

# Cooperative Breeding and the Evolutionary Origins of Shared Intentionality

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It has seemed to many theorists that our nature as a cooperatively breeding species is crucial to understanding how we became fully human. This article examines a particular strand within this thinking, according to which cooperative breeding drove the evolution of human skills and motivations for sharing intentionality. More specifically, I consider a model of the evolution of these skills and motivations offered by Tomasello and González-Cabrera (2017). Their model is “composite” in that it also recognizes an important role for collaborative foraging in the evolution of shared intentionality. I argue that their model—or more precisely, a natural construal of it—faces at least two problems: what I call the “reflexive metacognition problem” and the “bonding problem.” These two problems (as their names would suggest) concern the cognitive and emotional-motivational dimensions of the evolution of shared intentionality, respectively. I sketch an alternative evolutionary scenario which also posits a dual role for collaborative foraging and cooperative breeding. However, there are some crucial differences between the two models. In particular, the Tomasello and González-Cabrera model appeals to cooperative breeding in explaining the initial appearance of basic skills and motivations for sharing intentionality. In contrast, I argue that cooperative breeding, at least initially, instead served to drive down the age of development of preexisting skills and motivations for sharing intentionality that originally evolved to support collaborative foraging in adult life. This alternative model avoids the reflexive cognition and bonding problem, and has other advantages which I highlight.


## Keywords

cooperative breeding • collaborative foraging • shared intentionality • reflexive metacognition • (social) bonding • cultural learning • phenotypic plasticity

## 1 Introduction

Humans cooperate in many striking ways, among them, reproductively. More specifically, cross-culturally, and almost certainly for a period reaching deep into the Pleistocene, humans have

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practiced a form of reproductive cooperation known as *cooperative breeding* (Hrdy 1999; 2009). In cooperatively breeding species, non-parents systematically contribute to the direct or indirect care of dependent young.<sup>1</sup> The form this care takes of course depends on the specific needs and features of the species in question. In the case of humans, we contribute care by, for example, babysitting, carrying, and feeding others' children.<sup>2</sup> In this regard, we stand out in the primate order with the exception of *Callitrichidae*, a family of New World monkeys (Burkart et al. 2009; Burkart and van Schaik 2010, 2016; van Schaik and Burkart 2010). Like us, *Callitrichidae* cooperate in a variety of ways to help each other's young survive into reproductive maturity.

It is now widely accepted that our history as cooperative breeders has significantly shaped our life history. In particular, humans show a much prolonged childhood and adolescent period relative to other great apes, during which time we remain crucially dependent upon adults for vital resources (most obviously, food). But at the same time, we wean our children at an earlier age and return to the business of reproduction sooner than other great apes, a fact reflected in our significantly shorter interbirth intervals (Pilbeam and Lieberman 2017; Nakahashi et al. 2018). Very plausibly, this life history pattern could not have established in our lineage without group members systematically contributing to the care of others' young.

The evolution of cooperative breeding has no doubt transformed our lifeways in other respects, too. For example, the nature of social learning in our line very likely changed dramatically. As we transitioned into a cooperatively breeding species, humans' social tolerance must have increased. Group members must have grown more tolerant of young individuals being in close proximity to them (along with all of their antics), including around food. Accordingly, the young enjoyed more and better social learning models (Burkart et al. 2009; Burkart and van Schaik 2016). And social learning must have also become less rigidly vertical (i.e., from parent to offspring), as well. Moreover, the extended childhood and adolescent period enabled by cooperative breeding meant more time to engage in learning—of both individual and social varieties—before having to rely on one's foraging knowledge and skill set for survival.<sup>3</sup> So, both the bandwidth and fidelity of intergenerational social learning must have increased significantly, with broad effects on our lifeways. This was very likely a crucial step on the road to developing a genuinely cumulative culture.

It is also very likely that cooperative breeding drove changes in our intrinsic cognitive and motivational makeup, though the nature of these changes is less obvious. It is thus no surprise that there is less agreement on this topic. According to one recent and influential line of thinking, cooperative breeding played a foundational role in the evolution of shared intentionality in our line (Hrdy 2009; Burkart et al. 2009; van Schaik and Burkart 2010; Hawkes 2014; Hrdy 2016; Tomasello and González-Cabrera 2017; Tomasello 2019; Hrdy and Burkart 2020). Exactly what shared intentionality consists in will be discussed in detail below; for now, suffice it to say that it is standardly conceived of as the capacity and motivation to share mental states, broadly construed, with conspecifics. In my view, the most promising version of this idea contends that, as we became cooperative breeders, basic skills and motivations for shared intentionality evolved in the service of attracting more care and attention from adults.<sup>4</sup> Young

<sup>1</sup>Provisioning mothers or mothers-to-be is a form of indirect care of dependent young. Alloparental contributions to mothers reduce maternal strain, in turn allowing mothers to invest more in young.

<sup>2</sup>See Hrdy (2009) for a most impressive overview of the full suite of cooperative breeding behaviors in humans.

<sup>3</sup>For some recent work looking at the interplay among such variables, see, e.g., Kendal et al. (2018), Miu et al. (2020), and Garg et al. (2022).

<sup>4</sup>There is another version of the idea, according to which cooperative breeding selected for traits in adults (e.g., capacities for coordinating action, proactive prosociality [i.e., proactive sharing of food]) which, in turn, led to the emergence of shared intentionality (see, e.g., Burkart et al. 2009; Burkart et al. 2014; Finkleworth et al. 2016; Burkart et al. 2018). This thinking draws upon a combination of field studies—primarily of callitrichid monkeys—

children who possessed an “edge” in this arena were better looked after and hence enjoyed a survival advantage.

A core aim of this article is to examine this influential proposal. In the view of many theorists, the evolution of shared intentionality was a watershed moment in our evolution. This is because—according to these theorists, anyway—so much of what is distinctive about human social and cognitive life is based in shared intentionality: it is foundational for collective action, language, moral norms, and much else. Whether or not shared intentionality is of such sweeping importance, it is clearly very significant to our social, emotional, and cognitive lives. So, if correct, the proposal is of clear theoretical importance. In considering this proposal, I will take as my exemplar the model advanced by Tomasello and González-Cabrera (2017; see also Tomasello 2019 for essentially the same model). There are several reasons for this choice. Firstly, it is a useful synthesis of much (though not all—see footnote 3) earlier work in the area carried out over the last several decades. Secondly, the model contrasts with earlier treatments in being very clear about the precise cognitive and motivational features that it seeks to explain—about the particular skills and motivations of shared intentionality. And thirdly, it recognizes and seeks to articulate the ongoing importance of these features beyond early developmental stages, thus providing us with a more complete account of the ontogeny and phylogeny of shared intentionality. Less clear is the intended scope of this model. More specifically, the model can be given (a) a conservative construal, on which it simply seeks to highlight the selective pressures that were relevant to the evolution of shared intentionality, or (b) a more ambitious construal, on which it also presents an evolutionary account of the steps that led to the origins of shared intentionality in our line. In my view, several of the things Tomasello and González-Cabrera say are difficult to make sense of unless their model is interpreted along the latter lines (we shall see one especially clear example of this below). That said, I am far less interested in such exegetical matters here than I am in the cogency of the evolutionary scenario which their model at the very least strongly suggests. So, it is this evolutionary scenario or sequence—and hence the more ambitious construal of their model—which I shall work with in what follows. To the extent that Tomasello and González-Cabrera in fact intended their model to be taken only along the former, more modest lines, they might welcome the alternative evolutionary scenario I shall go on to present as a way fleshing out their model.

