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Creativity and Experience in Nonhuman Primate Communication

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Creativity and experience in nonhuman species: State of the art

The word *creativity*, coined undoubtedly for human achievement, has perhaps never been applied to the behaviour of nonhuman species. Whether this was simply to avoid the threat of anthropomorphism or whether there are qualitative differences between the innovative behaviours of nonhuman and human animals that would preclude the former from being included in the category of creative beings remains an open question. There has, however, been a growing interest in *creative* behaviours in nonhuman species since Lloyd Morgan (1912). Morgan observed that the behavioural repertoire of every animal consisted of two kinds of behaviour, some repetitive and a small proportion of novel behaviours, which were distinctly different from the former regular behaviours. It is this second kind of behaviour that interests us here.

Innovative behaviour in animals has been long investigated under various titles such as neophilia (attraction for the new), exploration, or learning (see Reader and Laland 2003)

but it had neither been shown much academic interest in terms of its functional importance nor considered analogous to human creativity until as recently as twenty years ago (Reader and Laland 2003). Some comprehensive accounts reported tendencies of innovation in certain animal taxa (Thorpe 1956; Cousteau 1958; Cambefort 1981; Lefebvre *et al.* 1997), and argued for a phylogenetic trend of more innovative behaviours being preferentially associated with 'higher organisms' with larger brain sizes (Morgan 1912; McDougall 1936; Wyles *et al.* 1983; Lefebvre *et al.* 1997).

One of the pioneering papers that first drew attention to novel behaviours in animals was a review of primate innovations by Hans Kummer and Jane Goodall (1985). They not only discussed the striking variety of behavioural innovations possible but also highlighted the functional importance of such behaviours. More functional explanations of novel behavioural responses to ecological change have been provided over the years in a wide range of taxa including fish, birds and primates (Fisher and Hinde 1949; Hinde and Fisher 1951; Goodall 1964; Beck 1980; McGrew 1994; Laland and van Bergen 2003). Subsequently, attention was drawn to the psychological and cognitive processes that could underlie innovative behaviours, as, for example, the positive correlation of forebrain size with innovation frequency in birds (Lefebvre *et al.* 1997), which opened up a new approach to study innovation in animals. Such an approach provides an opportunity to carry out investigations regarding the psychological processes underlying innovative behaviour as well as the role of innovation in evolutionary processes (Reader and Laland 2003). With these developments in animal innovation or creativity studies, another area of research has gained more attention, perhaps independently or in conjunction with these endeavours - that of animal social traditions or cultures. These include behaviours that nonhuman animal species develop through their own experience in everyday life or learn from others by observation. During the 1990s, some path-breaking work reported and explained the phenomenon of animal behavioural traditions in a few mammalian species, particularly nonhuman primates (Quiatt and Reynolds 1993; King 1994; Quiatt and Itani 1994; Wrangham *et al.* 1994; McGrew *et al.* 1996). Soon other innovative studies, some conducted even earlier, began to attract attention; these documented social traditions in various other taxa including birds

(Lefebvre and Palameta 1988; Lefebvre *et al.* 1997), fish (Warner 1988) and cetaceans (Rendell and Whitehead 2001).

The notion of culture in nonhuman animals has, however, been challenged, primarily on the basis of the nature of the cognitive mechanisms underlying the inter-individual transmission of behaviours (Green 1975; Visalberghi and Fragaszy 1990; Galef 1991; Whiten and Ham 1992). This controversy mainly emerged from a human-centric definition of 'culture' wherein 'imitation' was supposed to be the only socially learnt process that could transmit behaviours (see Boesch 1995). Further work has, however, shown that social mechanisms other than imitation can underlie even human cultures and raised the idea that narrowing down the definition of 'cultures' too much would lead to ignoring crucial information. Other social learning processes such as emulation, social enhancement and trial-and-error learning were thus subsequently included in the definition of socially transmitted behaviours and what has now variously been called behavioural traditions, social traditions or arguably, culture in both human and nonhuman species (McGrew 1992; Boesch 1993; Wynn 1993; Galef 2004).

