

Social cognition, Stag Hunts, and the evolution of language

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Abstract According to the socio-cognitive revolution (SCR) hypothesis, humans but not other great apes acquire language because only we possess the socio-cognitive abilities required for Gricean communication, which is a pre-requisite of language development. On this view, language emerged only following a socio-cognitive revolution in the hominin lineage that took place after the split of the *Pan-Homo* clade. In this paper, I argue that the SCR hypothesis is wrong. The driving forces in language evolution were not sweeping biologically driven changes to hominin social cognition. Our LCA with non-human great apes was likely already a Gricean communicator, and what came with evolution was not a raft of new socio-cognitive abilities, but subtle tweaks to existing ones. It was these tweaks, operating in conjunction with more dramatic ecological changes and a significant increase in general processing power, that set our ancestors on the road to language.

Keywords Language evolution · Hominin evolution · Gricean communication · Stag Hunt · Social cognition

Introduction

In the last 20 years, a brilliant and pioneering research project led by Michael Tomasello has given us unprecedented insight into the socio-cognitive and communicative abilities of young children and our nearest living relatives, the non-human great apes. The findings of this project have given rise to a very influential theory about why it is that human children acquire language, given that

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our nearest cousins do not. According to this theory, which I'll call the Socio-Cognitive Revolution hypothesis (SCR) hypothesis (Tomasello 2008; Scott-Phillips 2014, 2015), humans acquire language because we possess biological adaptations for superior social cognition or 'theory of mind' ('ToM'). These socio-cognitive abilities are necessary for acting with and understanding the Gricean communicative intentions that are necessary for language development. It is because pre-verbal children possess the abilities required for Gricean communication that they acquire language; and it is because great apes lack them that they do not. While apes also lack other features required for natural language use—not least, abilities for syntax, and imitation—without the socio-cognitive foundations in place, their language development never gets off the ground.

A central implication of the SCR hypothesis is that, after the split of the *Pan-Homo* clade around 6 mya, the branch of *Hominini* from which humans evolved underwent a dramatic socio-cognitive revolution. This left them with the socio-cognitive abilities needed to engage in Gricean communication. Since no similar revolution happened in the clade that gave rise to chimpanzees and bonobos, humans but not great apes can act with and understand communicative intent. Consequently, it is only humans who acquire language.

In this paper, I argue that the SCR hypothesis is wrong, and that the driving force in language evolution was not sweeping biologically driven changes to hominin social cognition. Rather, our LCA with non-human great apes was likely already a Gricean communicator. What came with evolution was not a raft of new socio-cognitive abilities, but subtle tweaks to already existing ones. It was these tweaks, in conjunction with more dramatic ecological changes and a significant increase in general processing power that resulted from a new diet and resultant brain growth, that set our ancestors on the road to language. The uniquely human forms of social cognition that others have identified as foundational to Gricean communication likely emerged only later, following the cultural evolution of natural languages.

The paper has two parts. In the first part (which builds on Moore 2013b, 2016a, b, 2017a, b) I will argue that while there are differences between the socio-cognitive and communicative abilities of great apes and pre-verbal infants—for example, with respect to joint attention and the reliable production and comprehension of pointing—these are not fundamental to Gricean communication.¹ Against the SCR hypothesis, I will also argue that great apes do act with and understand communicative intentions—although their skills for pragmatic inference are much weaker than our own.

In the second part of the paper I sketch an alternative account of why apes do not acquire language. According to this view, since the split from our last common ancestor with apes, ancestral humans came under ecological pressure to collaborate in order to get food, in ways that great apes (and their more recent ancestors) did not. These ecological changes gave rise not to a whole new psychological

¹ Different journal publication schedules give a misleading impression of the order in which these papers should be read. I recommend: 2013b, 2016a, b, 2017a, b and then this one. This paper and 2017a are key.

infrastructure for intentional communication, but just small changes to social attention and motivation, along with more powerful inferential abilities.²

What is Gricean communication?

According to the SCR hypothesis, pre-verbal infants but not great apes understand communicative intentions—that is, intentions with a ‘Gricean’ intentional structure (Grice 1957). On Grice’s view, communicative intentions form the non-verbal foundation of linguistic communication. This insight has been developed by researchers working on issues of language development in ontogeny and phylogeny to explain how infants who communicate non-verbally can learn to incorporate linguistic tools into their communicative repertoire.

The precise formulation of a Gricean intention has changed since Grice’s first analysis (Grice 1957). However, a consensus view (Neale 1992; Sperber and Wilson 1995; Moore 2017a) is that:

A speaker S acts with communicative intent if and only if she produces an utterance x , for some hearer (or audience) H , intending:

- (1) H to produce a particular response r , and
- (2) H to recognize that S intends (1).

In addition to acting with intentions (1) and (2), it’s also necessary that the speaker should not act with any further intention:

- (3) that H should be deceived about intentions (1) and (2).³

On this specification, what the speaker meant to communicate by uttering is closely related to the response r that she intends to solicit in (1), and can be recovered by figuring out why she said what she did. According to Grice, the goal could be elaborated in one of two ways:

- (1) (informative utterances) S intends to produce in H the belief that p , or
- (b) (imperative utterances) S intends that H should Ψ ,

where Ψ specifies some action, and p is a proposition. Since the utterance x need not be linguistic, H ’s ability to infer the goals with which S uttered can serve as a foundation for his coming to understand and use language (Moore 2017d).

² A background assumption of both my view and the SCR is that there is a broadly Fodorian relationship between intentional psychology and computational-cognitive psychology, such that complex intentional states entail complex processing.

³ While communication often takes place in non-vocal modalities, I use the S – H formulation so that I can distinguish between interlocutors on the basis of gender— S (he) and H (e)—and so make keeping track of examples easier.