An outline of what follows: I begin by unpacking the Tomasello and González-Cabrera model (again, construed as presenting an evolutionary sequence). After that, I raise two problems for it. Each problem taken on its own is a serious worry. However, it is particularly the combined force of the two that, in my view, warrants a substantive rethinking of the model's basic assumptions. I take up that challenge in the final part of the article, offering an alternative model. The key differences between the two models will become clear below.

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along with (a limited number of) lab experiments (see, in particular, Burkart et al. 2014). I am quite skeptical, but unfortunately there is not room in the present article to fully explain that skepticism (that would take a whole other article). Suffice it to say the following, then. (i) In my view, Burkart and collaborators do not sufficiently appreciate the role unique features of callitrichid lifeways—in particular, the very high degree of genetic relatedness that is characteristic of their residential groups, and their genetic chimerism—has likely played in the evolution of the cooperative/prosocial traits that are of interest to these theorists. These features are not characteristic of hominin groups, so the use of callitrichid monkeys as a guide to hominin socio-cognitive evolution is suspect. (ii) There are many cases of cooperatively breeding species outside of primates where these cooperative/prosocial traits are not possessed, which puts pressure on the claim that cooperative breeding *as such* selects, or even tends to select, for such traits. (iii) The field reports of callitrichid behavior (e.g., of the proactive sharing of food) are questionable. And (iv) the experimental data Burkart and collaborators adduce regarding levels of proactive prosociality as a function of alloparental care in primates are similarly questionable (in part because the primates tested were all captives; in part, because of aspects of experimental design). (On (iii) and (iv), see Thornton and McAuliffe 2015 for a very good critical discussion.)

## 2 Tomasello and González-Cabrera's "Composite Model"

Tomasello and González-Cabrera present what they refer to as a *composite model* of the evolution of shared intentionality, and human collaborative capacities more generally. It is composite in the sense that it integrates the logic of two hypotheses previously on offer. One is the *interdependence hypothesis*, proposed by Tomasello et al. (2012). According to this hypothesis, shared intentionality evolved in the service of collaborative foraging, which eventually became obligate in our line (hence we came to *depend* on one another for survival). A lifeway centered on complex forms of collaborative foraging, such as big-game hunting, would have no doubt been demanding on cognition and motivation in a variety of ways. Agents must have been able to formulate plans for joint action and communicate about those plans in advance. They must have been able to control and adjust their contributions to joint action in real time, especially in the face of unexpected circumstances. They must have been able and motivated to temporarily switch goals to help a partner in need. To do all this, in turn, they must have had a sophisticated grasp of the collaborative activities they engaged in; for example, appreciating the different roles involved in the activity, and in a rather abstract way, allowing for agents to adopt different roles at and over time. Moreover, agents must have been motivated and willing to distribute the fruits of their labor in ways that did not destabilize future joint endeavors—and to collectively enforce such distributions.

It is plausible indeed that obligate collaborative foraging has been a major force shaping human social and cognitive evolution, probably since the time of *Homo erectus* (see also Sterelny 2012 on this point). Moreover, it is very plausible that a lifeway rich in collaborative foraging depends on a suite of impressive cognitive skills and motivations, just as Tomasello and colleagues propose. However, there is something peculiar about the ontogeny of these skills and motivations from the perspective of the interdependence hypothesis. Namely, they—or at least low-key versions of them—appear very early in life, many years before individuals are capable of engaging in collaborative foraging, or any other form of joint action that is economically significant (Hawkes 2012). This is where the second hypothesis, the *cooperative breeding hypothesis*, comes into play. According to it, shared intentionality arose in response to selective pressures created by cooperative breeding. Or more fully, once mothers came to depend on other group members to meet the costs of child rearing, children began to compete—including with their own siblings—for the scarce resource of adult care and attention. Towards this end, they evolved a variety of means of making themselves more attractive to adults. The capacity and drive to share mental states with others was among them (says the cooperative breeding hypothesis).

Tomasello and González-Cabrera (2017) take this logic on board. More specifically, they contend that it was cooperative breeding that drove the evolution of the most basic skills and motivations of shared intentionality. These skills and motivations were then transformed through synergistic interactions with more mature cognitive capacities as children grew up. The resulting more complex skills and motivations for shared intentionality were then put to other uses (i.e., uses other than attracting adult investment). In particular, they were primarily used to support collaborative foraging in adulthood. Hence, Tomasello and González-Cabrera tell us:

to explain the many and various unique forms of human cooperation requires both the cooperative breeding hypothesis, positing a unique selective environment for fostering the most basic skills and motivations of shared intentionality during infancy, and the interdependence hypothesis, positing a critical role for the obligate collaborative foraging of adults as a selective environment favoring individuals who could engage in various forms of complex social coordination and communication. (Tomasello and González-Cabrera 2017, 286)

Let me to now expand on this skeletal summary.

According to Tomasello and González-Cabrera, from around 6 weeks of age, human infants begin to exemplify a species-unique motivation to share positive emotional experiences with others. Outwardly, this is reflected in both smiling and laughing at others from a distance. These behaviors gradually give way to the “proto-conversations” of early infancy (Bateson 1979; Trevarthen 1979), in which babies take turns exchanging pleasant sounds and facial expressions with others. At around 9 months of age, this motivation to connect by sharing positive emotional states begins to interact with the development of a great ape-wide understanding of intentional agency (though the latter developmental trajectory appears to be cued earlier in humans than in other great apes [Wobbler et al. 2014]). Shared intentionality is—as Tomasello and González-Cabrera see things—the result of the coming together of these two developmental pathways. (Or, as Tomasello [2019] puts it, “This synergy represents nothing less than the birth of shared intentionality” (56).)

Around this time that the capacity and drive to share attention to external objects and events (i.e., triadic attention) appears. Infants attempt to initiate episodes of shared attention with others and are receptive to others’ attempts to do the same. Shortly thereafter—at about 1 year of age—infants begin communicating with adults in uniquely human ways; for example, by pantomiming and pointing to things informatively rather than imperatively. The motives behind these early communicative acts have been thoroughly experimentally investigated by Tomasello and others, and a large body of evidence now exists which shows that infants are interested in more than simply directing others’ attention to objects or events; they also want to share that experience with their audience.

Tomasello and González-Cabrera also draw attention to uniquely human forms of helping that develop early (though, it must be said, these behaviors are less obviously instances of sharing intentionality proper). They note that, while other great apes have been observed to offer rudimentary forms of help to others, human infants provide help that is tailored to its recipient in sophisticated ways. For example, infants provide help by supplying relevant information to others, and may factor in how another has recently behaved or been treated in deciding whether to help them. Thus, in contrast to other great apes, the help human infants provide seems to be shaped to some extent by meta-psychology or at least perspective-taking skills.