In more recent years, research in the field of animal creativity or innovation has focused on the connections between behaviours that are primarily socially learnt through individual experiences in daily life and the inception and establishment of these novel behaviours in the repertoire of the population to which such experienced individuals belong (Galef 2003; van Bergen *et al.* 2004; Boogert *et al.* 2008; see also Reader and Laland 2003).

In this paper, we digress from the usual model of discussions on the innovation-social learning links in animal creativity and examine a range of novel communicative behaviours that nonhuman primates adopt under certain ecological or social conditions (Kummer and Goodall 1985; Goodall 1986; Rowe 1996). An investigation of the variation in nonhuman primate gestures and vocal signals, typically employed in social contexts, both affiliative and agonistic, might throw light, at the proximate level, on the flexibility of both, the production and usage of such signals. Such an analysis should prove insightful not only in understanding the behavioural plasticity underlying

communication modalities in nonhuman primates, but also the creativity that typifies these communicative processes. Ultimately, we might be able to understand the mechanisms with which individual primates learn, if they do, the use of social communicative behaviours and discover whether these could contribute to the establishment of potential social or behavioural traditions akin to human language. We also consider the possibility that such an analysis could finally illuminate the processes underlying the evolution of human language.

Defining creativity and experience in nonhuman species

Creativity in humans has been defined mostly as 'an idea, practice or object that is perceived as new by an individual' (Rogers 1995) or simply as a creative process (Simonton 2003). The definition of creativity or innovation, thus, takes into account the final product of or a process involved in a new behaviour. There are, however, two distinct approaches in defining innovative behaviours in nonhuman species, which hardly overlap, unlike the definitions of human creativity. The common feature of both these perspectives is that they regard innovation as a novel behaviour pattern previously unobserved in the population. One school considers innovative behaviour as a product, which could be a solution to a novel problem or a new solution to an old problem (Kummer and Goodall 1985). The other school defines creative behaviour as a process that includes the inception of a new behaviour, its use in solving a problem, and its subsequent spread in the population (Wyles *et al.* 1983; Lee 1991).

Innovation can, thus, be regarded as a new or modified behaviour (innovation *sensu* product) or as a process that leads to the establishment of such a novel or modified behaviour (innovation *sensu* process; see Reader and Laland 2003). As the interchangeable use of innovation as product or process can be quite ambiguous, it is essential that a proper analysis be conducted of what is actually involved when an innovation is operationally defined in a particular context. The process of acquiring a new behaviour cannot, by itself, be considered an innovation unless the behaviour is newly created or an existing behaviour is modified in a novel manner. Usually, innovation also requires that this novel behaviour be then incorporated into the behavioural repertoire of the individual and used, possibly, in a novel context as well.

For example, when a bird learns a song from its tutor, it is social learning, but if it adds a different note from another adult bird into its song and sings a complete new song, such an end result, the new song in this case, would be considered an innovative behaviour rather than just a process of social learning (Slater and Lachlan 2003). Thus, innovation is a new behaviour 'invented' by an individual (Reader and Laland 2003) or a group of individuals (Laland and Plotkin 1990; Paquette 1992) and it could develop by chance or by individual- or group learning.

