of the evolution of the world's first writing and recordkeeping systems. Instead of attempting to mimic speech, early systems codified and stored knowledge that had no oral equivalent (Goody, 1977; Cooper, 1989; Daniels, 1996). For example, accounts for rations, livestock, offerings, and divinations had no oral counterpart (Cooper, 2004). In Mesopotamia, some of the earliest documents contain lists of workers, rations, and tasks (Daniels, 1996). These records facilitated the cooperation of large numbers of workers by providing an index of individuals and individual efforts alongside an individual's respective compensation (i.e. rations). Person names, place names, and institution names were common in some of the earliest writing and recordkeeping systems in Egypt and Mesopotamia (Woods, 2010; Goody, 1977). These early records facilitated the identification and tracking of individuals within large groups.

As reputational records, writing and recordkeeping function to store information regarding large numbers of interactants alongside records of the results of previous interactions (e.g. ledgers containing lists or tables) (Goody, 1977). This function increases the number of exchanges with positive-sum exchange partners by providing a tool to increase investor-trustee coordination (i.e. direct reciprocity) or by increasing the probability that potential interactants will enter into reciprocal exchange with those with a positive reputation (i.e. indirect reciprocity) (Alexander, 1987; Nowak and Sigmund, 1998). Conversely, reputational records also decrease the number of exchanges with free-riders by increasing the predictability of a zero-sum or negative-sum exchange (North, 2005; Henrich, 2006; Basu et al., 2009b). When stored cumulatively, shared, and accurately referenced prior to entering into a reciprocal exchange, these reputational records inhibit the viability of free-riding in a large group. In other words, they facilitate conditional reciprocity (Fehr and Fischbacher, 2004). Examples of reputational records abound in large, modern societies. Amazon or eBay seller ratings, credit scores, credit histories, and resumes are frequently used by potential interactants to assess the probability of a zero-sum or positive-sum reciprocal exchange without the need for previous personal interactions, thereby minimising risk while maximising the number of potential interactants (Resnick et al., 2006; Basu et al., 2009b). This functional application of writing and recordkeeping also

evolved thousands of years ago. In ca. 3100 B.C. Uruk III, for example, detailed transactional data allowed for commodities such as grain, slaves, and livestock to be associated with the individuals or groups involved in the exchange over time (Gelb, 1963). This ancient functional application of writing and recordkeeping allowed interactants to track and assess the reputation of a given interactant over time.

Recent empirical data supports the argument that external identification devices and reputational records function to increase reciprocal exchange between interactants. Basu et al. (2009b) showed that recordkeeping promotes reputation formation and maintenance and spontaneously increases investor-trustee coordination. In the iterated multi-dyad trust game mentioned above, one investor was paired anonymously with 5 trustees and given 10 units of experimental currency for each trustee for each of the 10 periods of the game. The investor chose how much currency to send to each trustee for each of these 10 periods. Each investment was tripled en route to each trustee, who then chose how much to send back to the investor. Cumulative 'image scores', a relatively well-attested empirical proxy for reputation that co-varies with the degree to which an interactant is likely to cooperate (Nowak and Sigmund, 1998; Leimar and Hammerstein, 2001; Milinski et al., 2001; Panchanathan and Boyd, 2004), were compiled for each interactant in the game. Two conditions were held in this game. The first provided access to a recordkeeping technology, a text-based electronic notebook, while the second condition did not. The mean correlation between trustee and investor image scores in the recordkeeping condition was over twice as large when compared to the no recordkeeping condition ($p = 0.05$), suggesting that interactants in the recordkeeping condition were better able to identify and track the reciprocal behaviours of individuals. The difference in mean correlation in the recordkeeping versus the no recordkeeping condition for return on endowment scores, which is a measure of the investor's reward relative to the investor's endowment for each transaction period, was also significant ($p \leq 0.05$), suggesting that there is more positive-sum reciprocity in the recordkeeping condition. This experimental evidence suggests that recordkeeping provides interactants with a more accurate and cumulative means of conditioning their interactions by allowing them to construct more accurate reputational representations.

In sum, writing and recordkeeping principally function in two ways to extend our evolved psychological abilities to form and maintain relevant reputational knowledge. As external identification devices, they function to efficiently and accurately identify previous interactants. As reputational records, they function to store relevant information regarding large numbers of interactants alongside records of the results of previous interactions, enabling interactants to recall the relevant outcomes of previous exchange and cooperate conditionally. These functional applications of writing and recordkeeping work in tandem to facilitate reciprocal behaviours in large group living.

