

## 6 Theory of mind and the evolution of language

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### 1 Introduction

While language and its processes have attracted considerable interest from both linguists (with a primary interest in its intrinsic structures) and psychologists (with interests in how languages are learned and how speech is perceived), questions about the function of language and its evolutionary origins have largely been ignored. This has probably been inevitable given the limited information available, but it is ultimately necessary that such questions should be asked. Failure to do so is the equivalent of describing in minute detail the mechanical structures of a motorcar, but refusing to ask either how cars came to be there or what they are used for. If we do not understand why we possess a trait (particularly one that appears to be all but unique to our species), we will never fully understand either its properties or its failures in individual cases.

Biologists have long been used to distinguishing four different kinds of questions that are now widely identified as *Tinbergen's Four 'Whys'* (Tinbergen 1963). These refer to questions about *function* (purpose), *mechanisms* (the machinery), *ontogeny* (development) and *phylogeny* (evolutionary history). These four kinds of questions are logically independent of each other, but all need ultimately to be addressed if we are to claim that we have understood a phenomenon properly. Functional questions are particularly important in this respect, because they lead us to an understanding of just why traits exist. However, functional questions are probably among the most difficult to deal with. Indeed, function is particularly difficult to identify when only a single species possesses the trait, as is the case with language. Nonetheless, considerable in-roads can be made into these kinds of questions without having to resort to 'just-so story-telling'.

In this chapter, I shall try to address some of these issues. One crucial concern will be to identify the functional origins of language in humans. Another will be the relationship between language and the phenomenon now known as 'theory of mind' (one of many elements in the mechanisms category). A third will be the evolutionary history of language: when did language first appear in the hominid lineage? My intention is not to give a full account in each case (these can be found elsewhere: for overviews, see Dunbar (1996, in press)), but rather to draw attention to the kinds of questions that we need to ask and to the kinds of answers that these questions require.

## 2 The function of language

Conventional wisdom assumes that language is either an epiphenomenon consequent on the evolution of large brains or that it evolved to facilitate information transfer (for more detailed discussion, see Pinker & Bloom (1990), Pinker (1994)). Moreover, if any scenario is offered at all for the latter selective advantage, it is implicitly of either the 'There-are-bison-down-at-the-lake' or the 'How-to-make-a-tool' variety: in other words, language exists to enable humans to exchange factual information about the external world (the unwritten assumption being that this most often had something to do with hunting or tool-making, and therefore with male activities).

Biologically speaking, the epiphenomenon argument flies in the face of the fact that brains are extraordinarily expensive organs to evolve and maintain (Aiello, this volume; Aiello & Wheeler 1995). The average human brain weighs about 2% of adult body weight, yet consumes something approaching 20% of the body's total energy intake. Such an exceptionally high energy consumption imposes significant costs on the individual in terms of its time budget and its exposure to predation risk while foraging (when it could be resting in a secluded hide). The sheer cost of maintaining brains acts as a steep gradient against which any selection pressure favouring bigger brains has to push. In the absence of any selection pressure, larger brains will not evolve. Yet primates in general (and humans in particular) have unusually large brains, even by mammalian standards (Jerison 1973). Since brains do not come for free, some very powerful selection pressure is required to make it worth a species' while evolving them. Given this, having any

space at all dedicated to language (or speech!) must add measurably to the costs incurred by the individual, and would thus be selected against unless countervailing selection pressures made language advantageous.

The main thrust of most of the recent research in this area has favoured the view that the required force was social, not environmental or technological (Barton 1996; Byrne 1995; Byrne & Whiten 1988; Cheney & Seyfarth 1990; Dunbar 1992, in press; Sawaguchi & Kudo 1990). The need to hold large highly structured groups together has been more important than the need to solve ecological problems. (This does not mean that ecology is not, ultimately, the driving force in evolution: the issue is whether ecology influences brain size *directly* or whether it does so *indirectly* via group size. Biologically speaking, these involve two very different mechanisms.) In response to ecological pressures demanding large groups, species were forced to evolve proportionately larger brains in order to allow large groups to remain stable (for the history of this idea, see the early chapters in Byrne & Whiten 1988). This has given rise to the so-called 'social brain' hypothesis (Barton & Dunbar 1997; Brothers 1990) which emphasizes the claim that the primate brain (at least) is largely a social rather than an ecological tool. This view in turn rests on growing evidence that primates (in particular) are significantly more skilled at solving social problems than they are at solving ecological problems (Cheney & Seyfarth 1990) and that a significant component of these social skills involves what has become known as 'Machiavellian Intelligence' (Byrne & Whiten 1988).