The appearance of a novel behaviour may then be followed by a mechanism that would introduce the variant behaviour, now a stable component of the innovator's behavioural profile, into the population's behavioural repertoire. The process of diffusion of this new behaviour to the learning audience could occur through the processes of imitation, emulation, stimulus enhancement, observational conditioning or, more indirectly, by the immigration of new individuals into the group (Whiten and Ham 1993; for a discussion, see McGrew 1998). In a nutshell, all these processes can be perceived as being the experience of an individual embedded in a group. An individual in isolation would not experience the process of social learning although it can be argued that such experiences are not essential for the expression of creativity. An innovative behaviour that has developed by chance or trial-and-error learning in an individual in isolation could also be reinforced by repetition and could contribute to individual experience of a different nature. Although such behaviours could then spread through the group by mechanisms of social learning, there might be instances where the creative novel behaviour does not diffuse to the other members of the group. Rather, it remains restricted to the 'inventor's' repertoire, and the behaviour exists as long as the inventor uses it. In this case, individual learning alone underlies the inception of a novel behaviour, one that never becomes a tradition in the group (Whiten and Ham 1993).

To summarise, we need to distinguish an innovative product from the process that generated it while defining creativity. The product could consist of the final form of a novel behaviour, which either arises *de novo* or by modification of a pre-existing behaviour, but which enables an individual animal to solve a new problem or an old problem in a new way. Such a behavioural innovation *sensu* product has been

considered evidence of creativity by Reader and Laland (2003). This product may or may not then be followed by social learning mechanisms through which another individual experiences the invented behaviour and adopts it in its own repertoire, thus giving rise to a cultural or behavioural tradition in the population, and this has been considered innovation *sensu* process. It can, therefore, be concluded that innovation *sensu* product is a necessary condition for innovative behaviour or creativity while innovation *sensu* process or experience may not always be.

Innovation in nonhuman primate communication

Both innovation and cultural traditions possibly reach their pinnacle in humans, more specifically in a behavioural attribute that is almost uniquely human: organised language. A search for the evolutionary roots of human language and culture should thus involve a close understanding of nonhuman primates (henceforth referred to as primates), with whom we share our closest ancestors. Like us, nonhuman primates lead rather complex lives – and this is often reflected in the intriguing diversity presented by their behaviour. Primates typically live under ecologically unpredictable conditions. Individual primates are thus often called upon to develop innovative behavioural responses to meet the challenges of their physical and social environments and effectively adapt to them. For example, experiences of food scarcity could favour the development of creative foraging strategies while an abundance of food could lead to novel ways of exploring these resources (Knott 1998). Moreover, most species usually live in complex social groups that may change over time and this uncertainty of the social environment also requires individual primates to be behaviourally flexible and innovative in order to survive and reproduce successfully (Reader and Laland 2001; Sinha 2005). Crucial survival strategies, often involving creative behaviour, thus occasionally emerge and these could spread both within and without the group as effective problem-solving abilities that influence the behaviour of succeeding generations as well.

Although nonhuman primate communication has been explored extensively in the wild and in captivity, what continues to remain controversial is the extent of flexibility in vocal communication displayed by individual primates. For example, it has long been debated

whether the development of primate vocalisations is completely hardwired or whether there is a certain flexibility in their production and usage, influenced by social learning processes during early ontogeny (Janik and Slater, 1997, 2000; Hammerschmidt and Fischer 2008). What is more accepted, however, is the significant flexibility of primate gestural communication, which appears to stem from a social learning process of ontogenetic ritualisation during development (Tomasello 1996; Tomasello and Call 2007). The spread of some novel gestures as a group-specific tradition, however, apparently needs different learning processes (see Pika 2007).

A close analysis of innovations in nonhuman primate vocal and gestural repertoires may unveil the role of individual creativity in generating some of these behaviours. Moreover, they might reveal whether novel social learning processes other than the usually understood ontogenetic ritualisation could be responsible for their further development and establishment as behavioural traditions within certain primate groups. We now present some examples of apparently novel nonhuman primate vocalisations and gestures that allow us to understand the level of plasticity underlying such communicative behaviour.