3.3. Social norms and norm enforcement

Social norms and their accompanying enforcement are important tools for the formation and maintenance of cooperation in small group living. Explicit social norms can function to minimise free-riding behaviours by encouraging the adoption of already widely-shared or highly-valued beliefs about how an interactant should behave in a given situation. Despite the observed heterogeneity of human social norms and their accompanying enforcement strategies, they are shown to remove the selection advantage of norm violation and favour the selection of norm-abiding behaviours within small groups. Social norms provide the normative legitimacy behind moral punishments (Fehr and Fischbacher, 2004).

Ambiguity about the mutual adherence to social norms increases in large group living for two reasons. First, interactants in large groups are less sure about what the norm actually is and whether they will be punished for not adhering to the social norm. Second, interactants are less sure that others are following a perceived social norm or that others will be punished if they do not follow a perceived social norm. This increase in ambiguity about mutual adherence to a social norm decreases the probability that an interactant will be included in the consumption of a public good, encouraging the economic incentive to free-ride. Consequently, social norms and their associated moral punishments become less effective in encouraging reciprocal behaviours, which undermine their cooperative function. Palaeographic (Baines, 1983; Goody, 1987; Cooper, 2004) and grammatological (Gelb, 1963; Daniels, 1996; Clark, 1998; Coulmas, 1999) evidence suggests that early writing and recordkeeping systems acted to mitigate the effects of increases in group size and complexity on the construction, transmission, and maintenance of social norms and moral punishments. Writing and recordkeeping systems are shown to serve two principle functions in extending the ability of social norms and moral punishments to facilitate cooperation to large group living. First, writing and recordkeeping systems provide a mechanism for the construction of authoritative, standardised, permanent, and unambiguous social norms. Second, writing and recordkeeping systems facilitate the transmission of social norms by providing a portable, high-fidelity, and repeatedly accessible mechanism by which social norms can be rapidly spread. These two functional applications of writing and recordkeeping also function to deter and punish transgressors. The principal functional applications of writing and recordkeeping to the extension of the cooperative tool of social norms are explored in more depth below.

First, writing and recordkeeping systems encourage the construction of social norms by providing authoritative (Goody, 1968; Gellner, 1988), standardised (Daniels, 1996), and unambiguous (Goody, 1977) statements of the norm. Moreover, when encoded in writing, social norms can be distanced from the identifiable self-interests of their respective authors and presented more objectively (Coulmas, 1999). Similarly, if an interactant is conscious that a speaker is making reference to that which has been recorded and, therefore, that which is open to subsequent inspection, then the interactant is more likely to attribute authority of the speaker (e.g. 'According to the Bible. . .') (Goody, 1977). Not surprisingly, the mandate for reciprocal behaviours is ubiquitous in written moral codes (Wilson, 2000). Early Egyptian hieroglyphs, for example, provide evidence

for the use of writing in facilitating the construction of social norms and moral punishments. Old Kingdom (2600–2150 B.C.) Egyptian texts, which were exclusively produced by officials of the state, often asserted the need to conform to social norms, especially those related to class and rank. Similarly, during the Middle Kingdom (2040–1640 B.C.), 'wisdom' texts emerged that provided instructions for how to best adhere to social norms as well as prescriptive guides for how to live a virtuous life (Baines, 1983).