In line with the logic of the cooperative breeding hypothesis, then, Tomasello and González-Cabrera contend that infants recruit these basic skills and motivations for shared intentionality to endear themselves to adults and, in so doing, attract investment from them. One striking piece of evidence they report in support of this idea is that infants and toddlers apparently exhibit the above behaviors at much higher frequencies with adults than with peers. This makes good sense on the cooperative breeding hypothesis, for the hypothesis contends that it was adults who delivered the bulk of the care to dependents. This assumption is well supported by evidence from ethnographically-known hunter-gatherer societies (Konner 2013).

But in order for this strategy on the part of infants to succeed, it must of course be the case that adults are actually “wooded” by these behaviors. That is, adults must (i) recognize these efforts, (ii) find interacting with infants in the relevant ways intrinsically rewarding (for adults generally stand to gain little or nothing from such interactions), and (iii) consequently be motivated by these experiences to invest in these infants going forward. Tomasello and González-Cabrera point this out themselves, though only in passing. They write:

Note that in this hypothesis, it must be infants who lead the way in skills and motivations for joint attention. In the early evolutionary steps, they must have

used joint attentional skills to “hijack” already existing adult emotional and bonding mechanisms for their own ends. (Tomasello and González-Cabrera 2017, 282)<sup>5</sup>

I will return to this issue below, for in my view, it poses a significant issue for the model.

Continuing on for now: Tomasello and González-Cabrera envision these basic skills and motivations for shared intentionality as being retained beyond infancy. As children grow up, these skills and motivations synergistically interact with later-developing cognitive capacities. So, for example, as more advanced planning capacities come online, individuals became able to plan joint actions to be taken in the future. Likewise, as more advanced problem-solving skills come online, individuals become able to behave jointly to accomplish a wider range of goals. The result is a more powerful package of skills and motivations for sharing intentionality, which now serves new ends.

More specifically: as children enter early and middle childhood (~4–12 years of age), they begin to spend a majority of their time with other children. Tomasello and González-Cabrera propose that, during this stage, skills and motivations for shared intentionality begin to be used to forge and maintain cooperative relationships with same-sex peers. In turn, success in this domain functions to signal one’s value as a prospective mate to opposite-sex peers. But possessing these skills and motivations during early and middle childhood is useful for another reason: it provides an opportunity to refine and extend them through practice, thereby resulting in an even more upgraded package by the time these individuals reach adolescence and adulthood. Going by Tomasello et al. (2012), this package includes the following: “the ability to coordinate actions, form shared goals and joint commitments, monitor and reverse designated roles, communicate relevant information and action plans, and share resources dependently upon prior collaboration” (Tomasello et al. 2012, 689). By this developmental stage, the function of these skills and motivations has shifted to supporting flexible and efficient collaborative foraging. Those individuals were best able to work together to obtain food, and to manage the various other sub-challenges this entailed, were positively selected for.<sup>6</sup>

Thus, on Tomasello and González-Cabrera’s model, the evolution of shared intentionality is a story of the ontogenetic transformation of uniquely human skills and motivations for attracting adult investment in a cooperative breeding niche, with the function of these skills gradually shifting over time to skilled participation in complex forms of collaboration and cooperation in later life.

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<sup>5</sup>This is the passage I alluded to earlier in suggesting that their model be interpreted as committal on evolutionary steps.

<sup>6</sup>Tomasello and González-Cabrera sometimes talk of traits “migrating up/down” in ontogeny. But then they slip into talk of selection pressures “migrating up/down” in ontogeny. The two are crucially different, however, and must be kept separate. As far as I can tell, on their model, there is no actual “migration up” or “migration down” of skills and motivations of shared intentionality. (At a minimum, their model is deeply ambiguous on this crucial issue.) That is, there is no (obvious) *trait* migration. These skills and motivations originate in infancy and are retained into later life, sustained by their immediate and ongoing usefulness. However, Tomasello and González-Cabrera do posit migration up and down of *selective forces* over the life cycle, as these skills and motivations come to take on new functions over the course of life. But even here their language is confusing. For example, because basic skills and motivations for sharing intentionality turn out to support collaborative foraging in adulthood, Tomasello and González-Cabrera describe these skills and motivations in infants as “ontogenetic preadaptations” for collaborative foraging. I take it the idea is that, in the next generation, infants are selected for having these skills and motivations in part because they will be useful in adulthood for collaborative foraging. Hence, selective pressures relating to collaborative foraging can then be said to have “migrated down.” I find that this language creates more confusion than illumination, and hence I have avoided it here. I flag the issue just to forestall any objection that I have missed something crucial in their model. (As will become clear below, on the alternative scenario I present, we might say there was “migration down” of certain adult traits into early ontogeny over evolutionary time. I do not use that language in describing the model, however.)

### 3 The Reflexive Metacognition Problem

That is the model in outline; now to its problems. The first concerns the origin explanation the model provides for shared intentionality—I call this the “reflexive cognition problem,” for reasons that will become clear presently. As mentioned, the appearance of shared intentionality is explained as the result of a synergy between a motivational drive in infants to share positive emotional experiences with adults, and the development of an understanding of intentional agency that is common to other great apes. Here is how Tomasello and González-Cabrera put the idea:

What happens, then, is that the sharing of emotions extends to the sharing of attention and interest in external objects and events—behaviors in which great ape infants never engage ... —via a synergistic combination of uniquely human emotion sharing and great ape-wide cognitive skills for understanding the intentionality of others. (Tomasello and González-Cabrera 2017, 281)

The worry with this idea is that it assumes other great apes already possess the cognitive wherewithal for shared intentionality; what they lack is simply an emotional-motivational component.<sup>7</sup> However, it is widely assumed—including by Tomasello and his collaborators—that shared intentionality requires some kind of capacity for thinking about others’ thinking about one’s own thinking. More specifically, it is widely assumed that sharing intentionality requires that agents “know together” that they are in the same mental state; it is not enough for them to simply be in the same state. Here is Tomasello et al. (2012) on this requirement:

[k]nowing together means engaging in some form of recursive mind reading (we each know that the other knows, etc.), which is the basic cognitive ability that enables humans to engage in all forms of joint and collective intentionality (Tomasello 2008, 2009), including joint attention, common conceptual ground, and all “public” knowledge and activities. (Tomasello et al. 2012, 677)

Tomasello and González-Cabrera also assume this. For example, they characterize infants’ attempts to share attention with adults by actively offering or showing an object to them as involving “a recursive cognitive process in which each expects the other to expect them to expect ... (and so on)” (Tomasello and González-Cabrera 2017, 281).

Thus, the model’s origin explanation in effect assumes that other great apes are already capable of engaging in this “recursive cognitive process.”<sup>8</sup> In this article, I shall instead talk of “reflexive metacognition” (and similar). As I understand the notion, reflexive metacognition also “loops back” on itself just as recursive cognition does. However, I do not take reflexive metacognition to be iterable, in the way that recursive cognition is generally taken to be (as when, e.g., Tomasello and González-Cabrera write “and so on” above).<sup>9</sup> A capacity for reflexive metacognition is thus less demanding than recursive cognition. Clearly, those who think sharing intentionality implies recursive cognition will accept that it requires reflexive metacognition

<sup>7</sup>Burkhardt et al. (2009) are likewise committed to such an idea. Similar problems to those raised below befall their proposal in my view.