Creativity in nonhuman primate vocalisations

In direct contrast to the widely held belief that most primate vocalisations are involuntary responses, there have emerged, in recent times, studies that report a certain level of plasticity in the production of specific calls (reviewed in Snowdon 2009). We stress on vocal production because the usage and comprehension of vocalisations have already been accepted to show clear signs of flexibility (Seyfarth and Cheney 1997). Such lability is usually reflected in the developmental processes that allow naïve individuals to learn the apt usage of specific calls rather than to produce them perfectly, and more explicitly manifest in the generation of novel calls or in creative modifications and usage of pre-existing calls (see also Sinha 2003, 2005).

Examples of creative vocal production from the wild are quite rare. Although there are examples of behavioural traditions in call structure within populations of chimpanzees, tarsiers and other species, the point of inception of such variant calls remains unknown.

The possibility of genetic drift giving rise to such differences, for example, cannot be easily ruled out (Mitani et al. 1992; Mitani and Brandt 1994; Burton and Nietsch 2010). There does exist a single report, however, which confirms the failure of genetic drift to explain inter-population differences in the structure of pant-hoot vocalisations in chimpanzees (Crockford et al. 2004). Such differences in vocal production might contribute to the ability of individuals to distinguish between group and non-group members and these could, therefore, rapidly establish themselves as cultural traditions between groups. Similar observations have been reported in populations of pygmy marmosets, where individuals modified their J-calls and trill vocalisations depending on the habitat conditions (De la Torre and Snowdon 2009). Ecological conditions also seem to affect the vocal production of wild olive baboons, similar to that reported for pygmy marmosets, with baboons in forested areas producing calls of relatively lower frequency and longer durations than those in populations inhabiting open fields (Ey et al. 2009).

More creativity in the production of vocalisations has, however, been observed in captive groups of several species of nonhuman primates. For instance, two female juvenile Japanese macaques, who had been conditioned to respond to their names, given by the food provider, differently improvised the coo-calls in their repertoire (Masataka 1992). These responses were distinct to each individual and were described as 'idiosyncratic' improvisations, although they definitely fit into the category of creative production of vocal signals. Barbary and Japanese macaque groups arising, in each case, from an original founder population and separated subsequently for 20-30 years, were observed to develop novel variations of social shrill-bark vocalisations and coo-calls, respectively, in captivity (Fischer et al. 1998; Tanaka et al. 2006). These differences could only be attributed to flexible inventions peculiar to each group as the short time of separation of these groups from the founder populations precluded the appearance of significant genetic differences between them. The coo-call variation displayed by the captive Japanese macaques was reported in adults alone while infants only developed the variant calls after experiencing a certain level of exposure to the calls – a clear example of innovative behaviour diffused by social learning. What, however, remains unknown is whether these novel calls were products of individual

creativity or of group innovation. Pygmy marmoset captive populations have also been experimentally shown to modify their calls under changed social conditions (Snowdon 2009).

The relatively higher levels of innovation in vocal production displayed by primates in captivity than in the wild could be an artefact of the lower number of studies in the wild and the greater amount of time spent on captive populations for experiments. More investigations of primate communication in the wild have also been carried out to understand the referentiality of individual calls with significantly less attention paid to contextual social calls of the study species. It is, however, social calls that appear to exhibit a relatively greater potential of plasticity than do other calls that are involved in more survival-related functions like the avoiding of predators or the finding of food. It should, however, also be borne in mind that there are also instances where novel vocal production has been observed in typically costly situations such as predator attacks. A Japanese macaque individual, for example, once invented an alarm call for a rattlesnake, a novel predator for the species (see Reader and Laland 2003). A more holistic approach to involving a greater variety of vocalisations is thus called for if one wishes to understand the inherent flexibility of primate communication systems.

Creativity in nonhuman primate gestural communication

Gestural communication in nonhuman primates, particularly the great apes, appear to be more creative and shows considerable flexibility in the production and usage of gestures both in the wild and under captivity. Comparative studies on prosimians and monkeys are, however, rare and present an urgent need for the future.