The strongest evidence to support this claim is provided by the finding that social group size correlates very closely with relative neocortex size in primates (Barton 1996; Dunbar 1992, in press). More importantly, a number of other analyses have revealed correlations between neocortex size and (a) frequencies of tactical deception (Byrne 1995), (b) alliance clique size (Kudo, Lowen & Dunbar, submitted) and (c) social skills involved in male-male competition (Pawlowski, Dunbar & Lowen, in press). In contrast, neocortex size does not correlate with a number of ecological variables that are associated with foraging demands (e.g. range size; day journey length; degree of frugivory, extractive foraging skills) (Barton & Purvis 1994; Dunbar 1992, in press).

It seems that this relationship between neocortex size and social group size applies even to humans. A group size of 150 is predicted from human neocortex size on the basis of the primate neocortex-to-group-size relationship and groups of this size appear with monotonous

frequency in a variety of contexts in both traditional and modern post-industrial societies, particularly those contexts that involve detailed personal knowledge of other group members (Dunbar 1993a, 1996).

The size of these groups creates an interesting problem. Primates bond their social groups by intensive use of social grooming. Exactly how grooming works to bond relationships within groups remains unclear (though we know that at least part of the process involves the fact that grooming acts to release endogenous opiates, and these opiates act as one of the proximate reinforcers for grooming: Keverne, Martinez & Tuite 1989). The important point in this context is that grooming apparently acts to bond primate social groups. This is evident from the fact that there is a linear relationship between group size and the amount of time devoted to grooming (at least among the Old World monkeys and apes (Dunbar 1991, 1993a)) and that, in species like baboons, social groups that devote less than the amount of time predicted by this relationship to social grooming are unstable and highly likely to fragment and/or undergo fission (Dunbar 1993b). The impact of this effect can even be seen clearly at the level of the individual: female baboons attempt to protect their time investment in social grooming against its erosion by the increased demands for feeding time as their babies grow, giving way only once all other sources of alternative feeding time (principally resting time) have been exhausted (Dunbar & Dunbar 1988).

The relationship between group size and grooming time observed in primates can be used to predict the amount of time that humans would have to devote to grooming if they were to bond effectively the groups of 150 predicted by the size of their neocortex. The answer turns out to be something in excess of 40% of total daytime. This is approximately double the highest amount observed in any wild primate group (20% in one population of gelada (Iwamoto & Dunbar 1983)). Clearly, no species that has to live in the real world can afford to devote so high a proportion of its time to social interaction, unless it is prepared to starve.

Ancestral humans thus faced a dilemma: while increased group size was being demanded by ecological pressures, time budget and energy constraints were preventing them from evolving these large groups. A species in this kind of ecological dilemma has two choices: acquiesce quietly (as it were) in the inevitability of extinction or alter its behaviour (and the anatomical mechanisms that underpin this) in such a way as

to resolve the problem. I have suggested that our ancestors adopted the second strategy by evolving language to cut through the Gordian Knot of the time budget constraint (Dunbar 1993a, 1996).

Language was an effective solution for several reasons. First, it allows more efficient use of time because an individual can 'groom' up to three individuals at the same time (Dunbar, Duncan & Nettle 1995). In contrast, social grooming is a strictly dyadic activity: you cannot groom more than one individual at a time. Second, language allows the direct exchange of information that can be used to build and service relationships without the need for direct physical contact. Language can be used for advertising oneself, for courting prospective allies or partners, for acquiring information about the behaviour of prospective or existing partners when these are not physically present. The latter seems to be especially advantageous because all other species are totally dependent on direct personal observation to learn about the behaviour of other group members. In contrast, humans can find out very rapidly about the reliability of an ally or about a friend's good or bad behaviour via third parties (Dunbar, Duncan & Marriott, 1997).

One way to test the suggestion that language enables savings of time would be to show that the amount of time devoted to social interaction is no greater in modern humans than the limiting value of approximately 20% of time found in other primates (and certainly lower than the 40% predicted by the primate regression equations). Data are sparse on this topic, and differences in the way activities are categorized make direct comparisons between studies difficult. Nonetheless, there does seem to be general agreement that the amount of time devoted to social interaction in a wide variety of cultures is rarely more than about 20% of the waking day (Table 6.1). This is particularly clear in the two studies that report conversational or social time directly. Emler (1994) found that his Dundee (Scotland) subjects engaged in about 20 conversations a day on average, each typically of about 10 minutes duration. Thus, about 3.3 hours out of a 16-hour active day (approximately 21%) was spent in conversation (the principal mode of interaction among humans). Grossman (1984) provides time budget data on Kapanara (traditional horticulturalists from New Guinea) which suggest that, on average, 20% of the day is spent in social interaction.