<sup>8</sup>That, or infants’ drive to share positive emotional states with others combined with an understanding of shared intentionality common to great apes is somehow sufficient for the development of this ability—a scenario too outlandish to take seriously, in my view.

<sup>9</sup>Here I am following Levinson (2020) who uses the term “reflexive cognition,” as opposed to “recursive cognition,” though I think that “reflexive metacognition” is actually the more technically correct term for the relevant form of cognitive processing.

in the present sense. But some theorists (myself included) think that reflexive metacognition may be sufficient. This is all that is needed for the present argument.

The problem in a nutshell, then, is this: there is simply little to no evidence—either empirical or theoretical—for thinking that other great apes possess the capacity for reflexive metacognition.<sup>10</sup> And in fact, what evidence does exist in this area has strongly suggested to theorists that the opposite is true.<sup>11</sup>

Importantly, one need not think that infants possess reflexive mind reading abilities on par with normal adults to find this aspect of the model problematic. Virtually everyone who thinks shared intentionality requires reflexive mind reading is quick to add that young children do not manifest the skill to the same extent as do adults. For example, Tomasello (2019) writes (though here talking of “recursive cognition”): “It is not that the infant engages in this kind of recursive thinking explicitly, but that the underlying structure of joint attention means that they both know together that they both are attending to the same thing” (Tomasello 2019, 56). Such attempts to immediately walk back the claim that infants can reflexively mind read can certainly seem like an attempt to have one’s theoretical cake and eat it too. *Either infants can, or they can’t, engage in such thinking!* one might protest. But this is arguably too quick. Much space exists between a perfectly explicit mental representation—a representation of the sort that an agent might freely make use of in domain-general reasoning, and verbally report on, for example—and information that is merely implicit in the behavior of an agent (Karmiloff-Smith 1992). This fact tends to be obscured by the near exclusive reliance upon folk psychology in the literature to describe the relevant cognitive processes and mechanisms. For the vocabulary of folk psychology is both imprecise and much impoverished from a scientific point of view of the mind (see Heyes 2018 for the same point, though in the context of the cognitive science of social learning; and see Planer and Sterelny 2021 for a discussion of this point in the context of linguistic communication).

What, exactly, are the reflexive mind reading abilities of young children like, then? Unfortunately, a sharp characterization is still lacking and is probably a way off. But in the meantime, experimental results provide a useful window. A prime example is provided by Grosse et al. (2010). In this experiment, 18 month-old children communicated their desire for a particular object to an adult experimenter, which they did with a combination of pointing and whining. In the crucial test condition, the experimenter passed the infant the object he or she had in fact requested, but produced signs that the experimenter had actually misunderstood the request (e.g., having requested the toy cow rather than the toy horse, the experimenter said, “Oh, you want the horse?! Sorry, I can’t give you the horse right now,” while offering the cow to the infant). In this condition, infants frequently repeated their initial request and/or engaged in other repair behaviors. And they did so only if they believed that the experimenter had misunderstood them; they did not repeat their request nor attempt to repair communication if the experimenter properly understood the request, but simply denied them the requested object (e.g., after having requested the cow, the experimenter said, “Oh, you want the cow?! Sorry, I can’t give you the cow right now.”)

The behavior of the toddlers in this experiment naturally invites a description of them in the vocabulary of folk psychology as not only wanting, e.g., the cow, but of wanting the experimenter

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<sup>10</sup>Note that some agent/species could have quite a rich theory of mind—quite a rich understanding of intentional agency—while wholly lacking reflexive metacognitive capacities. For my part, I am convinced great apes have some sophisticated theory of mind abilities (see, e.g., Krupenye et al. 2016; Kano et al. 2019). (For a recent review of the relevant literature, see Planer 2021). But it is clearly a further issue of whether they possess reflexive metacognitive capacities.

<sup>11</sup>For one good discussion of the evidential situation, see Scott-Phillips (2014, 86–91).



to know that they want the cow. But a number of cognitive science explanations exist that would serve to distinguish what is going on in the toddler's mind in this case from the sorts of full-blown reflexive mind reading or mind simulating that adults engage in.<sup>12</sup> Even so, there is still a clear sense in which to adequately explain and/or predict the toddlers' behavior in this context it is necessary to attribute to them some form of thinking about another's thinking about their own thinking. The "thinking" in question need not be anything like a decoupled representation that is available for use in general reasoning, planning, etc. But there is some kind of reflexive processing going on. The issue at hand is whether the ability to engage in this sort of processing—whatever its form in early life, and however it is ultimately realized in cognitive mechanisms—is shared with other great apes, and there is currently no good reason to think that it is. Or at least the burden is very much on those who would have us think otherwise.

What this suggests is that any account of the evolutionary origins of shared intentionality is bound to be incomplete without a story about the origins of some kind of capacity for reflexive mind reading/simulating/monitoring, etc., in our lineage.<sup>13</sup> I will return to this challenge below.

#### 4 The Bonding Problem

The model faces another serious problem, one I call the "bonding problem." Put simply, the problem is this: while it may be true enough that adult humans are disposed to bond with and so invest more in children who are better at sharing intentionality with them, to suppose that such a bonding mechanism existed in adults *prior* to the evolution of shared intentionality amounts to positing an evolutionary miracle. Let me explain.

Tomasello and González-Cabrera cite work by Wolf et al. (2015) suggesting that when two individuals share attention to some location in the environment, they wind up feeling socially closer to one another. Thus, Tomasello and González-Cabrera's idea is that, by sharing attention with adults, infants bonded with adults, and this bond translated into increased investment. But on closer inspection, it is hard to see how this is supposed to go, evolutionarily speaking. This is because sharing attention is something that two agents do *together* (in contrast to having the *capacity* to share attention, which is an individual trait). When two agents share attention to some object, each is aware of the object, each is aware that the other is aware of the object, and each is aware that the other is aware that they are aware of the object (Carpenter and Call 2013). That is, shared attention involves the same kind of mental toing-and-froing as do other forms of shared intentionality (i.e., reflexive metacognition). However, in the scenario portrayed by the Tomasello and González-Cabrera model, it is only infants who have the capacity to engage in shared attention proper at the start of the evolutionary process. As they say:

infants ... lead the way in skills and motivations for joint attention .... Adult skills and motivations for shared attention ... then followed as these skills and motiva-

<sup>12</sup>There are relevant ideas in Sterelny (2017), Planer (2021), and Planer and Sterelny (2021), though none of these works deal specifically with the Grosse et al. (2010) experiment.

<sup>13</sup>One might object (as one referee did object) that it is unreasonable to expect any model to provide a complete explanation of the target phenomenon, and so it is not really fair to describe the present issue as a "problem" for the Tomasello and González-Cabrera model. While I of course agree that it is antithetical to the very nature of a model to provide an exhaustive explanation of its target phenomenon, I think the present issue is fair game: reflexive metacognition is not only a core moving part of the model; it is also a trait which is absent in our closest great ape relatives, and hence, presumably, a derived feature of our line (or so I have argued). It is common practice in the literature on the evolution of human social and cognitive uniqueness to avoid such unexplained leaps in our logic—or "miracles" as they are sometimes called—when presenting an evolutionary scenario. (I would say the same thing in response to a similar objection levelled at the next issue we shall consider.)

tions also provided fitness benefits to individuals at older ages. (Tomasello and González-Cabrera 2017, 282)

But how, then, could adults carry out their half of the cognitive work? Evidently, they could not on this scenario.

