It Makes a Village: Allomaternal Care and Prosociality[*]

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Abstract

A recent hypothesis suggests that an impetus for human cooperation could have emerged from the needs of mothers to elicit and sustain help from others, i.e. allomaternal care, for the purpose of bringing offspring to maturity. We design a novel economic experiment to elucidate the relationship between allomaternal care and cooperative behavior among a random sample of 820 adults and 200 children in the Solomon Islands. Our results show that allomaternal care, especially by non-kin, nurtures adult reciprocity and altruism, and impersonal prosociality among mothers. We also document socio-cognitive benefits to children from child care by non-kin, based on daylong vocalizations analyzed using a multilingually-trained neural network. Further analysis utilizing cross-cultural ethnographic data shows a positive relationship between allomaternal care and societal orientation toward trust. Altogether, our findings suggest an important role for allomaternal care - especially by non-kin - in supporting societal cooperation.

Keywords: Allomaternal care, Altruism, Child vocalizations, Dictator game, Reciprocity.
JEL Codes: I15, O15, Z13

1   Introduction

Humans' exceptional capacities for cooperation (Boyd and Richerson, 2009; Tomasello, 2009; Bowles and Gintis, 2011) are increasingly recognized as the ultimate reason for our distinct cognition, technology, and culture (Gintis et al., 2005; Tomasello and Vaish, 2013; Henrich, 2016). Other-regarding preferences, both pure altruism and punishment of free riders, appear to be critical for enabling human cooperation (Bowles and Gintis, 2011; Burkart et al., 2014). Yet, the origins of human hypersociality are still widely debated (Fehr and Fischbacher, 2003; Bowles and Gintis, 2011; McCullough, 2020). Cooperative relations occur at various scales, motivated by plausibly different reasons. Altruism toward family members, for instance, could be explained by the benefits that cooperators bring to close genetic relatives (Hamilton, 1964a,b), while cooperation with friends could be explained by the mutual gains that reciprocity engenders through repeated interactions and mutual contributions to the benefits (fitness and inclusive fitness) of others (Trivers, 1971; Axelrod and Hamilton, 1981).

Yet, cooperation at large-scale and altruism in one-shot anonymous situations are less understood and remain intensely debated. A widespread hypothesis links the emergence of other-regarding preferences to intergroup competitions. In environments characterized by rivalries between groups, conditions may emerge for the selection of traits that increase the probability of group success by favoring norms, values, and institutions beneficial to the ingroup, such as parochialism (i.e. altruism toward members of the ingroup and hostility toward members of the outgroup) (Boyd and Richerson, 2002; Choi and Bowles, 2007; Bowles, 2008). Laboratory experiments with conflict priming and post-war field studies provide evidence that exposure to conflict is frequently associated with parochialism and a greater capacity for cooperation, especially with one's ingroup.[1]

A recent hypothesis has turned the attention to another facet of human evolution: a system of child-rearing characterized by shared care (Kaplan et al., 2009), out of which the human capacity for understanding others could have evolved (Hrdy, 2009; Burkart et al., 2014; Hrdy and Burkart, 2020). According to the cooperative breeding hypothesis, slow maturing apes in the line leading to Homo Sapiens could not have

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[1]See, among other studies in a now large literature in economics, psychology, and political science Vugt et al. (2007); Yuki and Yokota (2009); Voors et al. (2012); Cassar et al. (2013); Rohner et al. (2013); Bauer et al. (2014); Mironova and Whitt (2021); and Bauer et al. (2016) for a review.

evolved without help in provisioning and care of offspring from allomothers, such as fathers, grandparents, siblings and unrelated individuals. Moreover, youngsters dependent on allomaternal care would have developed novel phenotypes that were subjected to social selection, favoring those best at monitoring and appealing to the mental states of others and ingratiating themselves with allomothers. By conferring a range of cognitive and socio-emotional competencies critical for navigating the complexity of social relationships – in primis, a capacity for intersubjectivity – this novel way of raising offspring may have laid the initial building block for the evolution of cooperation (Flinn et al., 2007; Snowdon and Cronin, 2007; Bergmüller et al., 2007; Burkart et al., 2009; Hrdy, 2009; Burkart et al., 2014).[2]

An implication of this hypothesis is that this novel mode of child rearing could have shaped the way mothers, and fathers, perceive and respond to others through a process of social selection favoring those best capable of securing help from others. One way to acquire such assistance would be to confer benefits to those who help, reciprocating in proportion to the support received or expected. The existence of shared care could thus provide a recognizable anchor on which to calibrate prosociality, cementing a network of reciprocity solicited and maintained for offspring care (Hrdy, 2009). From this complex web of help and reciprocity, prosocial behavior may have then extended toward other collaborative enterprises, eventually propelling altruism and trust in others, thus enabling the emergence of cooperation outside the family. Yet, while the association between allomaternal care and cooperation has been documented in other primates, principally callitrichidae, there remains a paucity of empirical evidence on this relationship in humans (Hrdy, 1999, 2009; Snowdon and Cronin, 2007; Burkart and van Schaik, 2016).

Our work investigates the relationship between allomaternal care and cooperation at the individual, group, and societal levels, and offers initial evidence of a robust and positive link. First, we quantify the sensitivity of prosocial preferences to variation in allomaternal care among a random sample of participants (N=820) in the Solomon Islands, three-quarters of whom (N=631) are parents of young children. The Solomon Islands provides a valuable setting for our study since the sample population resides in remote villages, with nonexistent or limited access to factors that may confound the relationship between allomaternal care and prosociality, such as institutionalized

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[2]Recent evidence also suggests that a capacity for intersubjectivity in childhood is a strong predictor of adult economic success (Fe et al., 2022).

or monetized childcare, widespread formal employment, and markets.[3]

Our experiment consists of a series of independent gift-giving choices based on the dictator game, in which participants make incentivized decisions about how much of an initial endowment (equal to SI$40, roughly the average daily GDP per capita) to share between themselves and specific individuals in their network (i.e., spouse, mother, father, sister, brother, mother in-law, father in-law, friend, neighbor, and strangers from the same and distant villages; "receivers" hereafter). We adopt a within-subject design and elicit these choices separately for each receiver, each time with a new endowment, and under two treatment conditions: (i) non-anonymous (the receiver is told who sent the gift), and (ii) anonymous (the receiver is not told who sent the gift) to assess the participant's reciprocity and altruism, respectively. In an exit survey, participants reported the amount of help with childcare and other forms of social, economic and emotional support that each receiver provides. We then analyze the relationship between participant's gift-giving in the dictator games and the amount of help with child care from the receiver, controlling for other dimensions of support provided by the receiver. Given the confoundedness of help with child care, family ties, other dimensions of support, and cooperative behavior, an attempt to empirically identify the link between allomaternal care and prosociality necessitates an approach of the kind we design with our experiment (i.e. a within-subject design).

We conduct our analysis at the level of a participant-receiver dyad, which allows us to control for both participant and receiver-type (i.e. spouse, mother, sister, etc.) fixed effects. This design enables us to isolate the effect of help with child care on the prosociality of the participant, independent of three sources of potential bias: (i) the genetic or social relatedness of the receiver to the participant (and their child) – which we control for using receiver-type fixed effects; (ii) unobserved characteristics of the participant, such as status, wealth, or personality, that could influence both how much help a participant receives and their cooperative inclinations – which we account for using participant fixed effects; and (iii) other forms of support the receiver provides to the participant – which we control for using survey measures of risk-sharing, productive, social, and emotional support.

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[3]Henrich et al. (2010) and Enke (2022) document how prosociality systematically covaries with market development and with community size. The development of markets, industrialization, and formal employment may directly influence prosociality as well as the need for working parents to solicit childcare, which would confound our analysis. This justifies our initial focus on small-scale subsistence communities.

Our results show that both mothers' and fathers' gift-giving in the dictator game is proportional to the amount of help with child care that the receiver provides. After controlling for both participant and receiver-type fixed effects, this relationship is only robust for mothers, highlighting the specific role of allo-*maternal* care in prosocial behavior. This relationship remains even after controlling for other forms of support that the receiver provides, which themselves hardly explain gift-giving in the dictator game and have no bearing on the relationship between help with child care and prosociality. After controlling for participant and receiver-type fixed effects and other forms of support, increasing help with care from a few times a month to a few times a week (a 1 SD increase from the mean) corresponds to a 3.8% increase in altruistic giving among mothers, on average.

Next, we test whether the relationship between allomaternal care and prosociality extends to *impersonal* prosociality by examining gift-giving toward strangers. Mothers who receive more help with child care from *non-kin* are significantly more generous toward strangers. Fathers follow a similar pattern, although the relationship loses significance in the most conservative specifications. Neither help with child care provided by kin, nor any dimension of emotional, economic, productive or social support is associated with gift-giving to strangers. These findings highlight the role of allomaternal care, particularly from unrelated individuals, in *impersonal* prosociality, even in one-shot anonymous interactions.