The other studies listed in Table 6.1 all concern traditional societies. Unfortunately, they use activity categorizations that do not always coincide precisely with our present interests; nonetheless, estimates of

**Table 6.1** Estimates of time spent interacting during a typical day in different cultures

<i>Society</i>	<i>Economy</i>	<i>Activity</i>	<i>Hrs/day</i>	<i>%*</i>	<i>Source</i>
Dundee, Scotland	industrial	conversation	3.3	20.6	Emler (1994)
Kapanara (New Guinea)	horticultural	social interaction	3.1	19.4	Grossman (1984)
Maasai (Tanzania)	pastoralist	leisure	2.8	17.5	Biran (1996)
Central African Republic	agricultural	non-work (leisure, dances, visits)	2.7	16.8	Berio (1984)
Nepal	agricultural	leisure/social	5.2	32.3	Berio (1984)
Ivory Coast, Africa	agricultural	social	1.2	7.2	Berio (1984)
Upper Volta, Africa	agricultural	free time (social, religion, errands)	3.3	23.6	McSweeney (1979)

\* Assuming a 16-hr waking day (see, for example, Berio 1984)

'non-work' and 'leisure' time in these studies all produce estimates that, with one exception, lie at or below 20%. The mean social time for the seven studies in the sample is 19.6%. Taken together, these data suggest that humans use the same limited social time as primates, but use it in a more efficient way to reach more individuals (see Dunbar *et al.* 1995).

I suggest, then, that the principal function of language was (and still is!) to enable the exchange of social information ('gossip') in order to facilitate bonding in larger, more dispersed social groups. Additional complementary benefits can, of course, be seen in terms of the ability to monitor and control social cheats (Enquist & Leimar 1993) and the spread of malicious propaganda (Machiavellian behaviour (Byrne & Whiten 1988; Kemmerer 1997)). However, it is worth noting that, important as these are in modern human societies, both of them are explicitly a consequence rather than a cause of large social groups. Social cheats only become a problem because they can hide more effectively in large social groups (Enquist & Leimar 1990). Some mechanism is still needed to hold large groups together long enough for freeriding to become a serious nuisance. It is more parsimonious to argue that language must have evolved as a bonding device first, and then later have acquired its more exploitative properties once the opportunities for exploitation became apparent than to argue that the Machiavellian properties were the driving force.

Exploitation is a centrifugal force in social systems because it imposes a cost on the victims. Groups can only persist in time providing the net benefit to *individual* members is positive. Group living always incurs ecological and physiological costs (Dunbar 1988; Van Schaik 1983) and social exploitation merely exacerbates those costs. If the benefits that derive from group living are less than the gross costs, then individuals will prefer to live alone (or in smaller groups). Machiavellian behaviour must be seen as a consequence of group living and the availability of language rather than their cause.

In the light of at least some responses to this argument (e.g. Aitchison 1996), it is probably worth making clear here that the social gossip theory of language evolution is not in conflict with the general principles of the Machiavellian Intelligence hypothesis of Byrne & Whiten (1988) and never has been. Indeed, the original group-size/brain-size relationship on which the gossip theory was built was designed specifically to test the validity of the Machiavellian Intelligence hypothesis (see Dunbar 1992). The substance of the Machiavellian Intelligence theory is really about

social skills, with tactical deception (i.e. true Machiavellianism) being a very clear benchmark of advanced social skills.

Logically, then, the most plausible starting point for the evolution of language is as a bonding device based on the exchange of social information concerning relationships within the social network. This does not exclude the potential importance of advertising as a component. Once such a facility has evolved, it is not difficult to see that it must have provided windows of opportunity for exploitation in promoting and controlling more Machiavellian strategies.

This claim is borne out by the evidence that a very high proportion of natural human conversations (i.e. those between familiars that do not involve formal lectures or exhortations of a political or religious nature) are devoted to social information exchange (who-is-doing-what-with-whom, personal experiences, likes and dislikes, etc.). Both our own studies (Dunbar *et al.*, 1997) and those carried out by other researchers (e.g. Emler 1992, 1994) suggest that around 60–70% of all conversation time is devoted to social matters, in these contexts.

There do, however, appear to be important differences between the sexes in this respect. Although female conversations appear to be primarily concerned with social information exchange, male conversations appear to be far more concerned with advertising and exercises in social dominance (Coates 1993; Tannen 1996). Coates (1994, 1996) has shown, for example, that women's conversations tend to be structured in a more collaborative way, with interlocutors commonly finishing off each other's sentences and often speaking simultaneously without losing the thread of the conversation; in contrast, men's conversations tend to be more formal in their structure with fewer overlapping speech acts and less fluidity. Conversations between females thus seem to be concerned much more with 'getting to know', whereas males' conversations are more competitive and appear to be intended either to acquire or reinforce status (when the interlocutor is another male) or to attract a mate (when the interlocutor is female) (Dunbar *et al.*, 1997; see also Dessalles, this volume).