To get around this issue, it seems we must (non-trivially) assume that adults simply recognizing that they were attending to the same thing as an infant was sufficient for the adult to feel socially close with the infant and hence bond with them. This did not have to be “known together,” which would require reflexive mind reading on the part of the adult (which, *ex hypothesi*, adults would have lacked). Perhaps this is not implausible. Even so, what an unusual and unusually specific disposition for adults to possess! Why should simply recognizing—on the adult’s part—that their attention was shared<sup>14</sup> with the infant’s serve to bond the adult to the infant? What could explain the evolution of this tendency (assuming it is real)? In principle, it could be a by-product of some other adaptive cognitive or motivational trait. Which, though? No obvious candidates jump to mind, and Tomasello and González-Cabrera do not offer us any suggestions or clues.

Much more plausible, in my view, is that this bonding tendency represents an adaptive specialization to a social niche already rich in collaboration (and hence communication). Here is one possible adaptive story (there are likely others). Sharing attention tends to promote greater cognitive and motivational overlap between agents. As agents orient similarly to the world around them—and especially when they do so with similar goals—we can expect many of the same sensory, cognitive, and motor representations to become activated in them. They experience greater “alignment,” and at multiple levels of psychological organization (Pickering and Garrod 2004, 2021). Relatedly, agents will tend to acquire the same or similar information from the attended-to part of the environment, and carry this information forward in time, increasing the common ground that exists between them. It is thus not implausible to think that, in general, sharing attention with another agent will tend to promote enhanced prediction and explanation of their behavior. This is because one important way we have of predicting and explaining others’ behavior is to use ourselves as a model system. We ask, “What would I do next?” or “Why would I have done that?,” exploiting our own psychological states and mechanisms to produce an answer. In philosophy and cognitive science, this general idea is known as *simulationism* or *simulation theory* (see, e.g., Goldman 2006), and has been much discussed over the last several decades, beginning especially with the discovery of mirror neurons in monkeys.<sup>15</sup>

In general, the better able we are to predict and explain others’ behavior, the better we should be at collaborating with them, for collaboration is very obviously facilitated by accurate prediction and explanation. If so, and if sharing attention indeed facilitates prediction and explanation, then it would make good evolutionary sense for us to have some preference or bias to socialize with those whom we are or have recently shared attention, all other things being equal. Shared attention likely serves as a cue that conditions are ripe for fruitful social interaction. Of course, such a bias or tendency can at most be only a part—and likely a very small part at that—of how agents actually selected partners for collaborative activities in the evolutionary past; those decisions were no doubt informed by a much broader range of factors. But that complexity seems

<sup>14</sup>In what follows, I will still characterize two (or more) individuals as “sharing attention” when they are attending to the same thing, even when it is not mutually known that this is the case. The prose would be too torturous otherwise. Context shall serve to make clear whether mutual knowledge is also part of the equation, as it is standardly taken to be when agents are described as engaging in shared attention.

<sup>15</sup>For a recent and very detailed theory as to how simulation facilitates utterance prediction and understanding, see Pickering and Gambi (2018).

compatible with the basic idea that infants exploited the above tendency on the part of adults, thereby disposing them to direct more attention and care towards them.

What, exactly, is the problem then? On the Tomasello and González-Cabrera model, shared intentionality appears in infants, and was positively selected for because it helped infants attract more adult investment. These skills and motivations of shared intentionality later led to enhanced collaboration, communication, and cooperation in our line, and were subsequently transformed in the process. So, on their model, shared intentionality was a *prerequisite* for the human expansion in collaboration, communication, and cooperation. But at the same time, the model asks us to assume that adults were already disposed to bond over shared attention; else, infants' strategy for attracting increased investment by sharing attention with adults would not have gotten off the ground. What I have been arguing here is that such a tendency on the part of adults is most readily understood—and hard if not impossible to understand otherwise—as an adaptative specialization to a lifeway that had already come to feature a prominent role for collaboration (and hence communication). It is an adaptive response to such a social environment. But then this tendency on the part of adults is an evolutionary mystery; an unexplained explainer.

The model's logic thus turns out to be circular, and not in a way that is innocuous. In the remainder of this article, I want to sketch an alternative evolutionary scenario. On my model, shared intentionality first appears in the context of collaborative and cooperative interactions among adults—in line with the thinking behind Tomasello's original interdependence hypothesis. Then, what cooperative breeding eventually did was to select for the *earlier emergence* of these skills and motivations of shared intentionality in ontogeny. As will become clear, this model neatly solves (or avoids) both the reflexive metacognition and bonding problem.

But before going there, I want to briefly consider two possible responses that might be made on behalf of Tomasello and González-Cabrera at this point. Firstly, if the bonding mechanism in question is in fact shared with other great apes—or even just with *Pan*—then there is no actual bonding problem.<sup>16</sup> This is true enough, but I do not think it is plausible that the mechanism is part of the *Pan-Homo* baseline. Empirically, chimps famously show little to no interest in sharing mental states when tested. And theoretically, the above suggestion makes it mysterious why chimps have not evolved to use sharing attention as a means of bonding in their societies. Yes, chimp infants spend much less time away from their mothers during the first year of life as compared to humans. But they do eventually leave their mother's side, and while still quite vulnerable to infanticide and other dangers (Goodall 1967). Surely, they could still benefit from attracting increased care and attention from allomothers. Moreover, why don't chimps use attention sharing to build and maintain important social alliances in adulthood? I propose the answer is simple: they lack the relevant bonding mechanism.

Secondly, what if the bonding mechanism itself were a (by-)product of cooperative breeding? It is unfortunately beyond the scope of this article to consider all of the different ways this proposal might be developed. Suffice it to say that it is difficult to see why being disposed to bond in this way would be advantageous to adults in a cooperative breeding scenario. Why would an adult who was more apt to bond with an infant over shared attention have a fitness advantage over another adult who was not?<sup>17</sup>

<sup>16</sup>Or better: while we would still like an evolutionary explanation for this mechanism in the final analysis, it is not the job of Tomasello and González-Cabrera to provide one; it is available as a baseline trait for their model to draw on. (See footnote 13 here.)