To elucidate whether allomaternal care confers socio-cognitive benefits to children, we collect a novel measure of child cognitive development based on vocalizations. Child vocalizations are among the earliest and most robust expressions of infant communication and intersubjectivity (see e.g. Trevarthen, 1979). We record daylong vocalizations for 196 children using a cheap and easily scalable hardware solution well-suited to remote field conditions. We analyze recordings using a multilingually-trained neural network (Lavechin et al., 2020). This method is most appropriate for the present effort for several reasons. First, while commercial software has been used to measure language development in other populations (see Wang et al. (2020) for a review), no tool exists to measure language development in the youngest children in our sample, especially given the multilingual environment characteristic of the Solomon Islands – children in our sample are exposed to one or more of 12 different languages. Also, given the wide age range in our sample (6 to 48 months), any test must be standardized, and sample sizes in many of these languages are insufficient to

do so. Instead, our approach captures children's natural vocal behavior with minimal interference. Previous research shows that child vocalization counts thus estimated correlate with standardized language measures (Gilkerson et al., 2018; Wang et al., 2020), which are the current best infant predictors of academic achievement (Pace et al., 2019).

We correlate this measure of child socio-cognitive development with the amount of care the child receives from various caregivers. Again, our findings point to the unique and crucial role of caregiving by *non-kin*, which is associated with higher child vocalizations. The findings are robust to controlling for care provided by the mother, the father, or other kin of the child, for other forms of support that the mother receives, for other child-level stressors, and for a wide range of mother characteristics, including a proxy for cognitive functions. We address the possibility that our measure of vocalizations may be confounded by crying or distress in two ways. First, we use manual annotations from lab scientists to code the proportion of crying, laughing, canonical vocalizations (vowel-consonant alternations) and non-canonical vocalizations, or background noise. Our effect size suggests levels of crying that would be incommensurate with average levels of crying thus coded. Second, we collect biomarkers of stress (cortisol and cortisone) in hair samples from 102 mother-child pairs following a procedure adapted from Wright et al. (2018). We find that children who receive more care by non-kin are, if anything, less stressed (with effect sizes large although imprecisely estimated), suggesting that this form of care is not associated with distress or unmet needs. Although our setting for child-level regressions can only provide correlations, these findings offer supporting, if indirect, evidence for the theory that cooperative child rearing practices may have been critical to the evolution of human's socio-cognitive capacities.

Finally, we examine whether there is evidence that the association between allomaternal care and prosociality that we observe in our sample may generalize at a global scale. Using the Standard Cross-Cultural Sample (Murdock and White, 1969), a rich ethnographic dataset covering more than 100 societies throughout history, we correlate measures of societal orientation toward trust with the intensity of allomaternal care documented in each society. We find a strong correlation between the involvement of others in child rearing and the inculcation of trust in children across societies, even controlling for an array of potential geographic and society-level confounders.

Our work offers several contributions to the literature. First, we introduce a conceptual framework to understand the determinants of cooperative behavior, which is novel to economics. Prosociality – in particular, *impersonal* prosociality toward non-kin – is a key determinant of economic efficiency and social cohesion (Zak and Knack, 2001; Algan and Cahuc, 2010), and is at the core of the economic and institutional divergence between Western Europe (and its offshoots) and the rest of the world (Greif and Tabellini, 2017; Henrich, 2020). More generally, reciprocity, altruism, and trust sustain trade and markets in environments of incomplete contracts and asymmetric information (Arrow, 1972; Axelrod and Hamilton, 1981; Gambetta, 1988). Our work offers a conceptual micro-foundation for both the variation in prosociality within societies and historical divergences across societies. For example, the dislocation of kinship-based institutions under the marriage and family policy of the Christian Church has been linked to the evolution of cooperation and growth in Western Europe and in the United States (Greif and Tabellini, 2017; Enke, 2019; Henrich, 2020; Ghosh et al., 2021; Bahrami-Rad et al., 2022; Schulz, 2022), where the demise of clans and kinship networks would have pushed parents to seek help with child care from non-kin, igniting the kind of prosociality feedbacks we document in this paper. The link we establish between help with child care by *non-kin* and prosociality also provides an explanation for the negative relationship between the strength of family ties and prosociality documented throughout the economics literature (Banfield, 1958; Alesina and Giuliano, 2010, 2011; Ermisch and Gambetta, 2010; Alesina and Giuliano, 2014; Alesina et al., 2015).

Second, we use experimental data to calibrate the relationship between allomaternal care and social preferences and, through the use of the SCCS dataset, we show indicative evidence that our findings could generalize at global scale. Our approach is similar to the literature linking conflict exposure to prosociality (Voors et al., 2012; Bauer et al., 2016) in that, rather than test an evolutionary theory, it instead aims to generate insights into the presence of motivational proximate mechanisms and behavioral patterns (such as reciprocity and altruism) that intensify with more allomaternal care. Our findings suggest that allomaternal care is a salient and overlooked feature of societal cooperation.

Third, we document socio-cognitive benefits in children using daylong speech recordings in a naturalistic and multilingual environment, using the first application in economics of a cheap and easily scalable method. These findings speak to the

economic literature that investigates how early life experiences shape individual cognitive and non-cognitive skills. This literature has so far mostly focused on *parental* investment in children (see Attanasio, 2015, for an overview).[4] A related literature has documented that the provision of early daycare is associated with long-term advantages in cognition, educational achievement, non-cognitive skills and earnings (Cunha and Heckman, 2007; Heckman, 2013; Heckman et al., 2013; Felfe and Lalive, 2018; Cornelissen and Dustmann, 2019; Evans et al., 2021; Attanasio et al., 2022a,b; Bjorvatn et al., 2022),[5] and shapes children's social preferences (Cappelen et al., 2020), although some studies suggest negative effects of daycare on cognitive and non-cognitive performance due to the lower intensity of one-on-one interactions (Fort et al., 2016) (see also Baker et al., 2008; Cornelissen et al., 2018) and when the quality of the daycare service is low (Bernal et al., 2019).

We focus on a wider networks of caregivers, including *unrelated* but regular caregivers, friends and neighbors, in a context where formal childcare is nonexistent and where allomaternal care does not substitute for maternal care to the same extent as daycare does in an industrialized or urban setting. Nonetheless, our findings on the benefits of allomaternal care are consistent with the above-cited work on the benefits of early childhood interventions, as well as the hypothesis that care by unrelated individuals promotes crucial socio-cognitive skills for cooperation and communication (Hrdy, 2009). The finding that unrelated caregivers matter for child development has implications for the design of early childhood interventions, which have so far principally consisted either of support and educational programs for parents (principally, mothers) or formal daycare provision,[6] and suggests that interventions should consider other forms of care provided by regular but unrelated individuals, such as mothers' groups.

Finally, we contribute to a large and growing literature in the social sciences on

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[4]Papers in adjacent disciplines have investigated the role of grandparents (Hawkes et al., 1998; Sear and Mace, 2008; Danielsbacka et al., 2011) and older siblings, in particular sisters (Weisner et al., 1977; Turke, 1988). A recent study in economics documents benefits in terms of vocabulary and fine motor skills for children with older sisters (rather than brothers) in Kenya (Jakiela et al., 2020).

[5]See Cunha and Heckman (2007), Heckman (2013), and Heckman et al. (2013) for evidence among disadvantaged communities in the US; Felfe and Lalive (2018) and Cornelissen and Dustmann (2019) for evidence from other high-income countries, Bernal et al. (2019) and Attanasio et al. (2022b) for evidence in Latin America, and Bjorvatn et al. (2022) for evidence from peri-urban areas of Uganda.

[6]See Evans et al. (2021) and Attanasio et al. (2022a) for extensive recent reviews of the impacts of parenting programs and daycare provision in low and middle income countries.

the role of social and economic networks in low-income economies (Breza et al., 2019). Family, acquaintance, friendship, productive and risk-sharing networks are routinely elicited by researchers and policy makers and relied upon to facilitate the take-up and diffusion of important policy tools, such as micro-finance (Banerjee et al., 2013), agricultural technology (Beaman et al., 2021a), entrepreneurship or employment programs (Field et al., 2016; Beaman et al., 2018), public health interventions (Kim et al., 2015) and poverty-alleviation programs (Beaman et al., 2021b). Our finding that help networks in the context of child care supersede other social, emotional, risk-sharing, and productive networks as a source of prosociality suggests that network elicitation should routinely include child care networks as an important dimension of social networks.[7]

The rest of the paper is organized as follows. The next section provides additional background on the theoretical relationship between social systems of child rearing and cooperation. Section 3 presents the data, the experiment and the empirical set-up. Section 4 discusses the field results and global evidence. Section 5 concludes.

2   Background Literature

2.1   Cooperative child rearing

Cooperative breeding refers to a wide set of parenting and social systems in which conspecifics help parents raise their young (Burkart et al., 2017). Given the vast heterogeneity between and within species that can be characterized as cooperatively caring for their young - from about 15–25% of bird species to about 2.5–3% or more of mammals (Brown, 1974; Emlen, 1991; Solomon et al., 1997) - and the unique features found among humans, the literature is still debating the precise definition, with some researchers arguing that humans are better labeled as practitioners of biocul-

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[7]Our finding that these networks are particularly important predictors of behavior for women resonates with the fact that women and men have different social networks and use them differently. Women's social networks are more stable, composed of a greater proportion of strong relative to weak links, and less responsive information about the likely monetary returns to the link (Friebel et al., 2021). This may be explained in our context by the stylized fact that women rely a lot more than men on their unrelated acquaintances to take care of children (while men rely relatively more on their wives). The relative advantages of strong vs. weak lies are opposite for child care vs. job search contexts. In contexts like job search, weak links are often more useful: acquaintances' greater ability to provide novel information outweighs their lesser motivation to provide support and help (see Granovetter (1973) and Beaman et al. (2018) for empirical evidence). Conversely, in contexts like child care, the greater motivation and commitment of stronger links matters more than their ability to provide information.

tural reproduction (Silk and House, 2016; Bogin et al., 2014). Despite the variability of practices, or maybe because of those differences, the study of cooperative breeding systems and of their possible implications for human evolution, and especially cooperation, are the objects of vast literatures in evolutionary biology, anthropology, psychology and neuroscience (Clutton-Brock et al., 2001; Burkart et al., 2009; Hrdy, 2009).