Second, writing and recordkeeping systems facilitate the transmission of social norms and associated moral punishments by providing a portable (Goody, 1977; Daniels, 1996; Coulmas, 1999), high-fidelity (Goody, 1977; Changizi, 2009), permanent (Goody and Watt, 1963) and repeatedly accessible mechanism (Goody, 1977; Clark, 1998) for their dissemination. Writing and recordkeeping systems elaborate the scale of one-to-many transmission, exposing large numbers of individuals in far flung locales to a given social norm. Standardised written forms, such as those promulgated by the Middle Kingdom in Egypt (Baines, 1983), also facilitate the transmission of social norms across larger polities by providing for increases in the scale of communities of literates (Coulmas, 1999). Codified social norms and moral punishments in the form of written laws and religious doctrine extend the utility of social norms on large groups by replacing verbal testimony with an explicit, observable, and relatively stable alternative. Early Chinese script, for example, contained descriptions of standardised punishments for violations of social norms. Shang dynasty oracle bone inscriptions, for example, contain characters for common punitive measures, such as 'cut off the nose' or 'cut off the foot' (Shaughnessy, 2010). Laws, contracts, and other legal documents also help to maintain social norms between individuals, even amongst those who have never interacted (Coulmas, 1999). These literate forms are stored permanently and are open to public inspection. Legal codes and religious texts can also be directly compared, facilitating the identification of contradictions and inconsistencies and, therefore, mitigating or even forestalling disputes as well as non-authorised innovations (Goody and Watt, 1963; Goody, 2000). Having a trusted individual present during the creation of a given record has a similar effect on ensuring the veracity of a given record (Ijiri, 1975). Beginning with the Old Kingdom, Egyptian writing includes examples of legal documents referring to legal precedent and established legal statutes. Often, ancient Egyptian social norms were formalised and disseminated in perpetuity through their inscription on permanent monuments in accessible, yet protected locations (Baines, 1983). Permanent and public legal documents also function to deter and punish transgressors. Codified legal systems often assign a specific penalty to a given transgression. Modern road signs exemplify the role of writing and recordkeeping systems on deterring potential transgressors (e.g. 'No Littering: Violators Will Be Prosecuted', 'Unauthorised cars will be clamped. Release fee £100'). These signs and their associated penalties function as deterrents for behaviours that deviate from the social norm and threaten the consumption of a public good. Historical examples of the application of writing and recordkeeping systems to this functional domain are ubiquitous. The monumental Code of Hammurabi (ca. 1760 B.C. Babylonia), for example, contained numerous unambiguous statements of social norms and their associated punishments. For example, according to the Code, 'if a man has struck a gentleman's daughter and caused her to drop what is in her womb, he shall pay 10 shekels of silver for what was in her womb; if that woman has died, one shall put to death his daughter' (Fish, 2008).

3.4. Group identities and empathy

Experimental (Dion, 1973; Kramer and Brewer, 1986; Buchan et al., 2009) and cross-cultural studies (Buchan et al., 2002; Gächter et al., 2010) suggest that group identity is a powerful cooperative tool (Buchan et al., 2011). In increasingly large groups, the construction and maintenance of salient and shared group identities poses a significant challenge to cooperation. Evidence from grammatology (Daniels, 1996; Coulmas, 2003; Trigger, 2004; Rogers, 2005), folktale studies (Zipes, 2006), and European history (Watt, 1957; Eisenstein, 1980; Scribner and Dixon, 1988; Donald, 2001) suggests that literacy functions in two ways to exploit human evolved psychology and elaborate the cooperative tool of group identity.

First, group identities in literate societies are often tied to the use of writing systems, themselves, which are incredibly costly to develop and learn. Writing systems are difficult to develop and standardise and are less functional if they are not widely shared. This is evidenced by the fact that independent script emergence only occurred a few times in human history (DeFrancis, 1989; Daniels, 1996; Coulmas, 2003; Cooper, 2004; Trigger, 2004; Rogers, 2005). As a result, there is a selective pressure to learn and use widely shared writing systems (i.e. a cumulative advantage effect) (Merton, 1988). In addition, learning to use a writing system is arduous and time-consuming, requiring highly repetitious formalised training (Rayner et al., 2012). Since the cost of learning a new writing system is high, individuals are unlikely to learn more than one writing system or to switch systems. These selective pressures to learn and maintain widely shared writing systems expands the community of writing system users and provides the potential for these previously distinct groups to create a common group identity through a shared writing system. For example, the dissemination of the Latin alphabet to encode numerous languages expanded group identities during the Christianization of Europe, while the Chinese script spread beyond the limits of the Chinese empire together with Buddhism and Confucianism. Similarly, the Arabic abjad or alphabet came to serve people of three continents in the wake of the Islamic conquest (Coulmas, 2003; Trigger, 2004). In these ways, the expansion of writing systems facilitates the expansion of group identities through time and space.

Second, the application of writing systems to forms of literature (e.g. epic, history, drama, poetry) facilitates cooperation in large group living by functioning to standardise, store, and transmit group identities across increasingly large numbers of individuals. Folktale scholars have long recognised the importance of narratives to the construction and maintenance of group