Gricean communication and cognitive development

The SCR hypothesis is given initial plausibility by standard characterisations of the socio-cognitive prerequisites of doing so. Gricean communication is typically thought to require (i) possession of a concept of belief, (ii) the ability to make complex inferences about others' goal-directed behaviour, and (iii) the ability to entertain fourth-order metarepresentations (see Moore 2017a for discussion). This combination of abilities has currently been identified only in humans. A challenge for the SCR view is that for Gricean communication to play a role in explaining human language development, the socio-cognitive abilities that it requires would need to be both present in some form in pre-verbal children (≤ 14 months) and absent from apes. Problematically, this evidence is currently lacking (Moore 2017a).

Against the SCR view, I have argued that we should reject the analyses that entail that Gricean communication is socio-cognitively demanding, and concede that non-humans may also be Gricean communicators. If this is right, no socio-cognitive revolution in the hominin lineage was required for language to emerge. In the following sections I will review a number of arguments for rejecting the SCR view. I will defend some of the arguments in detail, but where the arguments essentially reiterate claims that I have published elsewhere, I will merely sketch the claim while pointing to the relevant literature.

Gricean communication and ToM

Differences between great ape and human social cognition are sometimes summarised by the claim that our species has a superior ToM. This is the set of abilities that we exploit in attributing intentions, beliefs, and desires to others in order to predict and explain their behaviour. Without question, adult humans are much better at this than any other species—including chimpanzees and bonobos, our nearest living relatives. However, the implications of this for language evolution have not always been clear.

Until relatively recently it was doubted that young children understand that others' beliefs can be false. This is often taken to be necessary for possessing a concept of belief, which has in turn been thought necessary for possessing a ToM (Bennett 1978; Dennett 1978). In a now notorious paradigm designed to test whether they can answer questions about how agents with false beliefs are likely to act (Wimmer and Perner 1983), children younger than 4 years systematically reported that an agent would look in the location where the object he sought was hidden, and not where he had last seen it. This was interpreted as showing that young children do not grasp that beliefs can be false, and consequently that they lack a concept of belief. Since this was taken to be necessary for Gricean communication (Breheny 2006), and so fundamental to language acquisition, this finding seemed to threaten our best theories of language development (e.g. Tomasello 1999; Bloom 2000). It gave rise to what has been described as a

“paradox at the heart” of research on children’s language acquisition (Astington 2006).

Just over 10 years ago, new experimental data suggested a solution to this paradox. Since the measures of false belief understanding used in early paradigms relied upon on children’s understanding of verbal questions, it was possible that young children really did understand false belief—they just did not understand the questions asked in these studies. A series of false belief tasks appeared that use children’s gaze behaviour to determine whether they anticipate that agents with false beliefs will act as if they had true beliefs, and it was found that pre-verbal children perform well in these tasks (e.g. Onishi and Baillargeon 2005; Kovács et al. 2010). Around the same time, data from great apes was showing that they understand more about the intentions and goals of others than had been supposed, but which nonetheless did not deliver evidence that they understand false belief (Kaminski et al. 2008; Call and Tomasello 2008).

This key difference between infant and ape mindreading, and the supposed centrality of the concept of belief in Gricean communication, might explain why children but not apes acquire language. However, recently a version of a non-verbal false belief task that tested great apes has suggested that they possess an understanding of false belief comparable to that of pre-verbal children (Krupenye et al. 2016; see also Buttelmann et al. 2017). Whether tasks like this one really give evidence of ‘full blown’ false belief understanding is still being debated (Apperly and Butterfill 2009; Heyes 2017). However, if both pre-verbal infants and non-human great apes pass a non-verbal false belief task, then whatever abilities this implicates, it suggests that at the time of children’s first use of words (around 14 months) infant and ape false belief understanding may not be categorically different.

Uncontroversially, older children can reason ‘explicitly’ about others’ false beliefs in ways that non-human great apes cannot. However, as far as language development research is concerned, it is significant that children cannot pass verbal false belief reasoning tasks before they are 3 years old (Rubio-Fernández and Geurts 2013). Moreover, four-year-old children’s ability to pass verbal false belief tasks is closely tied to their mastery of specific grammatical aspects of natural language (De Villiers and De Villiers 2000; Lohmann and Tomasello 2003; Milligan, Astington, and Dack 2007; Low 2010; Grosse-Wiesmann et al. 2016). Thus uniquely human forms of mindreading seem to be learned by children in ontogeny, as a consequence of the development of their communicative abilities, and in particular their acquisitions of certain natural language forms.

If we cannot appeal to first order false belief understanding to explain why humans but not apes acquire language, the ability to represent high orders of others’ beliefs may nonetheless be crucial. Scott-Phillips (2014) defends this view, by endorsing Sperber’s (2000) claim that Gricean intentions are fourth-order metarepresentations: to act with communicative intent, *S* must intend that *H* believe that *S* intends that *H* believe that *p*. In light of this analysis, and overwhelming evidence that infants understand communicative intentions, he argues that pre-verbal children do understand fourth-order metarepresentations, and predicts that future research using non-verbal paradigms will vindicate this claim.

Scott-Phillips may yet be right, but current indicators are far from promising. There is currently no evidence that either great apes or infants are capable of higher-order belief representations, and very good reason to think that they are not. Even twelve-year-old children struggle to understand fourth-order metarepresentations (Liddle and Nettle 2006). While six-year-olds can use second-order belief attributions to coordinate with others (Gruneisen et al. 2015), they struggle to answer questions that require second-order belief reasoning (Perner and Wimmer 1985). In this case, no existing data on apes' and children's reasoning about first or higher order beliefs shows that pre-verbal children are better at this than apes. Belief understanding is therefore a poor candidate for explaining language acquisition. While the simplest forms of belief tracking seem to be shared by humans and apes, more sophisticated ones emerge only after language acquisition.⁴

Responses to the paradox of language development

When combined with standard accounts of the socio-cognitive prerequisites of Gricean communication, empirical data on the developmental relationship between mindreading and language make infants' language acquisition mysterious. Language development theorists have responded to this challenge in different ways.