Cooperative child rearing in humans presents several distinct characteristics. Human mothers receive extensive support from a wide variety of helpers, known as alloparents (Hrdy, 1999), from grandmothers and older siblings providing babysitting services (Hawkes et al., 1998), to adult men - especially fathers - making substantial energetic contributions, to both older children and other related or unrelated adults (Hill and Hurtado, 2009; Kaplan et al., 2009), all of whom allow mothers to engage in productive activities that benefit the survival of their young (Turke, 1988). Extensive evidence reports that babies are carried, cleaned, soothed, cuddled, protected, and nursed by nonparent adults between 25% and 85% of the time during infancy across essentially all modern cultures, including foraging cultures, suggesting universal prevalence of, and substantial variation in, alloparenting (Hrdy, 2009). Interestingly, the intensity of care by different caregivers varies greatly across human societies (Kramer, 2010), with mothers performing roughly 50% of infant care across most societies, fathers' involvement varying from less than 1% of total care among the Alyawara of Northern Australia to 16% among the Aka of Central Africa, and grandmothers performing 1.2% of care among the Maya, but as much as 14% among the Mardu (Kramer, 2010, p. 421). Importantly, care by others, including unrelated individuals, while less systematically documented, has been found extensively across cultures, with, for example, rates as high as 29% among the Mardu and Toba people.

2.2   Help by kin and nonrelatives

The literature has advanced several motivations to explain why carers engage in allomaternal care. The principal explanation resides in kin selection, whereby an individual's reproductive success (i.e., fitness and inclusive fitness) is enhanced by acts of altruistic behavior that contribute to the reproductive success of relatives (Hamilton, 1964a,b). This motive could explain, for example, the involvement of grandparents and siblings in caring for children related to them, as well as fathers, inasmuch as men's reproductive success is tightly tied to their wives' (Kaplan et al.,

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2009; Schacht and Kramer, 2019). A second explanation resides in the concept of fitness interdependence and reciprocity: the provision of help that may be contingent on immediate or delayed reciprocal arrangements, either for child care or other dimensions of help, even among nonrelated individuals whose mutual support may help increase everyone's fitness (Trivers, 1971; Axelrod and Hamilton, 1981).[8] Recent literature discusses other motivations to help, for example those supported by the neurohormonal circuitry that evolved to support parental care (see Marsh (2019) for a review).

Here, rather than focusing on the motivations for care, we investigate the implications of cooperative child rearing for the expression of personal and impersonal reciprocity and altruism. Our theoretical framework is rooted in the cooperative breeding hypothesis, which sees the role of the human family as the cradle for the development of social skills via a network of kin and non-kin allomaternal carers (Flinn et al., 2015), rather than merely as an economic unit centered on the sexual division of labor (Becker, 1973, 1974b,a, 1981; Browning et al., 2014). One implication of this novel system of child rearing would be the necessity for both mothers and infants to develop the ability to elicit care from individuals, some of whom who may be related, but who have other competing interests (for example, grandmothers with several other grandchildren), and some who may not be related at all. Moreover, a reliance on allomaternal assistance would make maternal commitment to her offspring more dependent on the mother's perception of probable support from others (Hrdy, 2009).

A plausible consequence of a social context in which infants and children who are more skilled at reading intentions and engaging the solicitude of others are more likely to prosper would have important implications for the eagerness that human children exhibit for inter-subjective engagement (Hrdy, 1999). In this environment, prosociality may have coevolved with cooperative child rearing through the role of allomaternal care in fostering socio-cognitive and emotional skills in infancy – skills which are essential for child survival. Similarly, mothers who are better able to understand the intentionality of potential caretakers and navigate the complex web of allomaternal care relationships would have higher reproductive success. They would also be better able to engage in prosocial acts, as increased sensitivity to others'

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[8]In the case of market economies, the provision of help may also be dependent on financial rewards. We abstract from this case as the society we study has no form of institutionalized or monetized childcare.

intentions and accumulated experience of social interactions would make them less likely to be cheated and reduce the risk of harmful interactions.

A literature in economics documents how individuals with more accurate beliefs about others' intentions are better able to engage in relationships requiring trust (Butler et al., 2016) and how experience of interactions, especially with non-kin, enhances individual prosociality (Gambetta, 1988; Ermisch and Gambetta, 2010; Alesina and Giuliano, 2010, 2014). We thus expect the prevalence of allomaternal care, especially by non-kin, to be associated with increased prosociality, including reciprocity and altruism towards familiar individuals, as well as generalized prosociality.[9]

2.3 Further benefits of cooperative child rearing

The benefits of cooperative child rearing have been largely recognized as critical to human demographic success. During the Pleistocene, this novel parenting system would have permitted hominin females to raise energetically expensive (large brained and slow maturing) offspring without having to increase inter-birth intervals, allowing humans to move into new habitats (Hrdy, 1999) and contribute to human demographic expansion (Kramer, 2010). This interest on first order effects may explain why most field studies of the benefits of allomaternal help on maternal and child outcomes have so far focused on demographic parameters, in particular infant survival and parents' reproductive success (see Kramer (2010) for a review).

Yet, given that cooperative child rearing provides a social context in which infants and children who are more skilled at reading intentions and engaging the solicitude of others are more likely to prosper, one would expect to observe a range of proximate socio-emotional and cognitive benefits, in particular communication skills. Since vocalizations are among the earliest and most robust expressions of infant communication and intersubjectivity (see e.g. Trevarthen (1979)), we focus on this dimension in our analysis. We analyze vocalizations as an outcome, an inherently social outcome, rather than child BMI, because BMI could be influenced by a range of additional factors, particularly in our context where food availability is highly seasonal and variable. We also analyze stress markers as a measure of both children's and mothers' outcomes. Stress markers are recognized as tightly connected to the quality of social relationships, and so provide a direct and accurate measure of the socio-emotional

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[9]Suggestive evidence across 15 primate species shows that the extent to which a species engages in alloparental care is the best predictor of altruistic helping among unrelated adults (Burkart et al., 2014).

consequences of allomaternal care for children.

3 Data

3.1 Sample

We conducted our data collection from June to August 2019 among a random sample of 820 participants, living in 44 villages across two provinces, Western and Choiseul, of the Solomon Islands. The Solomon Islands are an archipelago of over 900 islands in Melanesia with a total population of around 700,000 people. Like most villages in the Solomon Islands, the villages in our sample are small, coastal lowland communities that depend mainly on subsistence horticulture and fishing for their livelihoods. On average, people work in their gardens a couple of times a week and sell goods in the market less than once a month, with no statistically significant difference across women and men. In addition, men fish a couple of times a week and women a few times a month. The average village consists of 87 households and 441 people, the majority of whom have no access to grid electricity, running water, or sanitation. Most villages are relatively remote, where the main mode of transport is by ship or outboard canoe, with extremely limited access to roads. The average travel time between villages and the provincial capital is six and half hours and the average travel time to the country's capital city, Honiara, is two and a half days, leaving most communities isolated from major market centers.

To construct our sample, we first selected a subset of villages with whom we had an established relationship through previous work (BenYishay et al., 2017; Beath et al., 2018). We then visited each village to randomly select a sample of 20 adults (per village) to participate in our experiment. Upon arriving in a village, we held a meeting with the village elder to introduce the study and obtain consent for our research. Village elders then organized a public meeting with community members who met the specific demographic for our study: individuals and couples between the ages of 18 and 45, who, if possible, were parents to at least one small child between the ages of 18 months and four years.

We randomly selected participants via public lottery according to the following criteria: five couples (five women and five men), five single women, and five single men, for a total of 20 participants per village. Selected individuals then participated in a series of dictator games, followed by a 30-minute questionnaire.

3.2 Experiment in the field and survey elicitation help

To measure prosociality, we implemented a series of dictator games with each adult participant. The dictator games proceeded as follows. Participants were given an endowment of SI$40 ($5 USD at the time of our study, the average daily GDP per capita), which they could keep for themselves or send a portion (or all of) to a receiver.

The main feature of our design was that participants were asked to make gift giving decisions across a menu of receivers, each time with a new endowment of SI$40. The menu of receivers included: (i) a random person in a distant village, (ii) a random person in the participant's own village, as well as the participant's: (iii) spouse, (iv) mother, (v) mother-in-law, (vi) father, (vii) father-in-law, (viii) sister, (ix) brother, (x) neighbor, and (xi) close friend. At the end of the experimental session, one receiver was chosen at random, and the participant's decision was implemented for real.

Participants were first asked to make each of their gift giving decisions anonymously (i.e., the research team would deliver the funds to the receiver, who would not know who sent the money, i.e. with the research team appearing as sender), and then again non-anonymously (i.e., the research team would deliver the funds to the receiver and tell them who had sent the money). The reason behind this method is that the amount sent anonymously would capture the participant's altruism toward the receiver (a sort of anonymous reciprocity for benefits received in the past), while funds sent non-anonymously represent reciprocity (both backward and forward), since the participant's signal of generosity is observed by the receiver.