<sup>17</sup>Burkhart et al. (2009) imagine a by-product scenario that could be relevant here. Specifically, they suggest that cooperative breeding selected for the motivation to share food in adults, and that this motivation in turn produced a motivation to share mental states as a by-product (see, as well, Burkart et al. 2018). But as far as I can tell, the

## 5 An Alternative Composite Model

The model I wish to propose shares a good deal in common with the Tomasello and González-Cabrera model. The main differences are as follows:

1. Basic skills and motivations for shared intentionality originally evolved primarily to support collaborative foraging. And very likely, their appearance reflected hominin *phenotypic plasticity* rather than the appearance and spread of some crucial new genotype.
2. As we came to increasingly depend on collaborative foraging and other forms of cooperation, *biologically-based* cognitive and motivational adaptations for sharing intentionality followed. This included some new mind reading abilities as well as ways of bonding.
3. Under selection pressures created by cooperative breeding, there was positive selection for individuals who developed these cognitive and motivational adaptations (or some subset of them) *earlier in ontogeny*. This was in part because individuals who did so were better at attracting more care and attention from adults.
4. The development of these skills and motivations at so early an age may well have led to the evolution of *still more sophisticated* skills and motivations for sharing intentionality—and probably more sophisticated versions of other socio-cognitive abilities, too—than had previously existed in our line.

Let me now flesh out these ideas.<sup>18</sup>

### *Origins*

Similar to Tomasello's original interdependence hypothesis, the current model contends that basic skills and motivations of shared intentionality originally evolved in the service mainly of collaborative foraging. But other forms of cooperation probably established at least as early, and are likely relevant. For example, collective defense of the residential group was likely an early and important form of cooperation (Sterelny 2012). In addition, it is plausible that cooperative breeding is also quite ancient. Hrdy, Hawkes, and others plausibly suggest that erectines practiced cooperative breeding. But it is plausible that cooperative breeding might go back even further, reflecting the novel demands of bipedalism on hominin mothers. For once we became bipedal, infants could no longer ride on their mother's back in the usual great-ape way as she moved from place to place foraging. Mothers may well have needed assistance with carrying or babysitting (Planer and Sterelny 2021). That having been said, collective defense and early forms of cooperative breeding probably made relatively modest demands on collaboration and communication as compared to collaborative foraging. Hence, the continuing place of prominence given to collaborative foraging in the model.

The model adds that the initial appearance of these basic skills and motivations for shared intentionality likely represented plastic responses to novel environmental challenges that rewarded cooperation and collaboration. Arguably, this is a good general pattern to assume in hominin evolution, as our ancestors must have had a high degree of phenotypic plasticity in order to cope with their constantly shifting physical and social worlds.<sup>19</sup> But it is perhaps especially

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plausibility of this idea rests entirely on the degree of likeness between sharing food and sharing mental states—an analogy that strikes me as superficial. No psychological story is provided as to how a motivation of the first kind might actually translate into a motivation of the second.

<sup>18</sup>Needless to say, an exhaustive defense of each of these ideas is a job for another day. My goal here is mainly to explain them and make them plausible.

<sup>19</sup>I thank Kim Sterelny for this point.

likely to be true in the case of the skills and motivations in question. For in general, these skills and motivations work—or at least work best—when multiple individuals possess them. There is little advantage in having the capacity to coordinate or communicate in complex ways with others if you are the only one who is able to do so.<sup>20</sup> It is easy to see how a group of individuals confronting the same environmental challenge might evolve one or more of these traits at the same time via processes of phenotypic plasticity.

### *Genetic adaptation*

As collaborative foraging became increasingly important to our lifeways, the model posits that there was selection for genetically-channeled cognitive and motivational adaptations for sharing intentionality. Of particular interest to us here is the biological evolution of some kind of reflexive mind reading abilities, as well as the tendency to bond over shared attention (and presumably other forms of shared intentionality).

In the previous section, we looked at one possible adaptive account for the tendency to bond over shared attention. Initially, this tendency might have been a plastic response to an environment in which collaboration was increasingly central, which was later genetically assimilated. Or its origins may well have been genetic, for its adaptiveness in such an environment does not seem to depend on additional tokens of the trait (or of tokens of a related, complementary trait) being present in others to confer a fitness benefit on its bearer. Either way, given some reasonable adaptive story here, there is no mystery as to how this tendency might have gradually evolved in our ancestors. But, and this is the crucial point, that is true only once hominin social worlds had already changed to more prominently feature collaboration.

What about reflexive mind reading? In principle, an ability to reflect on others' thinking about one's own thinking could be adaptive in an environment characterized primarily by conflict and competition. It could earn its keep primarily on Machiavellian grounds. But one wonders why chimps have not gone on to evolve it then. Much more plausible, I assume, is that it, too, is an adaptive response to a more collaboration-rich world. When a common goal is pursued, it is often in everyone's interest that one's intentions are clearly understood. We generally want our behavior to be intelligible to others in such contexts. Thus, as an awareness of others' interpretative efforts arises, we would expect agents to do what they can to facilitate the interpretation process, to make themselves easier to mind read. Behavior comes to exhibit so-called "recipient design" (Sacks et al. 1974).<sup>21</sup>

Also relevant here is reputation management. In a world in which fitness depends on being selected for collaborative activities, and in which others condition their choice of partner on one's past behavior (preferring cooperative partners), it is clearly in one's self-interest to manage one's reputation. Thus, we expect selection pressure for some ability to reflect on how others are apt to perceive one's behavior. Individuals who behave more prosocially while in the presence of potential collaborative partners, or even more simply, who merely refrain from engaging in anti-social displays in such contexts, are clearly at an advantage. From this perspective, it is not surprising that chimps have not evolved to care about their reputations (Englemann et al. 2012; Nettle et al. 2013; Englemann et al. 2016). For given that their lifeways feature little to no genuine collaboration, they stand to gain little to nothing from worrying about their reputations.

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<sup>20</sup>Hence why Chomskyans about language evolution, who posit that language originated due to a random genetic mutation, contend that language was originally selected for its effects on thinking, not communication (see, e.g., Berwick and Chomsky 2016).

<sup>21</sup>The term "recipient design" is most often used in discussing communicative behaviors. But there is no reason to limit the term in this way. Recipient design in communication is but a special case.

The thought, then, is that as collaborative foraging became increasingly central to our life-ways, cognitive adaptations supporting some kind of reflexive cognition biologically evolved. For these skills oiled the wheels of collaboration, and were also useful for minding one's reputation. Importantly, to say this is not to say that ancient hominins possessed reflexive mind reading abilities on par with those of fully modern, language-equipped adult humans. (Recall the discussion above about the reflexive mind reading abilities of human infants.) But they had some capacity to reflexively perspective-take or monitor. The great ape-wide understanding of intentional agency which was already possessed by hominins was thus supplemented with this additional mind reading ability.<sup>22</sup>

### *Selection for early development*

Once, *but only once*, these cognitive and motivational adaptations are onboard, the model predicts selection for individuals who develop them early in ontogeny—long before they are needed for collaborative foraging—under pressures created by cooperative breeding in our line. By being better at, and engaging more in, forms of shared intentionality with adults, dependent young attracted increased levels of care and attention from adult allomothers. Hence, those children were selected for. Thus, the model obviously remains a composite one, recognizing both a central role for both collaborative foraging and cooperative breeding.