identity (Zipes, 2006). The vast body of fairy tales created by Hans Christian Anderson, for example, combined regional folk linguistic forms, formal classical speech, and literary motifs to facilitate the collective group identification of previously distinct groups during the nineteenth century. The collection of folk tales by the Brothers Grimm had an analogous effect (Zipes, 2006). The rediscovery and distribution of ancient texts also functions to expand the temporal scope of group identities. For example, the fourteenth-century Italian rediscovery of the Greek and Roman classics prompted the creation of large, centralised libraries in Florence and radically expanded the temporal scope of Italian group identity (Donald, 2001). Similarly, historians of the European Reformation highlight the impact of writing and the printing press in the spread of Protestant group identity (Eisenstein, 1980). Writing and the printing press are also shown to have a profound impact on largely illiterate populations. For example, while it is estimated that only roughly five percent of the sixteenth-century population was literate and that only roughly two percent of the German reading public had direct access to Luther's writings (Scribner and Dixon, 1988), Luther's written and printed communications had a major effect on shaping group identifications around Protestantism because they functioned to authorise, standardise, store, and spread ideas which were subsequently transmitted through predominately oral conduits. In addition to new literate technologies (e.g. woodblock printing, moveable type, printing press, rotary printing), the rise of the new forms of literature, such as the novel in eighteenth-century England (Watt, 1957), function to increase literacy rates and provide new mechanisms for the transmission and extension of group identities across previously distinct groups.

Recently, the role of empathy in the expansion of moral obligations to those beyond one's immediate social group has received a considerable amount of scholarly attention (e.g. de Waal, 2009; Trout, 2009, 2010; Decety and Ickes, 2011; Perry and Szalavitz, 2011). Psychological experiments and behavioural economic games suggest that empathy is a crucial tool in the evolution of cooperation in groups (Krebs, 1975; Lanzetta and Englis, 1989; Baumeister et al., 1994; Batson and Moran, 1999; Fehr and Gächter, 2000; Batson and Ahmad, 2001; Lamm et al., 2007). Recent psychological and historical evidence suggests increases in literacy rates and the production of literature are tied to increases in empathy. In his discussion of the precipitous decline of violence in seventeenth and eighteenth-century England, Pinker (2011) suggests that increases in the production (e.g. the introduction and development of the printing press) and consumption (e.g. increased literacy rates, more accessible literature) of forms of literature (e.g. journalism, memoir, fiction, history) prompted readers to adopt the perspective of the individuals discussed in print. This projection or increased perspective-taking, in turn, induced a state of sympathy, which increased the probability that in individual in a reading public would conduct altruistic behaviours on behalf of the individual or group described in the literature. For example, popular novels such as Charles Dickens's *Oliver Twist* (1838) and *Nicholas Nickleby* (1839) induced empathy amongst their readers for London's orphans, while Harper Lee's *To Kill a Mockingbird* (1960) projected its readers into the racial and gender inequalities of the American South (Pinker, 2011).

This prediction is supported by historical data sets of efficiency in book production (Clark, 2007), numbers of books published (Simons, 2001), and literacy rates (Clark, 2007), which correlate with a decline in violence in seventeenth and eighteenth-century England. Additionally, the capacity for literacy to induce empathy is supported by experimental evidence using two versions of the Prisoner's Dilemma game. The first, a one-shot Prisoner's Dilemma, found that the rate of cooperating jumped from 20 to 70% when participants read a personal note from an interactant (Batson and Moran, 1999). The second, an iterated Prisoner's Dilemma, found that only 5% percent of the interactants cooperated in response to a defection, while interactants who had read a personal note from another interactant beforehand cooperated 45% of the time (Batson and Ahmad, 2001). Citing (a) the historical correlation between increases in the application and consumption of literacy and decreases in violence and (b) the function of literacy to induce empathy in behavioural economic games, literacy is shown to exploit human evolved psychology, extend the scale and scope of empathy, and facilitate cooperation in large group living.

4. Summary

While some of the problems of cooperation in large societies can be overcome by cultural mechanisms that can increase prosociality and reduce defection even among strangers, these solutions are not sufficient to sustain cooperation across indefinitely expanding territory. Writing and recordkeeping systems help to solve the problem of cooperation in ethnically diverse, ultrasocial polities by transcending the limitations of human cognition. First, writing and recordkeeping elaborate systems of reciprocal exchange by facilitating the tracking of heterogeneous interactions on an unprecedented scale and storing the information to guide future reciprocal behaviour. Second, they facilitate reputation formation and maintenance in large group living by providing a record of people's past behaviour and reputational status. Third, they promote the construction, transmission, and maintenance of social norms and associated moral punishments in large groups. Fourth, they expedite the creation of increasingly large and salient group identities by standardising, storing, and transmitting group identities across previously distinct social groups. Finally, literate systems have helped to build empathy towards others in increasingly large literate societies by making more accessible the perspectives of others with whom one would not normally directly interact. These varied functions of literacy have helped to solve the problem of cooperation in large group living.

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