As previously mentioned, some SCR proponents are willing to commit to the prospect that, with the advent of non-verbal paradigms for higher-order mindreading, the relevant ToM abilities will be discovered in infants (Scott-Phillips 2014, 2015). However, the empirical prospects for this manoeuvre look unpromising. Tomasello (2008) adopts a different approach. He concedes that 'full blown' Gricean communicative abilities develop gradually in ontogeny, and so are unlikely to be present in infants at the time they first use words. However, since Tomasello's account nonetheless appeals to children's understanding of communicative intentions to explain their language development, it still embodies a contradiction. Either infants must be Gricean communicators prior to their language development, or their language development cannot be a consequence of it.

This difficulty has motivated some to argue, contra Tomasello, that infants (not to mention *Hominini* and some non-human animals) might engage in non-Gricean

⁴ Scott-Phillips (2014, 2015) has proposed further criteria that he claims show that pre-verbal children but not apes are capable of Gricean communication. However, either these criteria also fail to pick out abilities that can be ascribed to pre-verbal infants but not apes, or they are multiply interpretable. For example, following Tomasello (2008), Scott-Phillips argues that one form of evidence for understanding Gricean intentions is 'hidden authorship' (2014) – in which an agent deliberately suppresses their Gricean second clause intention, to manipulate surreptitiously the behaviour of another. Young children can do this (Grosse et al. 2013). However, since the ability emerges only around 3-year old, it cannot be relevant to children's language acquisition.

Another criterion proposed by Scott-Phillips (2015) builds on the finding that 18-month-year-olds care about being understood over and above achieving their communicative goals (Grosse et al. 2010). Scott-Phillips (2015, p. 61) interprets this study as showing that infants intend "not simply to affect the adult's behavior ... but rather to change mental states", and he thinks the latter is necessary for Gricean communication. However, there are no strong theoretical grounds for holding that intending to change mental states is necessary for Gricean communication (Moore 2015, 2017a), so Scott-Phillips's use of the study is moot.

forms of intentional communication (e.g. Bar-On 2013; Planer 2017; Sterelny 2017). These views are consistent with the possibility that the abilities needed for ‘full-blown’ Gricean communication are language dependent. While these views do not claim that infants attribute communicative intent, they do face substantial challenges. Not least, to hold that infants communicate using non-Gricean intentions is not to give any account of how they could, on this basis, come to acquire either language, or the abilities needed for Gricean communication. At present, a wealth of data suggests that infants acquire language only because they can attribute communicative intentions (e.g. Tomasello 1999). To have a credible account of language development, proponents of non-Gricean views would need to reevaluate this data, and show that communicative intentions play no ineliminable role. Thus they commit to a reinterpretation project that may be futile.

I defend a third way that avoids both the empirical burden of the standard Gricean view, and the possible explanatory impotence of its non-Gricean alternative. The paradox of language development can be dissolved, because while the Gricean account of the nature of communication is right, Gricean communication does not require either (i) possession of a concept of belief, (ii) the ability to make complex inferences about others’ goal-directed behaviour, or (iii) the ability to entertain fourth-order metarepresentations (Moore 2017a). Consequently there is no reason to doubt that infants acquire language because they attribute communicative intentions. Additionally, there are good grounds for thinking that both pre-verbal children *and apes* are Gricean communicators (Moore 2016a, 2017a, b).

My arguments for the claim that ‘minimally Gricean’ communication is socio-cognitively undemanding are available elsewhere (Moore 2017a), so I will not rehearse them in detail here. However, to recap briefly, I argue that it is sufficient for Gricean communication that a speaker intentionally produce an utterance in order to solicit a response from her interlocutor, and that she intentionally addresses that utterance to her interlocutor as a way of soliciting this response (Moore 2017a). Great apes seem to do this (Moore 2016a, 2017a, b). If my arguments are right, they show that considerations about theory of mind cannot currently be used to adjudicate debates about whether apes are Gricean communicators.

If changes in ToM were not key to the emergence of Gricean communication in phylogeny, other factors may nonetheless have been crucial. Tomasello’s work identifies a number of further features that he takes to be crucial to the emergence of Gricean communication, and therefore language, in the human lineage. In the following sections, my reconstructions of Tomasello’s arguments stem not only from his published works (e.g. 1999, 2006, 2008) but from years of collaborative research and conversation with him.

Joint attention and language evolution

Tomasello has argued (2008), that in addition to theory of mind considerations giving grounds for thinking that infants but not apes are Gricean communicators, studies of great ape gestural communication support this claim too. In particular, he argues that two features of communication that emerge early in human ontogeny but

that seem not to be a part of the natural repertoire of apes are evidence that the former but not the latter are Gricean communicators. These features are pointing and joint attention (Tomasello 1999, 2008).

Joint attention occurs when two (or more) individuals attend both to the same referent, and to one another's attention to that referent. It emerges towards the end of human infants' first year, very often in the context of pointing interactions. Its emergence is significant because it constitutes an important way for children to learn about their world (Tomasello 1999). For example, by alternating its own gaze between a scary-looking jack-in-the-box and its mother's attention to the same object, an initially scared infant can learn that the toy is not an object to be feared, but a potential source of humour (Hobson 2002).

Tomasello does not, contra Carpenter and Liebal (Carpenter and Liebal 2011), argue that joint attention is itself a form of Gricean communication. However, he does think it a necessary precursor to the Gricean forms of communication that, on his view, find their earliest expression (both ontogenetically and phylogenetically) in pointing. Therefore its absence in great apes constitutes, on his view, a reason for thinking that they could not be Gricean communicators.

It is uncontroversial that some precursors of joint attention are present in apes. For example, all species of great apes follow another's attention to a distal target (Bräuer et al. 2005). However, there are no reliable reports of apes additionally attending to one another's attention to a referent. While some have claimed that chimpanzees do engage in joint attention (Leavens and Racine 2009), these claims are based on weaker definitions of 'joint attention'. In the state in which joint attention appears in humans, subjects must not just co-attend to a referent; they must additionally attend to one another and be aware of doing so. Evidence for this behaviour in apes is lacking (Carpenter and Call 2013).