These differences appear to have a very early ontogeny. Although it has been unfashionable to make such claims, there are in fact marked differences between boys and girls, both in the speed of language acquisition and in linguistic fluency. Girls learn to speak and to understand and use grammar significantly earlier than boys (Hirsh-Pasek & Golinkoff 1996); and, as they develop, their conversations are



commonly more intimate and social in orientation. Although boys often form larger social groups than girls do, these groups have a very different character: for boys, a relationship consists of kicking a football across a yard, whereas for girls relationships are a far more cliquish and intimate business with conversations often focused around who did what and why and how the participants felt about it (Savin-Williams 1980).

### **3 Language and the theory of mind**

In this section, I want to argue that, important as grammar is in allowing us to exchange information, it is not necessarily the only important feature of the language system. Cognitive mechanisms such as 'theory of mind' play an equally important role. Let me first begin, however, with some comments about the role of grammar in language.

Grammar is often assumed to be the fundamentally important feature of language that gives it its unique character. In one sense, this must, of course, be true. But in another sense, grammar can be seen as a mere outgrowth of a deeper underlying structure. Grammatical form, in which speech is naturally coded into some kind of subject-verb-object form (though not necessarily in that order), bears so close a resemblance to the natural way of thinking about the world that it is difficult to believe that the two are unconnected. The surface form of individual grammars may vary enormously (i.e. from SVO to OVS or SOV, or from simple to complex word structuring), but the fact remains that an ordered relationship between the actor, the action and the recipient forms a basic deep structure that seems to be universal. The origins of this surely lie in that fact that all mammals (at least) seem universally to form hypotheses about the world that are naturally based on causal relationships (Dickinson 1980; Dunbar 1995). This so-called 'mental models' approach to cognition (Johnson-Laird 1983) implies that animals naturally code the events in the world in what amounts to grammatical form.

There is, I think, an obvious reason for this: the world itself is naturally organized in this way. Things (or organisms) do things to other things (or organisms). Parsing the natural processes of the world in this way is simply the most efficient way of both storing knowledge about events and predicting the world's future states (Johnson-Laird 1983). Preference for SVO or OVS forms may indeed be arbitrary (though even this claim can be doubted (Fenk-Oczlon & Fenk 1985, 1996)), but this

does not obviate the fact that deep grammatical structure is derivative of natural ways of parsing the world.

But there is another reason why language should conform to this pattern. Language requires more than the mere coding and deciphering of well-formed grammatical statements. Indeed, as has often been pointed out, many everyday conversations are conspicuous by their lack of grammatical structure (Gumperz 1982). However important formal grammar may be in the precision of information transfer, it is surely the intentionality of speech (in the Gricean sense) that is the most demanding feature for both speaker and listener (Worden, this volume). The latter, in particular, has to make judgments about the significance and meaning of the speaker's utterances (Dessalles, this volume). Metaphorical usage is so intrusive in natural language that the listener's task of deciphering what he hears becomes of overwhelming importance. But the speaker's task (as Sperber & Wilson (1986) have pointed out) is just as exacting, for he/she has to monitor the hearer constantly and adjust the delivery and content of further utterances in the light of the evidence that the hearer has understood the intended message.

The latter, of course, is no novel feat. Even primates engage in this kind of careful monitoring and rapid response to signs of 'message-received-and-misunderstood'. Keverne (1982) offers experimental evidence of this from macaques: females who normally rely on olfactory cues to convey information on their sexual receptiveness will rapidly switch to more direct forms of communication (such as presenting) when males' nasal passages are blocked with wax plugs that deny them access to olfactory communication channels. However, such a practice is probably particularly important for human communication using language because of the added complexity and quantity of information involved. The metaphorical content of many speech acts makes this task especially taxing.

The extent to which we take this facet of language for granted is only brought home to us in those rare cases (e.g. autistic individuals) who fail to manage this task and instead take utterances at face value. Happé (1994) provides a classic example: an autistic adult was once asked by his mother to 'pull the door behind him' when he left the house to join her across the road, so he did just that (after wrenching the door from its hinges).