At the end of the dictator games, enumerators conducted a 30-minute survey questionnaire with each participant. The questionnaire elicited basic demographic, social, and economic information for the participant, as well as specific questions about each potential receiver in the dictator game and their relationship with the participant.

We use measures of economic, productive, and emotional support provided by the receiver to the participant and, because religion is an important part of daily social lives in the Solomon Islands, whether the receiver and the participant go to Church together. These questions were adapted from existing questionnaires on social networks (e.g. Banerjee et al. (2013)). The key innovation is to add a question on the help provided by the receiver to the participant for taking care of the participant's children.

The frequency of child care provided by each receiver to the participant is measured as follows: (i) never, (ii) less frequently than once a month, (iii) more frequently than once a month, (iv) once a week, (v) a few times a week, (vi) every day, a little bit, or (vii) every day, for a large part of the day. In our analysis, we standardize this measure to mean zero, standard deviation one, to ascertain relative increases in the amount of help with child care.

We measure emotional support by a question asking how often the participant and the receiver spent time together "to talk about [the participant's] feelings, joys, and sorrows". The answer scale was identical to the one used for the frequency of help with the children. Questions about economic and productive support ask whether the participant would go to the receiver if they needed to borrow: (i) a small amount of money, (ii) a large amount of money (yes/no answers), and (iii) how frequently the receiver helps them with cultivating their horticultural gardens or goes fishing with them (answer scale identical to the one used for the frequency of help with the children or for emotional support). Answers to the question about whether the participant and receiver go to Church together are either yes or no.

The individual survey elicited basic demographics and time use data for the participant, including asking the frequency of care provided to their own children, and the frequency of care provided to other people's children (i.e. how much help with child care the participant themselves provide to other people). Since the Solomon Islands experienced episodes of ethnic violence between 1998 and 2003,[10] we also ask participants whether they have ever "witnessed organized violence or warfare with people from another village" (mean: 0.44, s.d.: 0.50).

3.3 Child socio-cognitive and socio-emotional indicators

3.3.1 Child vocalizations

The number of child vocalizations was estimated from child-centered long-form recordings collected using a wearable, an increasingly used technique in early language development research (Lavechin et al., 2021). In urban conditions, a hardware-software combined solution called LENA is frequently used (Gilkerson et al., 2017; Cunha et al., 2021). LENA was suboptimal for the current approach for two key reasons. First, the lack of electricity and internet connection found in these remote communi-

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[10]Most of the violence occurred in the main island of Guadalcanal but other provinces, and particularly Western province, also experienced sporadic but intense violence.

ties meant that the licenses promoted by LENA were inappropriate here: To recover the audio-recordings, one needs to connect the recording device to a computer, have enough power and internet to extract and upload the recording (which is meanwhile stored in a proprietary format) before the recording device can be used again. Second, LENA's software was trained in urban conditions among monolingual American English learners, which raises questions about whether the software would be sufficiently accurate in our population of largely multilingual infants (children in our sample are exposed to one or more of 12 different languages: Avaso, Babatana, Marco, Marovo, Pidjin, Roviana, Senga, Simbo, Sisinga, Ughele, Vaghua, Varisi) growing up in rural conditions.

In our study, the child wore a t-shirt fitted with two small breast-pockets, into which a pair of USB voice recorders was inserted. Two recorders were used because in such field conditions, with high humidity and variable temperatures, some devices stop functioning. The recorder then functioned continuously for up to 15 hours, except if extracted from the t-shirt and turned off, which the family could do if they decided to exercise their right of withdrawal from the study, or at the end of the day, when the researcher picked up the equipment. This resulted in 374 recordings for 196 children, lasting on average 6.5 hours (SD 1.95 hours, range 0.48 minutes - 18 hours).

Each recording was then analyzed with a Voice Type Classifier (VTC, Lavechin et al. (2020)), an end-to-end neural network, which for every 10 ms frame returns whether the key child (i.e., the child wearing the recording device) was vocalizing or not. A vocalization is then defined as a sequence of frames where the child vocalizes. VTC was trained with a combination of various child-centered corpora of children aged 0-4 years exposed to one or more of a variety of languages (including Minn, French, Ju'hoan, Tsimane', English, and several others, in approximate order of data quantity). Importantly, these corpora included children growing up in multilingual settings, as well as languages spoken in the Pacific, with a wide variety of typological characteristics. The multi-corpus training was done to improve the generalizability of the network to unseen data sets. The corpora were divided internally into independent training, developmental, and testing sets. As reported in Lavechin et al. (2020), F-score performance on the test set of this multilingual corpus was 77.3% for recognizing the key child. In addition, that study also reports on performance for a wholly independent, unseen, test set comprised on monolingual English learners, for which LENA performance was also available. In that comparative dataset,

LENA's performance for the key child was 54.9%, whereas the VTC scored nearly 15% higher, at 68.7%. We also checked the performance of VTC in a small subset of data analyzed in the present paper. About 87 minutes of audio were annotated by research assistants who were unfamiliar with the language and the families that were recorded, which may have a negative impact on the accuracy of their annotations, so that performance of VTC is under-estimated. Nonetheless, performance was good, at 62%, and comparable to human-human F-score on the same data (64%).

VTC outputs a text file indicating at which points of the multi-hour recordings the key child vocalized. Following standard practice in the field (Cristia et al., 2020), we counted the number of vocalizations attributed to the key child over the whole recording. We then divided that by the length of the recording, to control for variation in recording length.

Recording young children's vocalizations through wearables is a promising method to assess language development. Long-form recordings have several advantages, including capturing the child's vocal patterns in their natural environment and being able to accumulate a great amount of data easily. However, this also means that the audio recording is harder to process than an audio recording gathered in more manicured and stable conditions. Automatized algorithms attempt to classify child vocalizations into crying, laughing, canonical, and noncanonical, but precision is still a challenge (Schuller et al., 2019; Semenzin et al., 2021). We address the possibility that our vocalization counts confound actual speech and crying in several ways. First, we rely on manual annotations from lab specialists to code the nature of vocalizations in a random subset of our data. In line with established research[11], cries constitute a small proportion of vocalizations: only 3.20% of the segments corresponded to crying. The majority of segments were speech-like (93.2%), and laughing amounted to a similar proportion to crying (3.01%). Second, we collect a direct measure of child socio-emotional wellbeing based on hormonal biomarkers for stress hormones.

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[11]Among a sample of either children younger than children in our sample (4-18 months) or slightly older children (11–53 months) but who were diagnosed with Angelman syndrome (a genetic disorder causing speech delays and intellectual disability), related research has shown that 72.89% of automatically identified segments were speech-like, 5.23% crying, and 1.65% laughing (Semenzin et al., 2021).

3.3.2 Cortisol and Cortisone

In Western province, only,[12] we invited the randomly selected married participants in each village to provide hair samples for the mother and child, following the procedure adapted from Wright et al. (2018). After all field work was completed, 102 mother-child pairs of hair samples were sent to a laboratory and evaluated for levels of cortisol and cortisone.

We specifically collect hair samples, rather than saliva, to circumvent known issues with collection timing and storage of saliva samples (Pruessner et al., 1997). Levels of cortisol among the children in our sample are, on average, 6 pg/mg, which is commensurate with levels documented in a Dutch sample of similar-age healthy children (de Kruijff et al., 2020).

Levels of cortisol and cortisone are measures of child socio-emotional wellbeing, which have been used in the literature to study stress and wellbeing responses of children to care environments (Groeneveld et al., 2010). Higher levels of cortisol and cortisone in children have detrimental developmental consequences for child cognitive and health outcomes. They are associated with the over-activation of the hypothalamic pituitary and adrenal glands, which may result in unfavorable developmental consequences, including suppressed immune responses and impairments to brain development (Lupien et al., 1998, 2009). Haushofer et al. (2022) show that increased cortisol is associated with lower prosociality of adults in laboratory settings, although the link has not yet been tested for children.

3.4 Descriptive statistics

3.4.1 Sample statistics

Appendix Table A1 presents the summary statistics for our sample. Consistent with our sampling method, half of the participants are women. On average, participants are nearly 31 years old and 77 % have children (N=631). The average age of the target child is 25.18 months, in line with our recruitment protocol, with 2 siblings on average. Slightly less than half of the children are female (48%). Family ties are relatively strong in our sample, where on average, participants have three kin members (i.e., blood relatives) living in the same village.

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[12]We could not collect hair samples from Choiseul Province for logistical reasons as our field team had to carry all materials and food on a round-trip around the island and did not have access to any storage solution.

Only 38% of the participant sample has completed secondary school, reflecting the low educational opportunities for people in the Solomon Islands, while on a test of cognitive ability (Raven's Test), participants answered just over 50% of questions correctly (12.79 out of 24), which is slightly higher than mean scores from samples in other low-income settings (Brouwers et al., 2009).

3.4.2 Who helps with child care

The summary statistics further reveal the extent to which help with child care is prevalent in these communities. On average, parents of young children (N=631) receive some form of help with care from 7.07 different people. In terms of frequent help with care, 52% of participants receive daily help from the spouse and 62% from someone other than their spouse, and a similar proportion of respondents provides care for other people's children.