Why apes do not engage in joint attention is not known. However, its (seeming) absence from their repertoire may not be a consequence of their being cognitively unprepared for it. Attention is not cognitively difficult, and plenty of evidence demonstrates that apes have a robust understanding of it. For example, chimpanzees will both avoid eating food seen by a dominant individual (Hare et al. 2001), and follow another's line of sight to a previously unseen object (Bräuer et al. 2005). Given that, it's consistent with current data that apes are merely unmotivated to engage in joint attention, even if cognitively they could.⁵ (Of course, there may also be cognitive factors playing a role in its absence—possibly including the working memory demands of combining attention to two sources and integrating their deliverances.) Nonetheless, while the emergence of joint attention in hominin history may well have been critical for the emergence of language, neither joint attention nor pointing could have been necessary for the historical emergence of Gricean communication.

⁵ Here some might object that joint attention has a recursive structure. Thus, it should be common knowledge among the participants an episode of joint attention that they are in that state. However, deflationary accounts of joint attention and common knowledge can be given (Campbell 2005; Wilby 2010; Moore 2013a).

Pointing and language evolution

It is beyond doubt that children's ability to use and understand points far exceeds great apes'. Before they start to use and understand language, infants are accomplished at pointing for others, and at grasping others' points (e.g. Tomasello et al. 2007; Behne et al. 2012). This is important, because pointing evidently plays a key role in children's language development (Tomasello 1999, 2008)—for example, by facilitating word learning through ostensive definitions (“Look, it's a *dog!*”). By contrast, great apes generally fare poorly in pointing comprehension tasks (Tomasello et al. 1997; Hare and Tomasello 2004; Herrmann and Tomasello 2006; Moore et al. 2015).

Tomasello has used data from studies of ape pointing comprehension to run two subtly different arguments against the possibility that apes could be capable of Gricean communication. The first is a theoretical argument, and is largely implicit in Tomasello's writing on the evolution of language (2008). These arguments suggest that in order to act with Gricean intent, a speaker's utterances must refer to triangulated objects—that is, objects that are independent of both speaker and intended audience—and to do so in the context of informative communication.⁶ Since ape gestures are largely dyadic and imperative—and depend on neither pointing nor joint attention—they are not Gricean (Tomasello 2008).⁷ The second argument is informed by evidence drawn from comprehension failure: Tomasello argues that apes' failure to understanding pointing shows that they cannot grasp communicative intentions (Tomasello et al. 2003; Tomasello 2006). Since Gricean communication just is acting with and understanding communicative intent, together these arguments preclude apes from being Gricean communicators.

Tomasello's argument from production

The structure of Tomasello's first argument is *modus tollens*:

- (P1) If great apes were Gricean communicators, then they would engage in pointing and joint attention.
- (P2) Apes do not engage in joint attention or pointing.
- (C) Therefore, apes are not Gricean communicators.

While the second premise of this argument is supported by the empirical data described above, the first comes from Tomasello's own reinterpretation of Grice's analysis of communicative intent. Impressed by Grice's claim that communicative acts can be non-verbal, Tomasello reformulates the original analysis in light his own desire to emphasise the role of pointing and joint attention in pre-verbal children's

⁶ For a more detailed explanation of why Tomasello thinks Gricean communication must be informative, and of why this is wrong, see Moore (2016b).

⁷ Another argument against apes being Gricean communicators argues that they are not, because their gestures are not ostensive (Scott-Phillips 2016). Since I have addressed this argument at length before (Moore 2016a), I will not revisit it here.

language development. He breaks the first clause of Grice's characterisation, which specifies the content of an utterance, into two constituent parts:

S acts with communicative intent *iff* she utters *x* intending:

- (1a) *H* to attend to some object [*referential intention*]
- (1b) *H* to respond to that object in a particular way *r* [*social intention*], and
- (2) *H* to recognise that *S* intends (1) [*communicative intention*].

Thus Tomasello effectively stipulates that Gricean communication must be referential in the intuitive sense that it specifies objects that are independent of both the speaker and hearer; and he takes the paradigmatic case of a non-verbal Gricean act to be cases of informative pointing (Tomasello 2008). Utterances like this would, he argues, be fundamental in both human evolution and ontogeny. In the former case, they could provide a basis for food sharing in our ancestors—"The stag is over here!"—which would, in turn, support societal development. In the latter, they provide infants with an entry point into language—"Look, it's a *dog!*".

The goal of Tomasello's reformulation of Grice's analysis is to isolate a class of utterances that have been fundamental to human development. However, while the motivations at work here are reasonable, the result is unacceptable. For it clearly excludes a whole class of communicative acts that do not refer to objects in the way that Tomasello requires—including, for example, "I'm unhappy," or "Go away!".

While the question of whether great ape communication is referential and informative is important, in making this a pre-requisite of Gricean communication, Tomasello errs. An account of the intentional structure of communicative intentions should be independent of the contents of utterances. That is, whether or not an utterance is meaningful should be (as Grice's analysis recognises) not a matter of *what* the speaker intends to communicate (*content*), but of the intentional structure of her communicative act (*form*)—i.e. whether the utterance was produced ostensively. Non-referential utterances evidently can be produced with the combinations of intentions that Grice first described. Indeed, there could be Gricean communicators whose communicative repertoire consists only of utterances that are dyadic (Moore 2017a). So much the worse for Tomasello's revision; we should not adopt it. The production of utterances incorporating pointing and joint attention cannot be necessary for the emergence of Gricean forms of communication.