Autistics highlight the importance of understanding speakers' intentions because they lack the crucial capacity commonly referred to as

having a 'theory of mind' (Leslie 1987; Premack & Woodruff 1978). More specifically, a theory of mind is the ability to understand another individual's mental state. This trait appears to be unique to humans, though there is evidence to suggest that great apes may also hover on this crucial threshold (O'Connell 1996; Povinelli, Nelson & Boysen 1993). Without theory of mind, there would be no language in the form we know it. To be sure, there would be communication, and there might even be grammatical communication, but what we would hear would be dull factual statements that provided all the human warmth of a conversation with *Star Trek's* Mr Spock. There would be no poetry and precious little literature. Indeed, the composition of a modern novel is probably dependent on the possession of at least fourth-order intentionality: the writer intends that the reader understand that one character thinks that another character believes something to be the case. By extension, fifth-order intentionality is required whenever the story concerns the eternal triangle of relationships involving three characters.

The crucial deficit exhibited by autistics is the inability to read another individual's mind, to understand an interlocutor's intentions. Monkeys (and some autistics) get by on a form of bootstrapping: they rely on a careful reading of their partner's behaviour, learning what amounts to clever generalizations about superficial behaviour without necessarily coming to any understanding of the mind-states that underpin that behaviour. Cheney & Seyfarth (1990) have characterized the difference rather neatly in observing that monkeys are very good ethologists (they can learn to read behaviour very well), but they are poor psychologists (they cannot learn to read the underlying mind). Humans (and perhaps great apes) are good psychologists as well as being good ethologists.

The crucial issue here is probably the fact that readings of superficial behaviour leave you open to both misinterpretation and deception. Actions are one step removed from intentions, and thus introduce one more point at which errors of transmission and errors of interpretation can occur (thereby making Machiavellian behaviour possible). Being able to get behind the behavioural façade enables you to second-guess the intentions of the speaker more accurately. (This, incidentally, is perhaps the most compelling evidence to support the claim that language evolved to facilitate and/or handle deception. If so, priority must still go to advertising rather than the detection of cheats. However, I would

probably still want to insist that the initial impetus for the evolution of ToM would have been the need to integrate groups effectively, even though this might have involved various psychological tactics like coercion, deception and advertising. There may well have been subsequent runaway selection in favour of the evolution of higher orders of intentionality as a result of Machiavellian behaviour, but, once again, this is a consequence rather than a cause of the evolution of language.)

That theory of mind is a costly facility can be illustrated by two observations. Kinderman, Dunbar & Bentall (in press) carried out an experimental study of theory-of-mind abilities in normal adults. In this study, subjects were presented with a set of stories, some of which had to be understood in terms of theory of mind and others that required simple causal analysis and memory for factual events in embedded causal relationships. We found that subjects performed equally well on both types of task up to fourth-order embeddedness: error rates remained constant at about 5–15%. However, while error rates remained at this level on fifth- and sixth-order embeddedness for physical cause tasks, error rates rose significantly on fifth-order theory of mind tasks to around 60%. A fifth-order theory of mind task requires that you remember that 'A thinks that B thinks that C thinks that D thinks that E thinks something is the case' (or alternatively that 'A thinks that B thinks that A thinks that B thinks that A thinks something is the case'). Clearly, subjects found these kinds of tasks exceedingly difficult to do. Fourth-order intentionality probably represents the limit at which people normally operate in real life; most everyday situations probably do not require much more than second-order intentionality.

The second piece of evidence to suggest that this theory-of-mind ability is very costly in cognitive terms is Worden's simulation model (this volume). In effect, Worden has been able to show that the major cost of evolving language is the computational cost of the theory-of-mind module rather than the cost of the grammar module. This is a particularly important demonstration because it has dramatic implications for our understanding of brain evolution in the human lineage. It implies that language (whatever the value of its emergent properties) was not itself the driving force behind the evolution of the superlarge human brain. This would explain why the key language areas (Broca's, Wernicke's and associated areas) are significantly smaller in volume than those areas associated with social skills and theory-of-mind abilities (the prefrontal cortex).

#### 4 Evolutionary history

The last point I want to touch on concerns the timing of language origins. Aiello & Dunbar (1993) exploited the relationships between neocortex size, group size and grooming time in primates to consider how grooming time requirements would have changed over time among hominids had they been trying to bond their groups using the conventional primate mechanism. We can safely assume that during their earliest apelike phase, the ancestral hominids would have been no different to any other primate and groups would have been bonded using social grooming.

By estimating neocortex ratios from cranial capacity (based on regression equations for living primates, including modern humans), we used the primate equations to predict group size and then grooming time requirement for individual fossil hominid crania. This produces a plot of grooming time that rises exponentially (following the brain volume curve) from initial values for the early australopithecines that are well within the range for modern apes. The curve is steeply bowed, and grooming time requirements do not exceed those observed in living primates until well into the *Homo erectus* phase. The crucial issue here is at what point the grooming time requirement would have been so great as to force the evolution of a more efficient bonding mechanism. We suggest that this must have occurred by 250,000 years ago at the latest, but dates as early as 500,000 years ago are not out of the question. In other words, the evolution of language seems to correspond in time to the emergence of our own species, *Homo sapiens*. Late *H. erectus* might have exhibited language in some recognizable form, but this would have been clearly confined to populations close to the *erectus/sapiens* boundary.