Our design enables us to capture how much help is provided by different people, kin and non-kin, as acknowledged by both mothers and fathers. Figure 1(a), based on the statistics reported in Appendix Table A2, illustrates three main patterns. First, help with child care follows genetic relatedness to the child. Parents provide significantly more care than others. Next is the participant's mother (one of the child's grandmothers), who helps once a week on average, followed by the participant's mother-in-law (the other grandmother), father (one of the child's grandfathers) and sister (child's aunt). Last are the participant's brother and father-in-law, who offer the least amount of help (on a less than monthly basis). Second, women provide more help than men - mothers more than fathers, grandmothers more than grandfathers, sisters more than brothers - a result still plausibly due to genetic relatedness (larger maternal investment, paternity uncertainty and longer reproductive lives for men make maternal care advantageous), but also likely reinforced by cultural norms about parental roles, depending on the costs and benefits of paternal investment. Third, child care relies substantially on the support offered by unrelated but well-known individuals, namely friends and neighbors. These findings are consistent with a large literature linking help to both genetic and social proximity (Barrett et al., 2002; Kasper and Mulder, 2015).

Patterns are remarkably similar across mothers and fathers, with a few exceptions. Both mothers and fathers report that the main source of care comes from their spouse (nearly every day), but fathers acknowledge more help with care from their wives than

mothers acknowledge receiving from their husbands (p-value=0.000). Mothers report more help from friends and neighbors, who help them as much as either grandmother, than what fathers report getting (p-value=0.000 and p-value=0.001, respectively). In other words, fathers rely more on their spouse, while mothers rely more on their friends and neighbors.

In Appendix Table A3, we analyze the determinants of help with child care. The main determinant of help from kin is the presence of kin in the village. The intensive margin of productive activities is an important predictor of help received with child care for mothers, but not for fathers. Mothers who work more in their gardens, in fishing, or who sell more in markets outside of their village receive no extra help from their husbands but receive more help from non-kin. An interpretation of this is that mothers augment help from the father's child with help from their friends and neighbors when they work. For fathers, the amount of help received with child care does not correlate with their involvement in economic activities, which can be explained by the fact that mothers provide so much of the care anyway. Another interesting pattern is that mothers who receive more help with child care also tend to take care of their own child more frequently. This highlights that in the context of the horticultural societies that we study, with limited involvement in outside economic activities, child care is a social activity. This stands in contrast with industrialized countries, where mothers are generally more socially isolated (Konner, 2017) and where formal childcare substitutes for parental care.

The intensity of help with child care is not predicted by other individual-level characteristics, such as cognitive ability, schooling, wealth, although for fathers it does. Younger parents receive more help, but the magnitude of this relationship is small.

In Appendix Table A4, we show how help with child care positively correlates with other dimensions of the dyadic relationship between participant and receiver. People who help with child care also tend to provide emotional support, attend the same church, help with garden work and offer financial support. The magnitudes are largest for attending the same church and help with production, and much more modest for large financial support, which is insignificant for fathers. These patterns suggest that help with child care is not perfectly predicted by other dimensions of social and economic support, but that controlling for these other dimensions may be important to isolate the influence of allomaternal care on prosocial preferences,
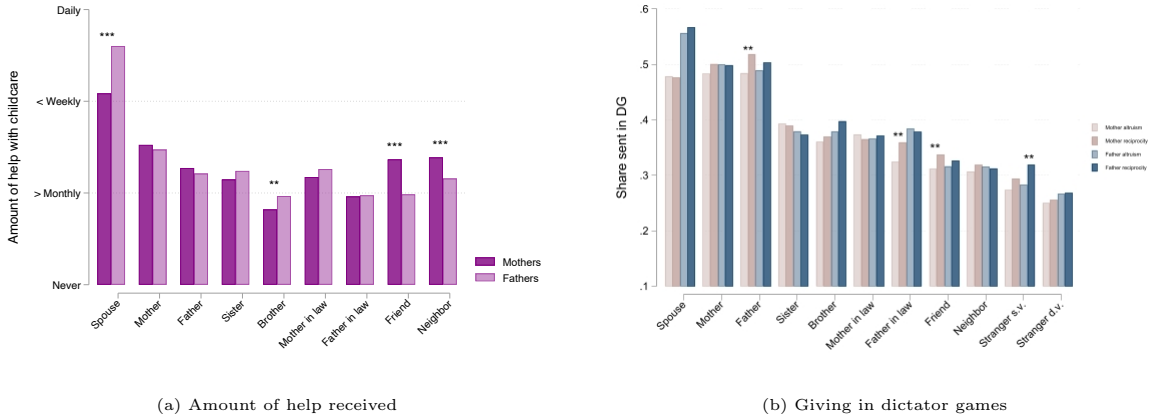
(a) Amount of help received
(b) Giving in dictator games

Figure 1: Help with care and cooperation in the dictator game

Notes: N=374 mothers and 257 fathers. In panel (a), bars represent the average amount of help with care that participants receive from the individuals in their network reported as: (0) never, (1) less frequently than once a month, (2) more frequently than once a month, (3) once a week, (4) a few times a week, (5) every day, a little bit, or (6) every day, for a large part of the day. Stars represent differences between mothers and fathers (** p-value < 0.05, *** p-value < 0.01). In panel (b), bars represent the average share of the dictator game endowment given to each receiver (each time from a new SI$40 endowment). Stars represent differences between giving in the anonymous (altruism) and non-anonymous conditions (reciprocity) (** p-value < 0.05, *** p-value < 0.01).

independent of other forms of support.

3.4.3 Altruism and reciprocity towards kin and others

Appendix Table A1 shows the mean share of the endowment sent in the dictator game, averaged across all receivers. In the anonymous (altruism) rounds, participants shared, on average, 39% of their endowment with receivers, while in the non-anonymous (reciprocity) rounds, they shared slightly more (40%; p-value difference = 0.002).

Figure 1(b) reports the average share of the dictator game endowment given to each receiver, separately for the non-anonymous (reciprocity) and anonymous (altruism) conditions (see the statistics in Appendix Table A5). Patterns of reciprocity and altruism follow approximately five tiers, which could be explained, only in part, by kinship.

First, mothers and fathers give the most to their spouses (the child's other parent) and their own parents (the child's grandparents), with shares hovering around 50% or more. One notable difference is that while women give similar shares to their husbands, mothers, and fathers, men give significantly more to their wives (∼56%) than what they receive from their wives (∼48%). Second, participants give significantly less to their own siblings and in-laws, around 36%-39%. This large drop in giving reveals that other factors, besides genetic relatedness to the child (which is

the same for grandparents, aunts, and uncles) are important determinants of both reciprocity and altruism. Similar considerations apply to unrelated individuals, like friends, neighbors, and strangers, who all receive non-negligible shares. Friends and neighbors receive around 32% of the endowment, significantly less than what is given to siblings and in-laws, but significantly more than what strangers receive (around 28% in the same village and 26% in the distant village). This is consistent with dictator game results in similar settings.

With respect to differences between the non-anonymous (reciprocity) and anonymous (altruism) conditions, we find that reciprocity overall motivates people more than altruism (respective averages: 0.382 vs. 0.372; p-value=0.019), although by gender and receiver, this difference is statistically significant only in a few cases (see Appendix Table A5). For mothers, we observe evidence of higher reciprocity than altruism with her own father, father in law and friends; for fathers, only with strangers in the same village.

4   Estimation Strategy and Results

Simple correlations between cooperative behavior in the dictator game and help with child care may be confounded by both the relatedness to the receiver (spouse, kin of the child, and non-kin), as well as factors that influence both the amount of help a participant can elicit and their prosocial inclinations (due to status, personality traits, or other unobserved factors). We first discuss how our experimental setup enables us to address these empirical issues and present our results. We then document how allomaternal care, specifically by non-kin, elicits impersonal prosociality and provides socio-cognitive benefits to children before discussing similar patterns across societies.

4.1   Estimation strategy

We conduct our main analysis at the level of a participant-receiver dyad in the dictator game, which allows us to exploit within-participant (i) variation in the share of the endowment (y_{irg}) transferred to each receiver (r), as well as variation in the amount of help with child care ($Care_{ir}$) provided to the participant by each specific type of receiver (e.g., spouse, mother, father, mother-in-law, father-in-law, brother, sister, friend or neighbor). We pool over the anonymous (altruism) and non-anonymous (reciprocity) gift giving conditions (g) and initially exclude non-parent participants, as well as giving to strangers, as there is no variation in help with child care under

either condition.

We estimate the following equations at the level of a participant-receiver dyad:

$$y_{irg} = \alpha + \beta_1 Care_{ri} + \beta_2 Care_{ri} * T_g + \delta T_g + X'_{ir}\Gamma + \rho_i + \mu_r + \varepsilon_{irg} \qquad (1)$$

where $Care_{ri}$ captures the frequency of help with child care provided by receiver r to participant i, which we standardize to mean zero, standard deviation one. We include an indicator variable for non-anonymous (reciprocity) giving in T_g. We allow the coefficient associated with $Care_{ri}$ to vary across reciprocal and altruistic motives by including an interaction between T_g and $Care_{ri}$. The vector X_{ir} captures other characteristics of the relationship between i and r, such as the other forms of support the receiver provides to the participant. We cluster standard errors at the participant level (ε_{irg}) to address correlation in giving across receivers from a given participant.