Note, however, there is no longer any reflexive metacognitive or bonding problem to contend with. When individuals are selected for developing skills and motivations for shared intentionality early in life, part of what they are selected for is developing the ability to engage in some form of reflexive cognition; an ability that previously evolved (*ex hypothesi*) to meet the demands of collaborative foraging. They are also selected for developing the same or similar drives which, in adults, motivate them (adults) to share intentionality. These motivations do not appear for the first time in cooperatively cared-for infants.<sup>23</sup> At the same time, adults in the group already possess the tendency to bond over shared attention, which again, we hypothesize was an evolved response to a collaborative foraging niche. This enables infants' strategy to engage adults with shared intentionality to actually work. Moreover, adults already possess reflexive mind reading abilities, so there is no mystery about them engaging in behaviors of shared intentionality with the young. It is also natural to now assume that adults would find engaging in such activities with infants intrinsically rewarding. For being motivated to engage in a joint activity in part *because* it is joint is a plausible candidate for another motivational adaptation that evolved previously in response to a collaboration-rich world.

Thus, on the current model, cooperative breeding drove down the age at which basic skills and motivations for shared intentionality developed in ancient hominins. But these were skills and motivations that had already existed in hominins prior to that time. This is perhaps the most

<sup>22</sup>The reader may well be wondering why I have made no mention of "Baldwinian evolution" through here. Mainly, the answer is that the term means different things to different theorists (see, e.g., the collection edited by Weber and Depew 2003.) But also because "Baldwinian evolution" connotes the idea that it is one and the same trait that emerges first in behavior via learning and then later comes to be genetically based. That is one possibility, but things might also be more complex than that. The emergence in behavior via learning of some trait *t* might create selection pressure on genes for the emergence of some slightly (or even not so slightly) different trait *t*\*.

<sup>23</sup>Thus, the current model also departs from Tomasello and González-Cabrera's on the issue of the origins of our motivation to "share experiences" with others. I wish to remain neutral here on the issue of whether a desire to share experience is the best way to think about infants' motivation to, e.g., engage in proto-conversations with their caretakers. It might be, but there are other possible interpretations, too (see, e.g., Csibra 2010). That having been said, it is compatible with the current model that cooperative breeding led to the evolution of some new forms of motivation or emotion relevant to sharing intentionality. It might have done so, both in the cared-for and in care-givers. But these would have been added to an already existing set of such motivations and emotions.

salient point of contrast with the Tomasello and González-Cabrera model, and other similar models that have come before it. That having been said, this shift in the age of development of these skills and motivations likely produced some important downstream effects for hominin social and cognitive evolution. Let me briefly explain.

### *Downstream effects*

One consequence of pushing back the development of basic skills and motivations for shared intentionality so dramatically in ontogeny is that hominins came to have considerably more time to practice sharing intentionality with others than was previously the case.<sup>24</sup> Presumably, they reached levels of competence in early life that were in the past characteristic only of later life stages. So, they had more time to refine and extend those competences in various ways. Moreover, the skills and motivations in question are often used for learning (more on this in the next section)—they are “mills” in Cecilia Heyes’s (2018) sense. Thus, young children were also working from a richer platform of learning capacities, drives, and information. An expanded information base alone would have likely scaled up their social cognition abilities. For example, one’s theory-of-mind abilities are affected by the size of one’s conceptual repertoire. In general, the more concepts one possesses, the better one will be at finding more and more predictive/explanatory patterns in others’ behavior (Planer 2021; Planer and Sterelny 2021).

In addition, early development meant novel forms of interaction with other developmental pathways. This links up with Tomasello and González-Cabrera’s point about developmental synergies. In my view, one crucial form of interaction would have been with the developmental pathway underlying play behavior. More specifically, the co-presence of basic skills and motivations for shared intentionality with the early-childhood motivation for play must have transformed both the structure and content of play. Play very likely went from being primarily or even exclusively a physical activity targeted on developing behaviors important in later life to *bona fide* pretend play with others. Such play involves coordinating fantasies, which is obviously demanding of reasonably advanced theory-of-mind and communicative abilities. This very likely had effects on hominin cultural evolution, as well, as play is an engine of creativity and innovation (Bateson and Martin 2013; Riede et al. 2021). Moreover, cooperative breeding itself would have supported an expansion in play, for it creates a safer environment for children to play and explore in. The larger the group of caregivers, the better children are supervised, even if that supervision is very hands off, and even if it is no one’s responsibility in particular to supervise them.

Finally, these and other effects of the developmental shift in question play out in the context of a brain that is significantly more plastic due to its young age. The brain is well known for overproducing connections in early development. Useful connections are retained while unuseful ones are “pruned” (Striedter 2005). This, too, may provide for some interesting forms of developmental synergies, including some far-from-obvious ones.

## 6 Integrating Informational Cooperation into the Model

Before wrapping up, I want to suggest a further tweak to the model. That collaborative foraging and cooperative breeding *coevolved* is implicit in both Tomasello and González-Cabrera’s model, as well as the modified model presented here. As collaborative foraging increased in scope and

<sup>24</sup>Recall from above that Tomasello and González-Cabrera also cite practice opportunities as a benefit. The point here is somewhat different, though: on their model, it is not the case that hominins evolved such that they came to possess much more time to practice the skills and motivations before adulthood.

efficiency in our line, more and higher quality foods would have become available for sharing with dependent children and their mothers, for example. At the same time, possible ways of foraging—particularly for mothers—would have depended on the forms of care available to them. Could they safely leave their infants alone while foraging? If so, for how long? For these and many other reasons, we should expect that changes in how our ancestors foraged affected how they cooperatively breed, and vice-versa.

However, there is a key ingredient missing from this mix: namely, information sharing. Sterelny (2012) persuasively argues that collaborative foraging tends to be an information-hungry activity selecting for informational cooperation. In the simplest cases—for example, collectively chasing a predator away from a kill site to obtain access to a carcass—success depends mainly on information about the present state of the environment and about the actions and intentions of one's collaborators. Agents share information to coordinate their behavior in real-time and stay safe. But as we transition away towards more complex cases, the informational demands rise steeply. This is particularly clear in the case of medium-to-big game hunting. Here, natural history information about the target is absolutely critical. As has been well-documented in the ethnographic literature, hunters are expert natural historians of their prey. They have a deep understanding not only of how the animal is disposed to react upon being encountered; they know its tracks, scats, mobility patterns, and more (Marlowe 2010; Kelly 2013). And as Binford (2007) has pointed out, the less sophisticated one's hunting toolkit is, the more critical this knowledge turns out to be. So, this is very unlikely to be true only for recent hunters. In addition, to the extent that hunters make use of weapons or other tools to kill or process their prey, there are informational demands of learning to make, use, and maintain those tools. Even in the case of basic tools (e.g., a handaxe), these demands can be quite striking. Moreover, information about the here and now—about both the target itself, and about the other agents pursuing it—is still crucial, of course. In particular, as the inherent risk of some activity goes up (hunting big game without guns is about as risky as things get!), agents benefit more from sharing information with each other about their respective risk assessments. For they are more apt to come to an accurate assessment this way. And obviously, the organization and control of behavior in real time is even more critical, as miscarried coordination cannot just result in failure, but death.

Complex forms of gathering also tend to have steep informational demands (Kelly 2013). Successful and efficient gathering requires knowledge of where and how the sought-after resources are distributed throughout the landscape, as well as knowledge of when they become available. Resources may well need to be extracted using particular techniques, which may in turn require particular tools. Moreover, resources may need to be processed either before being transported (to reduce transport costs), or before consumption, or both. Some forms of ethnographically-known processing procedures are notoriously complex and opaque, such as those used to detoxify certain foods (see, e.g., Henrich et al. 2001; Henrich 2016).