These figures are, of course, subject to considerable margins of error (though not of sufficient magnitude to make language origins significantly earlier or later). However, one point does emerge which is, I think, both robust and important. This is the fact that the general trend is smooth rather than catastrophic. Contrary to the views adopted by many linguists (see Bickerton 1990), there was no Rubicon at which language suddenly appeared, fully formed. Rather, language must have evolved piecemeal as more and more complex layers were added onto the existing primate communication system. The view that language evolved suddenly with no precursors seems to be based on a naïve

comparison between what humans, on the one hand, and monkeys and apes, on the other, do now, as though neither taxon had an evolutionary history.

Aiello & Dunbar (1993) argued that the data suggest that vocal grooming-at-a-distance gradually supplemented conventional grooming as time budgets became increasingly constrained by the demands of servicing relationships in ever-larger groups. Eventually, these vocalizations would have become sufficiently complex to take on a life of their own, but at this stage they would have been concerned more directly with the business of bonding. Symbolic language (the language of metaphysics and religion, of science and instruction) would have emerged later as a form of software development (it embodies no new structural or cognitive features not already present in social language), probably at the time of the Upper Palaeolithic Revolution some 50,000 years ago when we see the first unequivocal archaeological evidence for symbolism (including a dramatic improvement in the quality and form of tools, the possible use of ochre for decorative purposes, followed in short order by evidence of deliberate burials, art and non-functional jewellery).

I have deliberately said nothing about why the hominid lineage was obliged to increase its group size. The short answer is that, at the moment, we have no idea. Aiello & Dunbar (1993) offered a number of possibilities, but these are at best speculation until we know more about the forces acting on group size evolution in primates as a whole. Two points should, however, be noted.

First, the fact that we cannot offer an explanation for the evolution of large groups in hominids does not weaken the arguments deployed above for the evolution of language. (Nor does it mean that an explanation does not exist!) It is demonstrably the case that group sizes have increased in modern humans, and that is all that is needed to underpin the argument that language evolved as a bonding device. Language is a consequence not a cause of group size evolution. However, the implications of the relationship between group size and neocortex size (and between these and other aspects of behavioural ecology: see Dunbar 1993b; Williamson, Aiello & Dunbar 1996) is that, Bickerton (1996) notwithstanding, we are now increasingly in a position to say a great deal about group size and social structure in fossil species.

Second, it has been suggested that the causal arrow might be reversed: group sizes became large because brain size increased in order to make language possible (perhaps for technological reasons). Plausible

as it is at first sight, this argument begs questions that non-biologists commonly overlook about the costs of evolving particular traits. Everything we have learned from the past three decades of research on primate (and more generally animal) behaviour demonstrates that there are costs to living in groups. Animals do not live in groups merely because they can. The same is true of evolving large brains. The only way in which these three variables can be integrated such that the biological equations balance out is in the order I have suggested: the need to evolve large groups drove brain size upwards, and this in turn eventually required the evolution of language as a more effective bonding device.

## 5 Conclusions

I have tried to spell out the principal steps required of any explanation for the evolution and function of language. In doing so, I have sketched out the particular explanation that I have been led to by the data, as well as the evidence for this. The explanation I have offered runs counter to most conventional thinking on these issues, outside evolutionary psychology. Two important lessons emerge. One is that the past century of work in cognitive psychology and neuroscience has been directed down the wrong channel: all work in this area assumes that cognitive (and hence brain) function is concerned primarily with dealing with perceptual processing skills, but the social brain hypothesis suggests that our skills in these domains are all by-products of the fact that the (primate) brain evolved to handle day-to-day social problems. The second lesson follows on from this: if our brains evolved to handle social problems, then the same is likely to be true of language. Both the functions of language and its *modus operandi* must be sought in the social rather than the physical world.

These are strong challenges to conventional views. Whether they are right or wrong, all such challenges have the merit of forcing loosely conceived conventional assumptions into conflict with alternative hypotheses. Our understanding of processes like language will grow only by being challenged in this way, but it will do so only providing we resort to empirical testing of competing hypotheses. Armchair speculation has been all too characteristic of debate in this area in the past.