The direction of causality is implicit in the model, since allomaternal care by different caregivers is pre-determined at the time of our experiment. Moreover, our anonymous treatment removes the possibility that participants may treat transfers strategically so as to elicit more care in the future. However, any raw correlation between $Care_{ri}$ and y_{irg} could still be confounded by a number of factors. First, a participant's prosocial inclinations could be systematically correlated with how much help others are willing to provide. Others might be willing to help, for example, because the participant, or their child, are particularly agreeable and prosocial or have higher status. Similarly, more prosocial individuals or those with higher status may be more inclined to transfer higher shares in the dictator game. To address this, the participant fixed effects (ρ_i) in Equation (1) capture any unobservable characteristics of a given participant that may be associated with prosociality and allocare received.

Second, a certain type of receiver may both provide more care and receive larger gifts in the dictator games for reasons unrelated to any causal relationship between these two variables. This is the case for kin, who may both receive a greater share of the endowment in the dictator game and provide more child care due only to their genetic relatedness to the participant and their child. Receiver-type fixed effects (μ_r) capture the specificity of the relationship between a given receiver and the participant (or their child) that could drive both gift-giving and child care provisioning. We include a separate fixed effect for each type of receiver (e.g. spouse, mother, father, mother-in-law, father-in-law, brother, sister, friend, neighbor) and add a separate

fixed effect to account for the fact that for 17.6% of the individuals in the sample, the spouse is not the biological parent of the child.

Last, the provision of child care could be systematically correlated with other forms of help that the receiver provides to the participant. We elicit other dimensions of this relationship, including economic, productive, emotional, and social support, and check that our results are robust to accounting for their potential influence on gift-giving by including them as additional controls in X_{ir}. We first discuss how these different dimensions of the dyadic relationship between participant and receiver correlate with each other. We then present our results with and without other dimensions of support as controls.

The parameters of interest in Equation (1) are β_1 and β_2. These coefficients isolate the increase in dictator game transfers associated with additional help received with child care, after controlling for unobservable participant characteristics, the specific type of relationship between participant and receiver (e.g. specific family member, friend), and other dimensions of the relationship between participant and receiver that vary at the dyad level, such as the intensity of emotional support or economic risk sharing. When the full set of fixed effects and controls are included, the remaining variation comes from the fact that some receivers provide more help with child care than others for idiosyncratic reasons unrelated to their genetic or social relatedness to the participant, to the participant's characteristics, or to other dimensions of their relationship to the participant that we capture (e.g. emotional, economic, productive, or attending Church together). The friend of a given participant may help more than the friend of another because they like children more. A neighbor may have children similar in age to the participant's children, and hence be more inclined to provide child care than a neighbor without them. A participant's sister may live closer than the sister of another participant, and therefore be more willing to help because visiting is less time-consuming. Similarly, grandmothers with access to transportation may have an easier time helping than those without, who would help as much, but do not because of the distance. When all these factors are accounted for, the coefficient β_1 captures the elasticity of dictator game transfers to alloparental help in terms of altruism (anonymous treatment), while $\beta_1 + \beta_2$ captures the reciprocal return (backward and/or forward signaling reciprocity motive).

Because we only exploit variation in transfers across receivers for a given participant, our design is also insulated from potential confounds such as experimenter

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effects, social desirability bias, or cognition, which could influence how a particular individual would generally behave in the experimental game.

4.2 Help with child care elicits altruism and reciprocity

Results displayed in Table 1 first show that gift giving in the dictator game is positively correlated with help received with child care, both for mothers (Col. 1) and fathers (Col. 6), and for both anonymous and non anonymous transfers. Columns 2-5 for mothers and 6-10 for fathers add participant and receiver-type fixed effects, first separately and then together. The estimation results of Equation (1) are displayed in Columns 5 and 10, in which we control for participant and receiver-type fixed effects, as well as the other dimensions of social, emotional, productive, and economic support that vary at the dyad level.

The coefficient associated with help with child care for anonymous transfers (β_1) drops in magnitude between Columns 1 and 2 (mothers), and 6 and 7 (fathers), when we add participant fixed effects, suggesting a positive selection into receiving more help with child care for more prosocial individuals. The coefficient β_1 drops by an even larger magnitude when we add receiver-type fixed effects (Columns 3 and 8), especially for fathers. This suggests that the specific nature of the relationship between participant and receiver determines both how much help each receiver provides and how much the participant gives them. This confirms the descriptive patterns in Figure 1, which shows that specific individuals in the participant's network, tied either by kinship or friendship, systematically provide more help and receive more in the dictator game. Accounting for receiver-type fixed effects explains away roughly 46.43-49.06% of the correlation between help with child care and gift giving for fathers (depending on anonymous or non-anonymous treatment) and 28.95-36.67% for mothers. When we account for both participant and receiver-type fixed effects (Columns 4 and 9), both β_1 and $\beta_1 + \beta_2$ remain statistically significant for mothers.

The results thus show that help with child care elicits greater prosociality by mothers. These results could be due to the fact that receiving help, in any dimension, elicits greater prosociality. They could also be due to the fact that, as we have discussed, the provision of child care help correlates with other dimensions of support, which themselves elicit greater prosociality. To address this, we include controls for other dimensions of social, emotional, productive, and economic support in columns 5 and 10. Among these other dimensions of support, only emotional support elicits

higher gift giving by mothers, but the magnitude is smaller than the magnitude of the coefficient associated with child care help. Moreover, β_1 and β_2 are unchanged in magnitude.[13] These results suggest that other dimensions of support have no bearing on the relationship between allomaternal care and gift giving by mothers. This highlights the specificity of allo*maternal* care in eliciting prosociality. For fathers, no dimension of help significantly predicts gift giving once participant and receiver-type fixed effects are accounted for.

Turning to reciprocal and altruistic motives, the positive and statistically significant (p-value < 0.10) coefficient for *Reciprocity* (an indicator for the non-anonymous giving condition) in Table 1 suggests that reciprocity (backward and forward) is an important general motive for gift-giving. However, the coefficient associated with the interaction between *Care* and the anonymous treatment is negative, and at least for women, statistically significant, although small in magnitude, suggesting that eliciting further care may not be the most important motivation behind giving (i.e., gratitude for past help matters, as well).

Overall, the results suggests that receiving help with child care makes mothers more generous, both for reciprocal and, even slightly more so, altruistic motives. The point estimate suggests that a one standard deviation increase in help with child care (receiving help with care from a few times a month to a few times a week) is associated with a 1.5 percentage point increase in anonymous gift giving, a 3.84% increase at the mean.[14]

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[13]The difference in β_1 across specifications in Columns 4 and 5 is not statistically significantly different from 0 (P-value: 0.30).

[14]The mean anonymous transfer in the dictator game is 0.39 for women.

Table 1: Allomaternal care and cooperation in the dictator game

DV: Share sent in DG	(1)	(2)	(3) Mothers	(4)	(5)	(6)	(7)	(8) Fathers	(9)	(10)
Child care	0.038*** (0.007)	0.030*** (0.005)	0.027*** (0.007)	0.015*** (0.005)	0.012** (0.005)	0.056*** (0.007)	0.045*** (0.005)	0.030*** (0.008)	0.006 (0.005)	0.002 (0.005)
Reciprocity	0.011* (0.006)	0.011* (0.006)	0.011* (0.006)	0.011* (0.006)	0.011* (0.006)	0.008 (0.007)	0.008 (0.007)	0.008 (0.007)	0.008 (0.007)	0.008 (0.007)
Child care X Reciprocity	-0.008* (0.005)	-0.008* (0.005)	-0.008* (0.005)	-0.008* (0.005)	-0.008* (0.005)	-0.003 (0.005)	-0.003 (0.005)	-0.003 (0.005)	-0.003 (0.005)	-0.003 (0.005)
Small financial support (0/1)					0.013 (0.009)					-0.008 (0.008)
Large financial support (0/1)					-0.013 (0.011)					0.001 (0.011)
Help with production					0.002 (0.005)					0.008 (0.005)
Emotional support					0.008* (0.004)					-0.002 (0.005)
Attend same church (0/1)					-0.014 (0.010)					0.011 (0.015)
Participant FE:	N	Y	N	Y	Y	N	Y	N	Y	Y
Receiver FE:	N	N	Y	Y	Y	N	N	Y	Y	Y
Observations	4702	4702	4702	4702	4680	3530	3530	3530	3530	3522
Mean DV	0.40	0.40	0.40	0.40	0.40	0.41	0.41	0.41	0.41	0.41
SD DV	0.27	0.27	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26

* p<0.10, ** p<0.05, *** p<0.01. Unit of observation is a participant-receiver dyad in the dictator game, excluding strangers. Standard errors clustered at the participant level in parentheses. *Child care* is the frequency of help with child care that the receiver provides to the participant, normalized to mean zero, standard deviation one. *Reciprocity* is an indicator variable taking value one for the non-anonymous giving condition.

4.3 Help with care fosters cooperation toward strangers

To elucidate the relationship between allomaternal care and *impersonal* cooperation, we turn to the relationship between help with child care that participants receive and their generosity toward strangers. Our experimental design specifies that strangers are not related to the participant, or even known to them, so there is no history of reciprocal relationships. In this case, the distinction between reciprocity and altruism loses some of its importance. In practice, however, given how small the villages in our sample are, a stranger in one's village could be a distant relative or a friend, and a non-anonymous gift may sow the seed of future reciprocation. Therefore, to capture different degrees of social distance, we elicit gift giving to strangers in both the same and distant villages, again both non-anonymously (reciprocity) and anonymously (altruism).