So, one further consequence of the origins and expansion of collaborative foraging in our line was an increasingly central role for social learning. To become competent hunters or gatherers, the next generation had to learn a truly impressive amount of natural history, technique, and technological information. Moreover, as the learning process came to depend more on teaching, and later, on teaching involving symbolic communication, there were also numerous communicative conventions to be learned. One might well expect, then, the eventual evolution of cognitive and motivational adaptations for acquiring this information (reflecting selection on learners) and for transmitting it (reflecting selection on teachers).

Viewed from this perspective, the skills and motivations of shared intentionality in young children take on a different appearance. What we see is that, in addition to functioning to



attract increased levels of care and attention from adults, they would have also enhanced young children's ability to acquire invaluable cultural information (a point, I take it, on which virtually everyone would agree<sup>25</sup>).<sup>26</sup> Note that this suggestion fits neatly with the observed adult bias in these skills and motivations during early life which Tomasello and González-Cabrera report, for it is also adults from whom the very young predominately learn.<sup>27</sup> Children who were better at sharing attention and communicating with adults would have acquired more information from them; nowhere is this easier to see than in the case of learning communicative conventions (e.g., word-to-meaning mappings). Minimally, such children would have developed various forms of know-how and know-that at an earlier age as compared to those with lesser such skills and motivations. In turn, this would have given them a head start on the task of learning all that they needed to in order to become competent foragers, a head start that may well have translated into a future fitness advantage. Also, it is not implausible that, at some point, adults began to factor in children's learning abilities into their decisions as to whether/how much to invest in them. All other things being equal, an aunt might maximize her inclusive fitness by investing in whichever niece or nephew is the sharpest learner. In such a case, children would be selected for signaling those abilities, which they could do by displaying their abilities for sharing attention and communication. Adjusting the model to reflect these ideas serves to bring it into contact with the *natural pedagogy* theory of children's early communicative abilities (Csibra and Gergely 2009, 2011), which sees those abilities as primarily adaptations for (communicatively-mediated) cultural learning. However, the specific ideas and hypotheses of that theory (for example, about how human communication works, or about how children treat information coming from adults) are optional from the perspective of the current model.

In brief: to the extent that the evolution of shared intentionality depended on collaborative foraging and cooperative breeding, it likewise depended on information sharing. Skills and motivations for sharing intentionality, including in the very young, would have produced benefits of improved cultural learning which also explain the existence of those skills and motivations.

Let me finish with a word on costs. In developing the ideas in this article, no mention has been made of costs. But there very likely were costs to developing the skills and motivations in question at so early an age. To see this, consider the development of our understanding of intentional agency—of our theory-of-mind abilities—on which these skills and motivations depend. The development of theory-of-mind abilities in us gets underway considerably earlier than in other great apes (Wobbler et al. 2014). It is not implausible to think that this ontogenetic shift imposed brain development costs. That is particularly true if, as I have argued, human infants evolved to develop a more complex set of theory-of-mind abilities relative to other great apes (in particular, some capacity for reflexive mind reading). Even if the relevant brain structures were already part of the adult cognitive phenotype, and hence the child was bound to develop them anyway, it may still have been burdensome for the child to meet those costs (and/or for mothers/others to subsidize those costs) at so early a life stage. Minimally, energy spent on developing these brain structures is energy *not* spent on developing other phenotypic features. So, there are tradeoffs to consider.

<sup>25</sup>For useful general discussions of the connection between human social skills and cultural learning, see Herrmann et al. (2007) and van Schaik and Burkart (2011).

<sup>26</sup>Tomasello and González-Cabrera (2017)—I think wrongly—envision cultural learning as playing a relatively minor role in hominin evolution until much more recent times (the Late Pleistocene or the early Middle Pleistocene). It is thus not surprising that they overlook the possibility that skills and motivations for sharing intentionality likely functioned from their inception to facilitate cultural information flow from adults to children.

<sup>27</sup>And note, too, how the suggestion dovetails with points made at the start of this paper about the effects of cooperative breeding on social learning. That environment was all around more conducive to social learning.

To be clear, the issue is not whether developing skills and motivations of shared intentionality in infancy would bring benefits to an individual living in a cooperative breeding niche; I assume they would. Rather, the question is whether these benefits would outweigh the costs, for only then should we expect the skills and motivations in question to evolve. This question is complicated by the fact that infants can and do employ other means for attracting investment from adults (Hrdy 2009). They can invest in being physically “cuter,” for example, where this is a complex function of variables such as one’s degree of facial symmetry, the steepness of one’s forehead, and the width of one’s eye-set (Kringelbach et al. 2016). Being fat (up to a point) also helps (Cunnane 2005). Moreover, infants can invest in producing odors that adults find pleasant (“baby smell”) (Lundström et al. 2013). It has been suggested that babbling functions to attract adults, over and above its role in facilitating language acquisition. This idea is supported by the intriguing finding that marmosets—one of the only other cooperatively breeding primates—babble, and that babbling appears to get infants more attention from adults (Elowson and Snowden 1998; Snowden 2001).

The point is this. Given all the other ways and means the young have of attracting adult care and attention, why invest in developing (more/better) skills and motivations for shared intentionality? As far as I am aware, no defender of the cooperative breeding hypothesis has adequately answered (or even noted, for that matter) this question. Of course, the other strategies here have costs of their own; it is not cheap to develop and maintain facial symmetry, for example. But it is far from obvious that infants could not secure a better deal by investing more in one of these other strategies, or some combination thereof.

Recognizing that basic skills and motivations for shared intentionality in early life also function to promote cultural learning, and probably have done so for a very long time, significantly helps with this issue. It may be that developing these skills and motivations was in fact the only way the young could reliably meet the learning challenges that “growing up human” entailed. But more modestly: if these skills and motivations function both to attract more investment from adults and to facilitate cultural learning, then two fitness benefits are obtained for the price of one. The costs of developing these skills and motivations in early life are further offset by the gains they bring in the cultural learning domain. Plump babies would not have been better at social learning than skinny ones. But babies with skills and motivations for sharing intentionality would have certainly been better social learners than those without.

## 7 Conclusion

This article began by examining Tomasello and González-Cabrera’s model linking cooperative breeding to the evolution of shared intentionality. The model is “composite” in the sense that it also posits an important role for collaborative foraging. I argued that the model (or better: a natural construal of it, on which an evolutionary sequence is posited) faces two important problems—what I called “the reflexive metacognition problem” and the “bonding problem.” I then presented an alternative model which, among other things, avoids these problems. The view of the evolution of shared intentionality that emerges on this model is similar to that which emerges on the Tomasello and González-Cabrera model in a number of respects, especially at a zoomed-out level. But there are some crucial differences. In particular, according to the model presented here, what cooperative breeding did, at least initially, was *drive down the age of development* of preexisting skills and motivations for shared intentionality, not create those skills and motivations in the first place. In addition, these skills and motivations were probably always multi-functional, serving not only to attract increased adult care and attention in a cooperative breeding niche, but also to facilitate cultural learning on the part of the very young.

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