Tomasello's claims about the absence of informative and referential communication in apes are also undermined by more recent empirical data. First, apes regularly use gestures to request items that others are holding, and they respond appropriately to such requests. So while they do not excel at understanding pointing, they do engage in triangulated gestural communication—just not for particularly distal objects (Moore et al. 2015). They also do produce points—not just for human interlocutors (Leavens et al. 1996; Leavens and Hopkins 1998) but (occasionally) for other apes too. This has been reported both of apes in the wild (Veà and Sabater-Pi 1998; Hobaiter et al. 2014) and in Leipzig zoo (Pelé et al. 2009; Moore et al. 2015). Recently, great apes have even been shown to point for absent objects (Lyn et al. 2014; Bohn et al. 2015)—that is, objects that are no longer present at the time

of the gesture. Until recently this was thought to be an exclusively human form of communication (Liszkowski et al. 2009). While these behaviours are relatively rare in apes, the fact that they sometimes appear shows they cannot be cognitively out of reach, and plausible ecological explanations of why apes do not point can be given (Leavens et al. 2005).

Tomasello's scepticism about whether or not apes communicate with referential, informative intent may also be a consequence of his focus on gestural communication. In the past 30 years most great ape communication studies have focused on gestures, because vocal forms of communication have been thought more like an infant's screams than language: a non-intentional and fixed emotional response to external stimuli (Tomasello 2008). Recent evidence shows the emphasis on great ape gestures to be mistaken. Not only are some vocalisations used with more intentional control than has been assumed, they also seem to refer. For example, wild chimpanzees call to alert others to the presence of a potentially dangerous predator, and do so more when others are likely to be ignorant of its presence (Crockford et al. 2012)—suggesting both a degree of intentional control, and at least crude tracking of others' knowledge-like states. The seemingly informative, referential nature of this call satisfies even Tomasello's restrictive constraints on the content of Gricean acts.

In light of these considerations, data about referential and informative communication provide no grounds for denying that apes produce utterances with Gricean intent. What about utterance comprehension?

Tomasello's argument from comprehension

Apes' relatively poor performance in pointing comprehension tasks has sometimes been interpreted as showing that they do not understand communicative intent (Tomasello et al. 2003). This inference is too quick, though; and recent research shows that great apes' understanding of communicative intent is better than proponents of the SCR hypothesis have claimed. While no great ape species excels at pragmatic interpretation, they do seem to be capable of making simple inferences about others' communicative goals. For example, captive chimpanzees use background information about which tool a peer is likely to want in order to interpret ambiguous requests (Yamamoto et al. 2012; Moore 2016b).

The data on apes' pointing comprehension are also not uniformly bad. Enculturated chimpanzees and bonobos perform well in pointing comprehension tasks (Lyn et al. 2010), and in some paradigms great apes in zoos perform well too (Mulcahy and Call 2009). Even in standard pointing comprehension tasks (e.g. Moore et al. 2015), great apes do not perform uniformly poorly. If apes sometimes do better in pointing comprehension tasks, then an alternative explanation of why they usually fail is also needed. However, two such explanations are readily available. First, they may just be inattentive to human gestures. It is well established that apes do not copy precisely the manual gestures of others (Tennie et al. 2009; Moore 2013c). A corollary of this is that often they may simply not attend to the difference between a palm-up begging gesture (which they do understand), and an

extended-arm point of the sort that humans typically produce (which they find more difficult).

Second, apes are likely just poor at the particular sorts of pragmatic inference that pointing requires (Moore 2013b). As Tomasello's reformulation of Grice's analysis makes clear, in order to understand a point, a hearer must identify both the speaker's intended referent, and her reason for pointing to it. If apes are inattentive to human pointing gestures, it would follow that they might also be poor at using a point to identify a referent. Additionally, they also seem to be poor at figuring out why a speaker would point to a target on a given occasion. This is consistent with the claim that apes do not expect others' to point with helpful motives (Herrmann and Tomasello 2006). However, a failure to expect informative communication alone cannot explain apes' poor pointing comprehension—since they perform poorly not only in 'helpful' pointing tasks (e.g. Tomasello et al. 2007; Hare and Tomasello 2004; Herrmann and Tomasello 2006) but in competitive paradigms too (Kirchhofer et al. 2012; Tempelmann et al. 2013; see Moore 2013b for discussion).

Given the above, we should simply reject the claim that apes' relative weakness at understanding pointing, and the absence of joint attention from their repertoire, has any implications at all for their status as Gricean communicators (see also Moore 2016a). With respect to pointing comprehension, it's more likely that apes are just inattentive, and that they have only limited abilities for pragmatic inference. The inferences required in object choice tasks make attentional and inferential demands that bump against the limits of what they can do.

Cooperation and communication

Tomasello's writing on language evolution also contains another argument for doubting that apes could be Gricean communicators. It is grounded in what he takes to be the cooperative structure of acting with Gricean intent—and illuminates why he takes informative pointing to be the paradigmatic case of non-verbal Gricean communication. Since I have discussed this argument at length elsewhere (Moore 2016b), I discuss it only briefly here.

Tomasello argues that acting with and understanding communicative intentions is a fundamentally cooperative activity; and that since great apes are not cooperative in the way that children are, they cannot be Gricean communicators. The argument can be spelled out as follows:

- (1) Gricean communication is a variety of joint action, in which *S* and *H* work together to realise a common goal of *H*'s grasping the content of *S*'s message.
- (2) Non-human great apes are not motivated to engage in joint action.
- (3) Therefore, non-human great apes cannot be Gricean communicators.

Premise (2) here is supported by empirical studies of ape collaboration. Premise (1) is supported by Tomasello's characterisation of the attentional and cognitive demands of successful communication (and pointing in particular). He argues that what he calls "Gricean cooperative communication" requires intentional action on

the part of both speaker and hearer: not only must *S* formulate her utterance to facilitate *H*'s understanding; additionally *H* must engage in reason and inference in order to grasp *S*'s message. This can be construed as a collaborative interaction in which *S* and *H* work together to realise a common goal. Conclusion (3) follows deductively from (1) and (2), but is supported by a further sub-argument. According to this sub-argument, the emergence of joint action in hominin phylogeny came with obligate collaborative foraging. Only when our ancestors were forced to collaborate to get the food needed for their survival, did motivations for joint action arise.