Looking at the raw experimental results, Figure 2 suggests that help with care from non-kin is correlated with greater cooperation toward strangers. Comparing the shares of the endowment sent to strangers between those who receive high (above median) vs. low (below median) help from non-kin shows that participants who receive more help from non-kin demonstrate greater cooperation toward strangers (uncontrolled t-tests shown in Appendix Table A6). This is present in both mothers and fathers, although especially for mothers, who give significantly more to strangers in both the same and distant village, both anonymously and non-anonymously, when they receive more help from non-kin. Fathers demonstrate a similar pattern, although with loss of statistical significance in the distant village anonymous condition.

We test these relationships more rigorously through our main analysis in Table 2. We start by limiting the sample to participants (i) in village (v) with children and only keep receivers who are strangers. We estimate the following equation, separately for mothers and fathers, at the level of a participant-receiver dyad, pooled over the following treatment conditions: stranger in the same or distant village (s), and anonymous (altruism) and non-anonymous (reciprocity) giving (g):

$$y_{ivsg} = \alpha + \sum_{k=1}^{3} \beta_{1k} Care_{ki} + \beta_2 T_{sg} + \sum_{k=1}^{3} \beta_{3k} Care_{ki} * T_{sg} + X_i' \Gamma + \mu_v + \varepsilon_{ivsg} \quad (2)$$

where y_{ivsg} is the share of the endowment given to stranger s from participant i in village v under giving condition g, and $Care_{ki}$ is the amount of care provided
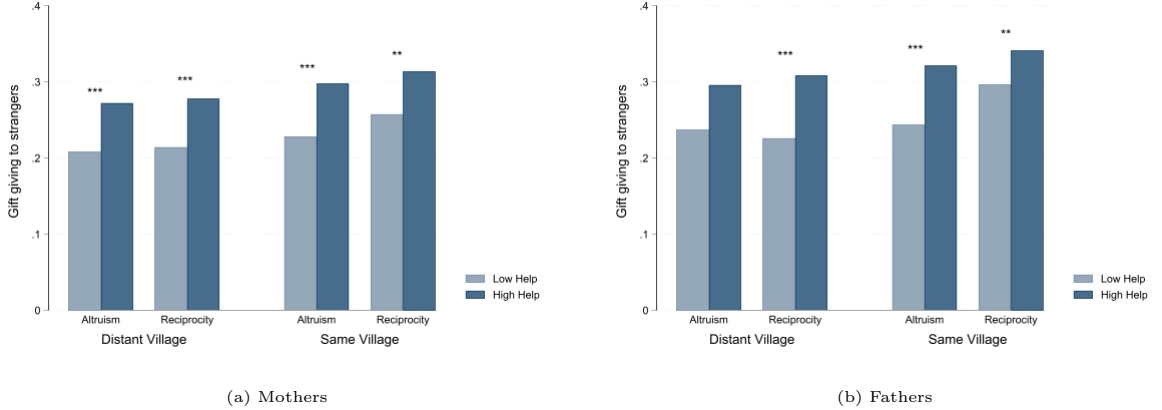
<center>(a) Mothers   (b) Fathers</center>

<center>Figure 2: Cooperation toward strangers and help with care from non-kin</center>

Notes: N=374 mothers and 257 fathers. Bars represent the average share of the dictator game endowment given to strangers for mothers and fathers who receive a high amount of help with child care (above median) vs. a low amount of help (below median) from non-kin (friends and neighbors). *Altruism* represents giving in the anonymous condition and *Reciprocity* represents giving in the non-anonymous condition. Stars represent differences between high and low help (** p-value < 0.05, *** p-value < 0.01).

by various kin and non-kin, including: (i) the spouse; (ii) other kin of the child, including the maternal and paternal grandparents, as well as the brother and sister of the parent; and (iii) non-kin (friend, neighbor). In all specifications we interact the treatment conditions T_{sg} (stranger in same vs. distant village; non-anonymous vs. anonymous) with each of the three child care variables to test different motives of cooperation toward strangers: (i) reciprocity (non-anonymous vs. anonymous), and (ii) social distance (same vs. distant village). Because the amount of help with child care does not vary across strangers for a given participant, our specifications cannot include participant fixed effects. We instead include village fixed effects μ_v that account for broad differences in cooperation or child care practices across villages. Additionally, we include a wide range of participant-level controls in X_i, such as age, proxies of the participant's presence of kin in the village, which is the main predictor of help by kin, proxies for social status, such as cognitive ability and wealth, which may influence both how much help participants are able to elicit and their generosity toward strangers. For women, work in the gardens and participation in markets are significant predictors of how much allomaternal care they receive. These variables may also systematically correlate with prosocial preferences. We therefore also control for the time participants spend working in their horticultural gardens and whether they sell goods in other villages. Given the substantial literature discussing how conflict exposure may affect prosocial preferences (see (Bauer et al., 2016) for a review),

<center>29</center>

we also control for exposure to organized violence. Finally, we account in X_i for other forms of social, emotional, productive and economic support provided to the participant.

We first present uncontrolled regressions, and then regressions that include individual-level covariates and treatment interaction terms. Table 2 shows that help with child care from spouse or from kin is not associated with generosity towards strangers. For fathers, we observe no statistically significant relationship between any form of help with child care and generosity toward strangers, except for care from kin in Column 5. However, mothers who receive more help from *non-kin* are systematically more generous toward strangers. This result holds regardless of possible motives of reciprocity or social distance, since none of the interaction terms are statistically significant at p-value < 0.10. It also holds controlling for a wide array of individual-level covariates, including how much social, economic, and emotional support the participant receives, proxies for status and wealth, and participation in markets. Again only child care help (from non-kin) matters: none of the coefficients associated with other forms of support is statistically significant for mothers, they are inconsistent in sign, with some positive (number of Church congregants) and some negative (total help with production), and generally smaller in magnitude.

Although some of the controls, such as participation in markets, are themselves correlated with allomaternal care from non-kin and have been described by previous literature as important correlates of prosociality, including the full range of individual-level covariates hardly affects the magnitude of the coefficient associated with allomaternal care from non-kin. Delta coefficients of an Oster test (displayed at the bottom of Table 2) suggest that the influence of omitted variables would need to be roughly twice as large as the influence of all included controls to explain away the coefficient associated with allomaternal care from non-kin, with some delta ratios even negative. In terms of magnitude, the results suggest that for mothers, a standard deviation increase in help with care from non-kin corresponds to a 0.25 s.d. increase in giving to strangers, relative to a mean of 0.27, a 9.26% at the mean.

Table A7 in the Appendix displays the coefficients associated with each individual control. For mothers, only time spent in the gardens is significantly associated with gift-giving to strangers. The coefficients associated with market participation are not significantly associated with gift giving to strangers. The coefficient associated with witnessing organized violence is negative, and only statistically significant for mothers

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at the 10% level. The negative sign is consistent with the literature on parochialism and previous results by Cassar et al. (2013) and Rohner et al. (2013), given that we elicit donations specifically to *strangers*. For fathers, the only significant coefficients are those associated with our wealth proxy, performance on a cognitive task, and emotional support. They are all negative, suggesting that men with higher status and more emotional support in their village are less generous towards strangers. We also find that, as expected due to social distance, the coefficients on *Same Village* indicate that gift giving to strangers in the same village is higher than to strangers in a distant village, both for mothers and fathers.

Table 2: Allomaternal care and cooperation toward strangers

DV: Share sent in DG	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Mothers				Fathers	
Care from: Spouse	-0.004	-0.005	-0.004	-0.005	0.005	-0.001	0.019	0.012
	(0.008)	(0.010)	(0.010)	(0.012)	(0.018)	(0.019)	(0.021)	(0.020)
Care from: Kin of child	-0.014	-0.013	-0.011	-0.009	0.021*	0.021	0.013	0.013
	(0.010)	(0.014)	(0.014)	(0.017)	(0.012)	(0.017)	(0.016)	(0.019)
Care from: Non-kin	0.024**	0.025**	0.024*	0.025*	0.013	0.019	0.014	0.021
	(0.011)	(0.011)	(0.013)	(0.014)	(0.015)	(0.015)	(0.019)	(0.019)
Same village × Care from: Spouse			0.003	0.003			-0.024	-0.023
			(0.010)	(0.010)			(0.019)	(0.019)
Same village × Care from: Kin of child			0.009	0.008			0.003	0.005
			(0.009)	(0.009)			(0.015)	(0.015)
Same village × Care from: Non-kin			-0.005	-0.005			-0.004	-0.006
			(0.008)	(0.008)			(0.016)	(0.015)
Reciprocity × Care from: Spouse			-0.003	-0.003			-0.003	-0.003
			(0.009)	(0.009)			(0.016)	(0.016)
Reciprocity × Care from: Kin of child			-0.016	-0.016			0.011	0.011
			(0.010)	(0.010)			(0.012)	(0.012)
Reciprocity × Care from: Non-kin			0.005	0.005			0.003	0.003
			(0.008)	(0.008)			(0.014)	(0.014)
Same village	0.030**	0.030**	0.033**	0.032**	0.034***	0.034***	0.045***	0.044**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)	(0.016)	(0.016)
Reciprocity	0.013	0.013	0.010	0.010	0.019	0.019	0.020	0.020
	(0.010)	(0.010)	(0.012)	(0.012)	(0.015)	(0.015)	(0.019)	(0.019)
Emotional support		-0.000		-0.000		-0.031**		-0.031**
		(0.013)		(0.013)		(0.014)		(0.014)
Small financial support		0.005		0.005		0.004		0.004
		(0.012)		(0.012)		(0.015)		(0.015)
Large financial support		-0.009		-0.009		-0.014		-0.014
		(0.010)		(0.010)		(0.013)		(0.013)
Production support		-0.021		-0.021		0.023		0.023
		(0.016)		(0.016)		(0.018)		(0.018)
Church congregants		0.012		0.012		0.014		0.014
		(0.013)		(0.013)		(0.014)		(0.014)
Additional controls:	N	Y	N	Y	N	Y	N	Y
Village FE:	Y	Y	Y	Y	Y	Y	Y	Y
Villages	44	44	44	44	44	44	44	44
Observations	1444	1444	1444	1444	968	968	968	968
R^2	0.247	0.273	0.249	0.274	0.218	0.262	0.220	0.264
δ Care from: Non-kin		1.73		-2.75		3.79		-2.76
Mean DV	0.27	0.27	0.27	0.27	0.28	0.28	0.28	0.28
SD DV	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.24