Examples of truly innovative gestures, generated in the wild, however, continue to be exceptions rather than the rule, even in apes. A pioneering paper on genuine gestural innovation in wild chimpanzees by Kummer and Goodall (1985) reported a classic example of males in a single group that repeatedly rattled and banged on empty kerosene cans in order to generate loud noises during aggressive interactions. Although many individuals of the group used the gesture, there was one particular individual who succeeded in actually threatening his group members through this

newly found gesture, thus retaining his dominant position in the group. In the same group, another novel gesture – that of inviting an infant to be carried – was repeatedly used and soon established itself as a group specific communicative behaviour as it was able to achieve its intended goal. Certain gestural innovations, however, may not succeed in establishing themselves as traditions in the group although they could have been used by more than one individual for a certain length of time. A female chimpanzee, for example, invented a gesture of wrist-shaking in an aggressive context (Goodall 1973) but though this practice was adopted by another female of the same group, it was eventually lost from the repertoire of the inventor as well as that of the adopter.

As in the case of vocal communication, captive primate groups typically show a relatively greater number of innovative gestures. Zoo-living orangutans, for example, were observed to modify their sequence of gestures to receive their desired food according to the level of understanding of the food provider (Cartmill and Byrne 2007). If they perceived the individual to have only partly understood their desire, they displayed the same gestures repeatedly while, in cases of complete misunderstanding, they created a new sequence consisting of novel gestures in order to achieve their goal. Another group of rehabilitated, captive orangutans adopted different types of novel gestures, amongst which an adult female invented a signal, arguably an iconic one, to communicate nursing behaviour to her infant while a juvenile female of the same group created a gesture to request her desired processing of a coconut to a food provider (Russon 2003).

The creative development and use of novel gestures appear to be more rarely reported among monkeys, especially in the wild. Sinha (2005) reported a number of innovative gestures used in communicative contexts in two populations of wild bonnet macaques in southern India. Three adult individuals of a troop, for example, systematically begged for food from people with their hands outstretched while standing bipedally on their hindlimbs – an interesting form of inter-species communication between two primate species. This appears to be an example of the rapid spread of a novel behaviour within a segment of a population implying the involvement of a largely horizontal, within-

generation cultural process (Cavalli-Sforza and Feldman 1981). These three individuals were amongst the highest ranked of all the adult males and females in the group and least shy of humans, implying a possible underlying role for temperament in such behavioural innovation. Only individuals that were motivated strongly to approach people and beg food from them were perhaps able to learn and/or display this behaviour

A different example of a group-specific behavioural tradition that also apparently arose from a creative innovation in a communicative context was demonstrated by the adult females of a troop in another population. Six of the nine adult females of the troop shook branches very frequently at human observers and less frequently towards other troop females during agonistic interactions; this is a behaviour regularly shown by dominant bonnet macaque males but rarely by females. Remarkably, not once did any of the adult females of a neighbouring troop display this behaviour under any circumstance. It is noteworthy that these two troops shared the same habitat and frequently interacted with one another – thus ruling out environmental causation for these behavioural variants (Sinha 2005).

A classic example of a novel gesture among monkeys, evolved under captive conditions, was that developed by female hamadryas baboons in Basel Zoo, who expressed affiliative interest for one another by walking in parallel with their tails intertwined and held erect (Kummer 1995). A captive group of mandrills invented a gesture of hand extension directed towards other adults in social contexts (Laidre 2008). The juveniles of the same group not only learnt this behaviour from the adults but used it in a completely different context – to solicit play from the adults as there were very few other juveniles in the group. This is not only an example of innovative behaviour diffusing through a group but also its adoption for a novel use in a different context by a different subset of individuals within the same group. Innovation can thus take on different forms, fuelled by individual creativity and experience. There are also occasional examples of idiosyncratic gestures, performed by single individuals, observed in several species, as for example, bonobos (Pika 2007). Although such records have not been given much importance, such gestures could, in future, mark

the beginnings of novel behavioural traditions in these groups; initial reports of the inception of these behaviours could immensely help in re-constructing the whole process.