Obligate foraging is key here because Tomasello holds that in order for early *Hominini* to be willing to engage in joint action, each participant must have been willing to work with others in order to realise a common goal. He takes it, further, that in a world of selfish agents (like great apes), this situation would emerge only when collaboration would improve the position of all agents. Consequently, he takes the origins of joint action to lie in situations like those modelled by the Stag Hunt (Skyrms 2004), in which all participants can improve their own position by collaborating (Tomasello 2008; Tomasello et al. 2012). In the Stag Hunt scenario, (i) individuals must collaborate with others in order to benefit, (ii) by collaborating, each individual can gain more than they could by working alone, and (iii) collaboration requires giving up the possibility of working alone. Thus, for example, *Hominini* who could forage alone and eat a hare could collaborate in order to eat a valuable stag. However to do this, they must give up the chance of catching a hare.

This scenario is relevant to the evolution of language, because Tomasello takes the original act of Gricean communication to be one of an agent's providing another with prosocial information that would help both to succeed in a joint action (for example, pointing to communicate "The stag is over there!"). In the context of this interaction, he takes *H*'s willingness to attend to and infer the content of *S*'s message to be a function of his expectation that by doing so, he will be rewarded (e.g. with a share of stag). As a further consideration, Tomasello takes it that the inferences that a hearer must make to recover the content of a speaker's message require the sorts of cooperative reasoning that Grice describes in his writings the maxims of conversation (e.g. 1989 chapter 3). Thus Tomasello holds that the motivations to attend to and interpret others' utterances arose in phylogeny only when our ancestors had to collaborate to eat. Further motivating the idea that Gricean communication requires informative pointing, he argues that obligate collaborative foraging was the historical cause of the emergence of Gricean communication in hominin phylogeny.

This is a clever argument that suggests that Gricean forms of communication must be cooperative on a number of levels. However, while I don't want to challenge the significance of cooperation for human evolution, as a story about the origins of Gricean communication, Tomasello's account does not work. As I have previously argued at length (Moore 2016b), not all Gricean interactions are well modelled as cases of joint action. While some communicative interactions—like conversation—take the form of a temporally extended collaboration in which interlocutors make an effort to attend to and interpret one another, not all communication is like this. Some interactions are fleeting, minimally taxing, and do not even demand intentional action on the part of the hearer. In that case, they are

not cases of joint action (*ibid.*). Since these interactions do still exploit agents' acting with and grasping communicative intent, though, the Stag Hunt scenario is not the right one for theorising about the foundations of Gricean communication. It describes only more sophisticated communicative interactions. Furthermore, Tomasello's claim that reasoning about communicative intent *requires* cooperative reasoning is surely too strong. Even if one thinks that Grice correctly identified the maxims of conversation that he described in terms of the 'Cooperative Principle', these are not the only way in which utterance interpretation could work. The maxims just describe one useful set of heuristics to which hearers could appeal when interpreting others' words.

Nonetheless, the Stag Hunt may still be the key to understanding why some Gricean communicators but not others evolved to use language. In the following section, I argue that while chimpanzees do act with and understand communicative intentions, they do not seem to be dependent on using their communicative abilities to hunt for food. By contrast, at some point in hominin history, our ancestors became dependent on using their existing but limited abilities for Gricean communication to engage in coordinated hunting. As they became more dependent on collaborative hunting, they underwent natural selection for a number of relatively small socio-cognitive changes that left them more attentive to one another, and more motivated to attempt to use their communicative skills to coordinate their activities. In turn, this allowed our ancestors to eat more meat—which supported brain growth, and gave rise to *Hominini* with more powerful abilities for inferring the communicative intentions of others. While this was not the only step our ancestors took on the way to language, it was key.

From meat to language: a first step

The second premise of Tomasello's cooperation argument appeals to empirical evidence that great apes do not engage in joint action. There are rare cases of what looks like joint action in chimpanzees (Melis and Tomasello 2013; Yamamoto et al. 2012; Moore 2016b), suggesting that this absence is largely due to motivational rather than cognitive factors. However, joint action in apes is rare, and as Tomasello (2008) argues, this is likely because they are not obligate cooperative foragers.

For the most part, chimpanzees survive on a diet of foods that can be foraged individually. While chimpanzees in the Tai forest hunt red colobus monkeys in groups (Boesch 1994), there are good reasons to think that the meat is not central to their diet in the way it was to our ancestors. Stable isotope analysis of Tai chimpanzees' hair keratin and bone collagen found that only adult male samples contained the high level of dietary protein indicative of long-term meat consumption (Fahy et al. 2013). This difference is supported by behavioural observations showing both that adult males are more involved in group hunting than others at Tai, and that they eat much more meat (Boesch and Boesch-Achermann 2000).

While these data do not show that meat is inessential to the chimpanzee diet, collaborative meat hunting does not seem to be necessary for chimpanzee survival. While collaborative hunting does slightly increase success rates (Tennie et al. 2009),

apes at some chimpanzee field sites—including Gombe (Goodall 1986)—hunt individually. Additionally, while meat may be a good source of nutrients, the same nutrients are likely also found in insect species that are foraged individually (Tennie et al. 2014). Perhaps because of this, intentional communication seems inessential for chimpanzee hunting and foraging.

Two recent studies of children’s and chimpanzees’ coordination in Stag Hunt paradigms (Bullinger et al. 2011; Duguid et al. 2014) support the conclusion that chimpanzees are not adapted to communicate in order to secure food. In both studies participants could eat a low value reward (the hare) alone or forsake this and collaborate for a better one (the stag).