One final point is worth making. Bickerton (1996) has asked how it is that individuals who have not served an apprenticeship studying

languages can possibly write authoritatively (or otherwise) on language and its evolution. The short answer is that nothing that linguists study is relevant to any of the questions I have discussed. No doubt non-linguists ought to hesitate before commenting on matters relating to the grammatical structures of languages, but these structures of language are not, in themselves, relevant to questions about the functions of language or its evolution. The function of grammar is to enable complex thoughts to be transmitted efficiently, but the function of language (as an activity) is to facilitate the management of social relationships: in other words, *how* language allows us to convey thoughts is not the same question as *why* conveying thoughts is useful. I am happy to leave grammar to the grammarians, if only because there are more than enough questions of interest to go round.

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### References

- Aicello, L. C. & Dunbar, R. I. M. (1993). Neocortex size, group size and the evolution of language. *Current Anthropology*, 34, 184–193.
- & Wheeler, P. (1995). The expensive tissue hypothesis. *Current Anthropology*, 36, 199–211.
- Aitchison, J. (1996). Creating language at a stroke. *The Times* (28 March), p. 38.
- Barton, R. (1996). Neocortex size and behavioural ecology in primates. *Proceedings of the Royal Society, London*, B, 263, 173–177.
- & Dunbar, R. I. M. (1997). Evolution of the social brain. In Byrne, R. & Whiten, A. (eds.) *Machiavellian Intelligence*, vol. II. Cambridge: Cambridge University Press: 240–263.
- & Purvis, A. (1994). Primate brains and ecology: looking below the surface. In Anderson, J., Theiry, B. & Herrenschmidt, N. (eds.) *Current Primatology: Proceedings of XIVth Congress of the International Primatological Society*. Strasbourg: University of Strasbourg Press: 1–11.
- Berio, A.-J. (1984). The analysis of time allocation and activity patterns in nutrition and rural development planning. *Food & Nutrition Bulletin*, 6, 53–68.
- Bickerton, D. (1990). *Language and Species*. Chicago: Chicago University Press.
- (1996). I chat, thereby I groom. *Nature*, 380, 303.
- Biran, A. (1996). Time allocation and domestic work among Maasai women: an evolutionary approach. Ph.D. thesis. University of London.
- Brothers, L. (1990). The social brain: a project for integrating primate behaviour and neuropsychology in a new domain. *Concepts in Neuroscience*, 1, 27–51.
- Byrne, R. (1995). *The Thinking Ape: Evolutionary Origins of Intelligence*. Oxford: Oxford University Press.



- Byrne, R. W. & Whiten, A. (eds.) (1988). *Machiavellian Intelligence. Social Expertise and the Evolution of Intellect in Monkeys, Apes, and Humans*. Oxford: Clarendon Press.
- Cheney, D. L. & Seyfarth, R. M. (1990). *How Monkeys See the World: Inside the Mind of Another Species*. Chicago: University of Chicago Press.
- Coates, J. (1993). *Men, Women and Language*. New York: Longman.
- (1994). No gap, lots of overlap: turn-taking patterns in the talk of women friends. In Graddol, D., Maybin, J. & Stierer, B. (eds.) *Researching Language and Literacy in Social Context*. London: Multilingual Matters: 177-192.
- (1996). One-at-a-time: the organisation of men's talk. In Johnson, S. & Meinhoff, L. (eds.) *Discourses of Masculinity*. Oxford: Blackwell.
- Dickinson, A. (1980). *Contemporary Animal Learning Theory*. Cambridge: Cambridge University Press.
- Dunbar, R. I. M. (1988). *Primate Social Systems*. London: Groom Helm.
- (1991). Functional significance of social grooming in primates. *Folia Primatologica*, 57, 121-131.
- (1992). Neocortex size as a constraint on group size in primates. *Journal of Human Evolution*, 20, 469-493.
- (1993a). Coevolution of neocortical size, group size and language in humans. *Behavioral & Brain Sciences*, 16, 681-735.
- (1993b). Time: a hidden constraint on the behavioural ecology of baboons. *Behavioural Ecology & Sociobiology*, 31, 35-49.
- (1995). *The Trouble with Science*. London: Faber & Faber.
- (1996). *Grooming, Gossip and the Evolution of Language*. London: Faber & Faber.
- (in press). The social brain hypothesis. *Evolutionary Anthropology*.
- & Dunbar, P. (1988). Maternal time budgets of gelada baboons. *Animal Behaviour*, 36, 970-980.
- Duncan, N. & Marriot, A. (1997). Human conversational behaviour. *Human Nature*, 8, 231-246.
- Duncan, N. D. C. & Nettle, D. (1995). Size and structure of freely forming conversational groups. *Human Nature*, 6, 67-78.
- Ekman, P. (1985). Why lies fail. *Bulletin of the British Psychological Society*, 38 (November), A104.
- Emler, N. (1992). The truth about gossip. *Social Psychology Newsletter*, 27, 23-37.
- (1994). Gossip, reputation and social adaptation. In Goodman, R. F. & Ben-Ze'ev, A. (eds.) *Good Gossip*. Lawrence: University of Kansas Press: 117-138.
- Enquist, M. & Leimar, O. (1993). The evolution of cooperation in mobile organisms. *Animal Behaviour*, 45, 747-757.
- Fenk-Oczlon, G. & Fenk, A. (1985). The mean length of propositions is seven plus minus two syllables - but the position of languages within this range is not accidental. In D'Ydewalle, G. (ed.) *Cognition, Information Processing and Motivation*. Amsterdam: Elsevier: 355-359.
- (1996). Co-evolution of cognitive functions and natural language. Paper given to 13th Conference of the International Society for Human Ethology, Vienna.
- Grossman, S. L. (1984). *Peasants, Subsistence, Ecology and Development*. Princeton, NJ: Princeton University Press.