Creativity and experience in nonhuman primate communication: Clues to the evolution of language

Creative innovations in nonhuman primate communication that often spread within groups through social learning, reinforced by individual experience, and give rise to group-specific behavioural traditions or cultures, present some interesting issues. First, virtually all the documented examples of such creativity seem to be related to calls and gestures in the social context, rather than, for instance, predator avoidance. One explanation for this could be that, evolutionarily speaking, social contexts are less critical in terms of the basic survival of individuals. Thus, individuals can afford to take the risk of behavioural flexibility in such situations. Another possible explanation could be that the social environments that primates live in are far more unpredictable. Individuals of a particular macaque species, for example, usually face similar kinds of predators in their natural habitats. The social environment for any individual of this species, in contrast, is often not as predictable. One could, therefore, expect that an alarm call is likely to be more stereotyped for the species while social calls, as for example those used in affiliative contexts, could be naturally selected to be flexible and innovative, depending on the contexts that the individual finds itself in.

Of greater interest, however, are the insights that could potentially be drawn from such examples into the evolutionary roots of human language. The dominant paradigm today argues for human language being categorically distinct, which could have evolved either gradually or suddenly (Chomsky 2007; Ghazanfar 2008). The suggested uniqueness of human language is believed to stem from the innate human capacities of innovation and social learning, with 'traditional transmission' by learning being a hallmark of human communication (Hockett 1960). A child thus learns socially to combine innate sounds or phonemes to form words and sentences (Vygotsky 1986). This ability to create an infinite set of words and sentences from a finite source of phonemes or, in other words, this 'double articulation' or 'duality of patterning' is considered to be yet another

exclusive feature of human language (Hockett 1960). Additionally, humans can invent new words and add meanings to them by improvising and creating new utterances (Hockett 1960).

The creation of novel communicative behaviours by nonhuman primates and their acquisition by naïve individuals through social learning, some instances of which were discussed above, however, suggests that the generation of human language may not truly be unique. Transmission of newly discovered communicative behaviours and their establishment as social traditions have now been well documented in Japanese macaques (Masataka 1992), Barbary macaques (Fischer et al. 1998), chimpanzees (Crockford et al. 2004), bonnet macaques (Sinha 2005) and orangutans (Cartmill and Byrne 2007). Nonhuman primates also combine different gestures to form sequences, (Poss et al. 2006; Call and Tomasello 2007; Cartmill and Byrne 2007), similar to the duality of patterning displayed by humans. Although we are still far from deciphering the meaning (semantics) and organisation (syntax) of such sequences, the fact that different modifications elicit different behavioural responses is proof enough of their differential information content. Finally, there is now increasing evidence of the capacity of monkeys and apes to produce new calls in novel contexts, both in the wild and in captivity (Japanese macaques, Masataka 1992; orangutans, Russon 2003; Campbell's monkey, Ouattara et al. 2009; see also Reader and Laland 2003).

Some of the characteristic features of human language, traditionally considered unique to our species, thus, appear to be present in nonhuman primate communication systems to varying degrees. This capacity to innovate and learn novel communicative behaviours socially, therefore, could be a general ability of nonhuman primates although it does not appear to manifest itself too commonly in the wild. This could be due to two possible reasons. First, as described above, creativity is not as critical for an animal's survival as are the immediate needs of survival (Kummer and Goodall 1985). More importantly, creative communicative behaviours could fail to be effective in groups that are not typically cohesive or where inter-individual behavioural coordination is weak. In captivity, however, where individuals live under energetically relaxed conditions, nonhuman primates do evolve innovations in novel situations. Systematic

investigations into creative innovations in nonhuman primate communication and their cultural transmission through social learning, usually accompanied by individual reinforcement learning, could thus further our understanding of the evolutionary pathways that have shaped human language.

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