In a low-risk paradigm, chimpanzees (Bullinger et al. 2011) and four-year-old children (Duguid et al. 2014) took part in conditions with two different levels of visual access (barrier vs. no barrier). In the no barrier condition, subjects could monitor one another and the stag freely. In the barrier condition, initially unsighted subjects could see one another only by abandoning the hare and approaching the stag. Irrespective of condition, both children and chimpanzees secured the stag in over 90% of trials. However, they communicated rarely ($\approx 10\%$ of trials for chimpanzees vs. $\approx 35\%$ of trials for children) and only after participants had

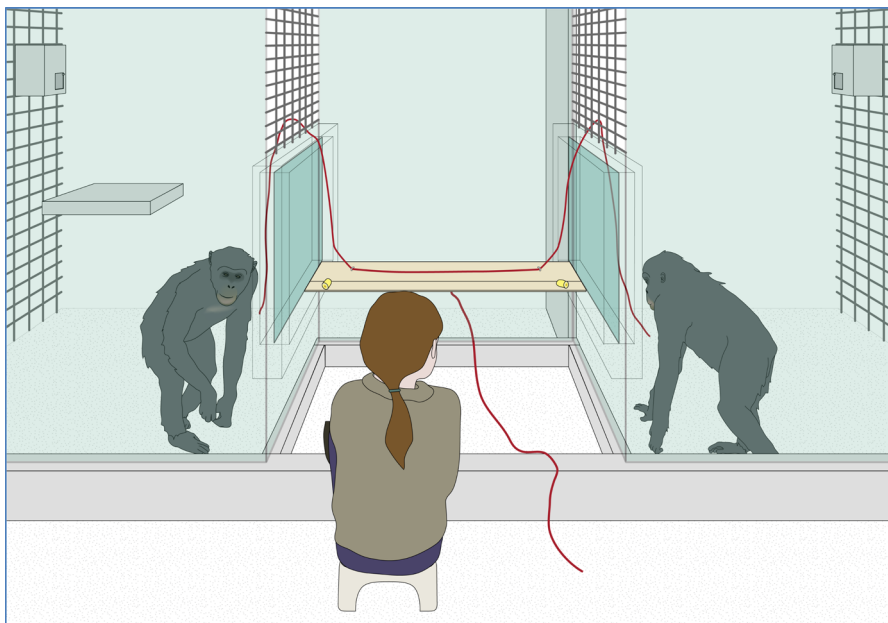


Fig. 1 Experimental set-up for a Stag Hunt paradigm with chimpanzee participants. Individuals can forage alone at their own ‘hare’ box (top left and right), or collaborate to retrieve the ‘stag’ (placed between the two cages). To get the stag, they must pull on the rope simultaneously. If only one pulls, the reward will be lost. The illustration depicts the no-barrier condition in Duguid et al. (2014). Fig. 1 reproduces a version of Fig. 2 from p.5 of: Duguid et al. (2014). Coordination strategies of chimpanzees and human children in a Stag Hunt game. Proc R Soc B 281:20141973. Used by permission of the Royal Society

abandoned the hare. In other words, participants of neither species tried to coordinate their behaviour before approaching the stag. Rather one left, and if the other did not quickly follow (perhaps on the basis of hearing the first individual's movements), the waiting partner urged them to do so.

A follow-up paradigm raised the stakes (Duguid et al. 2014). In addition to a higher value hare, soundtracks were played that stopped subjects from using audio cues to track one another's movements, and visual monitoring in the barrier condition was further restricted. In this paradigm, chimpanzees were less likely both to leave the hare ($\approx 70\%$ of trials), and to succeed in coordinating ($\approx 50\%$ of trials) – especially in the barrier condition. Moreover, they did not communicate more than in the simpler original paradigm, and no chimpanzee in either version of the Stag Hunt ever communicated before leaving the hare.

In contrast, children's ability to coordinate to get the stag was not greatly different in the low-risk ($\approx 95\%$ success) and high-risk ($\approx 85\%$) paradigms, with no differences between conditions. This is because children responded to the increased risk in the harder paradigm by communicating more often, and earlier. In the high-risk game, at least one partner communicated before either had left the hare in nearly 50% of trials (and 87.5% of dyads). The types of communication that children produced also changed. While utterances produced at the stag tended to be directive in nature (e.g. "Hurry up!"), when children spoke before abandoning the hare it was to signal the possibility of coordinating (e.g. "The stag is ready!").

The studies show that when the stakes increased chimpanzees were unable to raise their coordination game. Children, by contrast, coped well with the increased demands – because they talked to one another. While the children were already fluent communicators at the age when they were tested, the fluency with which they coordinated suggests that unlike apes, humans have undergone at least some selection for abilities to help them succeed in Stag Hunt scenarios.

On the story preferred by proponents of the SCR hypothesis, the appearance of informative utterances like those produced by children at the hare would be taken to demonstrate the existence in children of communicative abilities not shared by apes: a uniquely human form of "Gricean cooperative communication" (Tomasello 2008). However, in line with the arguments of the previous sections, a more nuanced and gradualist interpretation of the data is possible. Since chimpanzees sometimes do communicate informatively (Crockford et al. 2012), and since they can use communication to solve simple collaborative tasks (Yamamoto et al. 2012), they do possess communicative abilities that could be used to coordinate even in more complex Stag Hunts. They just don't use them.

A number of possible explanations for why apes do not communicate to coordinate suggest themselves. One is that chimpanzees' communicative abilities are very context bound (Hurley 2003)—and that they lack the imaginative abilities to grasp the possibility of using their existing skills in new contexts. Consistent with this, it may be if chimpanzees had more experience of Stag Hunt scenarios, they could learn to communicate more effectively. (Since the apes in the aforementioned studies have spent their whole lives in Leipzig zoo, where food is provided, their survival has never depended on their ability to secure food for themselves.) Whether or not chimpanzees could, with the right sort of pressure, learn to do this is an open

question. However, even if they could not, we need not suppose that doing so would require the sorts of sweeping socio-cognitive change envisaged by proponents of the SCR hypothesis.