- Gumperz, J. J. (1982). *Discourse Strategies*. Cambridge: Cambridge University Press.
- Happé, F. (1994). *Autism: An Introduction to Psychological Theory*. London: University College London Press.
- Hirsh-Pasek, K. & Golinkoff, R. (1996). *The Origins of Grammar: Evidence from Early Language Comprehension*. Cambridge, MA: MIT Press.
- Iwamoto, T. & Dunbar, R. I. M. (1983). Thermoregulation, habitat quality and the behavioural ecology of gelada baboons. *Journal of Animal Ecology*, 52, 357–366.
- Jerison, H. (1973). *Evolution of the Brain and Intelligence*. New York: Academic Press.
- Johnson-Laird, P. N. (1983). *Mental Models*. Cambridge: Cambridge University Press.
- Kemmerer, D. (1997). What about the increasing adaptive value of manipulative language use? *Behavioral & Brain Science*, 19, 546–548.
- Keverne, E. B. (1982). Olfaction and the reproductive behaviour of nonhuman primates. In Snowdon, C. T., Brown, C. H. & Petersen, M. R. (eds.) *Primate Communication*. Cambridge: Cambridge University Press: 396–412.
- Martinez, N. D. & Tuite, B. (1989). Beta-endorphin concentrations in cerebrospinal fluid of monkeys are influenced by grooming relationships. *Psychoneuroendocrinology*, 14, 155–161.
- Kinderman, P., Dunbar, R. & Bentall, R. (in press). Theory of mind deficits and causal attributions. *British Journal of Psychology*.
- Kudo, H., Lowen, S. & Dunbar, R. (submitted). Neocortex size as a constraint on grooming clique size in primates. *Behaviour*.
- Leslie, A. M. (1987). Pretense and representation: the origins of 'theory of mind'. *Psychological Review*, 94, 412–426.
- McSweeney, B. G. (1979). Collection and analysis of data on rural women's time use. *Studies in Family Planning*, 10, 379–383.
- O'Connell, S. (1996). Theory of mind in chimpanzees. Ph.D. thesis. University of Liverpool.
- Pawlowski, B., Dunbar, R. & Lowen, C. (in press). Neocortex size, social skill and mating success in male primates. *Behaviour*.
- Pinker, S. (1994). *The Language Instinct*. New York: Morrow; London: Penguin.
- & Bloom, P. (1990). Natural language and natural selection. *Behavioral & Brain Sciences*, 13, 707–784.
- Povinelli, D., Nelson, K. E. & Boysen, S. T. (1990). Inferences about guessing and knowing by chimpanzees (*Pan troglodytes*). *Journal of Comparative Psychology*, 104, 203–210.
- Premack, D. & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral & Brain Sciences*, 4, 515–526.
- Savin-Williams, R. (1980). Dominance in a human adolescent group. *Animal Behaviour*, 25, 400–406.
- Sawaguchi, T. & Kudo, H. (1990). Neocortical development and social structure in primates. *Primates*, 31, 283–290.
- Sperber, D. & Wilson, D. (1986). *Relevance: Communication and Cognition*. Cambridge, MA: MIT Press.

- Tannen, D. (1996). *Talking Nine to Five*. London: Virago.
- Tinbergen, N. (1963). On the aims and methods of ethology. *Zeitschrift für Tierpsychologie*, 20, 410-453.
- Van Schaik, C. P. (1983). Why are diurnal primates living in groups? *Behaviour*, 87, 120-144.
- Williamson, D., Aiello, L. C. & Dunbar, R. I. M. (1996). An assessment of the use of chimpanzees as models for early hominid behavioural ecology. Paper presented at Theoretical Archaeology Group meeting, Liverpool.