More likely, the emergence in phylogeny of child-like abilities for coordination might have come with just a few small changes. While our ancestors did not become Gricean communicators in the transition to collaborative hunting, they did start to use their existing abilities in more collaborative ways. This likely happened when they became more dependent on foods that could not be foraged or even hunted individually (Tomasello et al. 2012). Then our ancestors had to coordinate in order to eat. Individuals who were more attentive to one another, and better able to wield their existing communicative abilities in novel hunting contexts, proved better adapted to their new environment—giving rise to selection pressures for better social attention and responsiveness, and greater motivation to engage in joint attention and to use existing communication abilities to solve new challenges.

To suppose that evolution took this course is to think that the transition from ape to human-like coordination did not require new abilities for false belief reasoning or high orders of metarepresentation. It required only a few tweaks to the ways in which our ancestors interacted and attempted to deploy already extant skills (Moore 2016b). It is thereby consistent with a view on which the uniquely human forms of ToM emerge only after children's first forays into language.

From meat to language: a speculative conclusion

Even if the changes needed to bring great apes to coordinate in Stag Hunts are slight, this would clearly not be sufficient for them to develop language. So why did humans but not apes evolve to use language, if not because of differences in social cognition? In what follows I sketch a speculative suggestion that I think worthy of consideration. It is intended to complement and not exclude other gradualistic stories about the evolution of hominin social motivation and attention (e.g. moderate versions of the Cooperative Breeding Hypothesis (Hrdy 2009)).

I start by stating two somewhat crude but intuitive assumptions that I cannot fully defend, but can at least make clear. First, I take inferential abilities to be at least roughly correlated with domain-general processing power. Second, I take relative processing power to be predicted by relative measures of brain development.

Throughout this paper I have argued that while there are socio-cognitive differences between humans and apes, they are more subtle than has been claimed.

Table 1 Relative brain size and processing power in humans and chimpanzees (taken from Roth and Dicke 2012, via Jerison 1973)

Species	Brain weight (g)	EQ	$N_c (\times 10^9)$
<i>Homo sapiens</i> (male)	1361	7.79	8.83
<i>Pan troglodytes</i> (male)	440	2.48	3.62

In contrast, one large and non-socio-cognitive difference between humans and apes is likely to have been crucial: the processing power of their brains. While infants excel at grasping the communicative intentions of others, great apes do not. In comparison to humans, their inferential abilities are crude and inflexible. Consequently, the range of communicative intentions with which they can act and that they can attribute to others is limited, as is their ability to wield existing abilities to solve new problems (something that seems to point to a failure of imagination).

These differences are likely a consequence of limitations to their domain general computational abilities—or ‘general intelligence’ (van Schaik et al. 2012; Heyes 2018). Indeed, differences in processing power should be predicted by the relative brain sizes of humans and other apes, and are supported by several measures. First, the average human brain weighs over three times more than a chimpanzee brain (Table 1). Second, although estimates of processing power vary with the measures used, according to one—the encephalisation quotient (EQ, a measure of relative brain size used to theorise an approximate intelligence level)—the ratio is about 3:1 (Roth and Dicke 2012, cf. Jerison 1973). Third, the measure of ‘extra’ neurons (N_c) in the brain gives a further indicator of processing power (*ibid.*), and confirms the limitations of the chimpanzee brain relative to the human one.

A common view is that general intelligence in primates is a function of their sociality. According to the Social Brain Hypothesis (Dunbar 1998, 2009), primates “evolved large brains to manage their unusually complex social systems” (Dunbar 2009, p. 562). On this view, in line with the Socio-Cognitive Revolution hypothesis, an explanation of the relative power of human brains would be our having undergone a socio-cognitive revolution since the split of the *Pan-Homo* clade (in response to the growing demands of hominin social life). However, a more recent finding has challenged the correlation between sociality and brain size. Primate brain size is predicted not by sociality, but by diet (DeCasien et al. 2017). In particular, frugivores have larger brains than folivores.

The correlation between big brains and diet makes sense. First, foraging for fruits and seeds requires spatial memory and tool-use skills not required by folivores. Second, the greater energetic intake of frugivory is better suited to maintaining metabolically expensive brain tissue than is a foliage-based diet (*ibid.*). The implications of this finding extend to meat-based diets too. Brains are expensive to maintain, and one way in which this cost can be paid is with the acquisition of effective strategies for acquiring food. This is particularly so when those strategies are not vulnerable to seasonal change, and when they facilitate the rapid acquisition of high-value food (van Schaik et al. 2012; Tennie et al. 2014). Given this, mastery of the Stag Hunt, and the quantity of meat that it made available to our ancestors all year round, was likely a key step in evolving a bigger brain (Aiello and Wheeler 1995)—with important consequences for the evolution of language.

What the foregoing data suggest is that the computational power needed for communicative flexibility may not (or at least not only) have its origins in social brains that underwent adaptations for group living—as proponents of the SCR maintain. Rather, a key source of greater inferential power was likely the richly calorific meat-based diet that group hunting delivered. Our ancestors’ brain growth

then arose on the back of gradually improved social attention and ecological pressures for collaborative hunting. In that case, while Stag Hunts do not explain the origins of Gricean forms of communication, they may be the historical cause of the inferentially powerful and more flexible versions of that made possible the development of language in humans.

Without improvements to other abilities needed for natural language—not least, high fidelity imitation (Tennie et al. 2009; Moore 2013a, c; Fridland and Moore 2014, Tramacere and Moore 2016), and syntactic combination (Moore 2017c)—our ancestors would remain some distance from human-like language. Nonetheless, when they started to participate regularly in Stag Hunts, they took an important step on the way. Ultimately, the evolution of language enabled new forms of social coordination and cognition. A story about how this happened cannot be attempted here. But I hope to have shown, at least, that strong versions of the SCR hypothesis are unwarranted. A few tweaks aside, uniquely human social cognition is likely to be a product of communicative development, not its precursor.

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