* p<0.10, ** p<0.05, *** p<0.01. Unit of observation is a participant-receiver dyad in the dictator game, restricted to strangers, only. All estimates include village fixed effects. Additional controls include log of participant's age, cognitive ability, number of kin living in the village, ownership of consumer durables, and whether the participant ever witnessed inter-village violence. *Care* variables represent the amount of help with child care that each group provides to the participant standardized to mean zero, standard deviation one. *Reciprocity* is an indicator variable taking value one for the non-anonymous giving condition. Support variables represent the total amount of support received from the various individuals in a participant's network, normalized to mean zero, standard deviation one. Standard errors clustered at the village level in parentheses. The coefficients δ are calculated using the *psacalc* function in Stata assuming an R-max = $1.3 * R^2$ and represent the proportional degree of selection on unobservables needed to overturn the estimated effects. Missing observations imputed to the sample mean for control variables and all estimates include indicator variables for missing observations.

Finally, to shed some initial light on group-level effects, we limit our analysis to participants who do not have children, and thus do not directly benefit from the provision of child care. We correlate the share of the endowment that these non-parent participants give to strangers in the dictator game with the average amount of help with child care that parents receive in their village. Appendix Table A8 shows a positive and significant relationship (p-value < 0.05) between impersonal cooperation and village-level help with child care among those who do not directly benefit from child care. The statistically significant interaction term in Column 4 suggests that this relationship is driven by women in villages where non-kin provide a lot of help with child care, which is consistent with our previous result for mothers.

The results so far show that help with child care provided by non-kin is associated with more reciprocity and more altruism by recipient mothers, as well as heightened impersonal prosociality towards strangers. Overall, this suggests a link between allomaternal care and prosociality, which goes beyond simple reciprocal relationships and generalizes to impersonal interactions. This evidence provides support for the hypothesis that roots cooperation in the network of help and reciprocity solicited and maintained for infant care, suggesting that the capacity for generalized prosociality could have emerged specifically from cooperation with non-kin over child care practices.

4.4 Allomaternal care confers socio-cognitive benefits to children

We now investigate whether allomaternal care confers socio-cognitive benefits to children. The presence of such benefits would offer some supporting, although indirect, evidence for the idea that cooperative child rearing practices may have been critical in permitting the evolution of distinctively human social capacities.

We focus on language, a unique human social characteristic. We calibrate measures of child socio-cognitive development based on the number of child vocalizations estimated from child-centered long-form recordings collected from 196 children using a wearable recording devices (Lavechin et al., 2021). We analyze recordings using a multilingually-trained, neural network that outperforms other software alternatives (Lavechin et al., 2020). Generally, child vocalizations are among the earliest and most robust expressions of infant communication and intersubjectivity (see e.g. Trevarthen, 1979), and are correlated with standardized language measures that are the current

best infant predictors of academic achievement (Gilkerson et al., 2018; Wang et al., 2020).

We regress child vocalization counts on the amount of care that the child receives from various people, including their mother, father, other kin (grandparents, aunts and uncles), and non-kin (friends and neighbors).[15] We include village fixed effects to account for broad geographic, cultural, and linguistic differences across villages that could influence child outcomes. We include child-level controls, such as age and gender, which influence vocalizations, as well proxies of other child-level stressors, such as BMI, total number of children in the household, and whether the mother's spouse is the child's biological father, which could influence child socio-cognitive development and correlate with amount of care that the child receives from different caregivers (the father, in particular). We also control for the usual set of mother-level characteristics, such as age, a proxy for cognitive ability, wealth, and the amount of social, emotional, productive, and economic support she receives, as well as the presence of kin in the village, an important predictor of care by non-kin, time spent in gardens and market participation, which are important predictors of care by non-kin, and conflict exposure.

These controls may play an important role in our estimation. Mothers' time spent in gardens and market participation may reduce the time spent with her children and increase the amount of care given by non-kin. We thus expect the inclusion of these controls to improve the precision of our estimates. Yet, there is also a possibility that some of these controls are endogenous to child socio-cognitive outcomes and allomaternal care. For example, mothers of children with low socio-cognitive skills may participate less in markets if they cannot find any friend or neighbor willing to take care of the child. To address this possibility, we systematically present the results of specifications that include only basic controls (child age and gender, mother age), as well as the full set of controls.

The results displayed in Table 3 show that care from non-kin is the only robust and consistent predictor of higher child vocalizations. Care from any other caregiver does not consistently correlate with our measure of child socio-cognitive development. Care from the mother is positively associated with vocalizations, care by the father negatively, and care by other kin of the child inconsistent in sign; but none of the coefficients is statistically significant.

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[15]More information on the specification is included in Section C.2 of the Appendix.

Estimates displayed in Column 4 of Panel A (with minimal controls for child age and gender and mother age) suggest that receiving care by non-kin on at least a weekly basis is associated with significantly more vocalizations (26.8 per hour, a 12.47% increase at the mean, p-value < 0.10). Parsimoniously controlling for care by different caregivers as we do in Columns 1 to 4 may mask systematic correlations in care by different caregivers. To address this, Column 5 controls for all inputs by different caregivers together. The coefficient associated with care by non-kin is barely affected, and if anything, increases slightly in magnitude, suggesting that care by non-kin does not, in our context, substitute for care by other caregivers.

Child care provided by non-kin may also capture other dimensions of maternal support, such as emotional or social support. In specifications displayed in Panel B, we control for all other dimensions of maternal support, as well as the other mother-level controls discussed above. In particular, we control for time spent in gardens and market participation, which are important drivers of help with child care from non-kin for mothers.

As expected, controlling for the extended set of controls improves the precision of the estimate associated with care by non-kin. The coefficient suggests that receiving care by non-kin on at least a weekly basis is associated with 38.17 more vocalizations per hour, a 17.80% increase at the mean, (p-value < 0.05). The estimates displayed in Panel B also reveal that none of the various other dimensions of maternal support is a robust predictor of child socio-cognitive outcomes. This highlights child care, as opposed to social, emotional, productive, or economic support to the mother, as the driver of the child socio-cognitive benefits we document.[16]

The only other robust predictors of child vocalizations are mother's performance on a cognitive task (p-value < 0.05) and mother's participation in markets (p-value < 0.01). The positive and significant correlation between mother's cognitive ability and child vocalization is consistent with findings on the heritability of cognitive skills (Mollon et al., 2021) and provides a validation of our measure of socio-cognitive development. The result for mother's market participation suggests that such behavior may reflect mothers' non-cognitive skills, which may be partly inherited and predic-

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[16]In Appendix Table A9, we also control for the mother's stress hormone, noting that the sample size is reduced to only those children for whom a child-mother hair sample was collected (102 children). The estimates are robust to controlling for mother stress and confirm that care by non-kin is the only type of care that is positively associated with higher vocalizations. In addition, mother stress is, as could be expected, negatively associated with child vocalizations.

tive of children's socio-cognitive development. Although we observe a weak negative correlation between performance on the cognitive task and market participation (-0.17), the correlation between market participation and emotional support is positive (0.24), suggesting that market participation may indeed partly reflect social skills.[17]

A limitation of automated long-form recording data is the possibility that cries, and hence child distress, may be categorized as vocalizations. We address this possibility in two ways. First, given the magnitude of our results and the low average proportion of crying in vocalizations, it is unlikely that our results can be entirely explained by distress. The average proportion of crying in vocalizations coded by lab scientists in a random subset of our data was 3.20%; applying this to the mean vocalization suggests an estimate of 6.88 average crying vocalizations per hour. The coefficient associated with a one standard deviation increase in care by non-kin hovers around 27-28 additional vocalizations, which would represent a 400% increase in crying if the effect were entirely due to distress, which seems implausibly large. Second, to provide a more direct measure of distress, we collected measures of child emotional wellbeing from hormonal biomarkers for cortisol and cortisone in hair samples of 102 mother-child pairs. The rationale for collecting this data is that unmet children's needs, excessive crying, and distress under the care of others would translate into higher levels of stress.

The results displayed in Appendix Table A10 show that care from non-kin is associated with *lower* levels of stress hormones, cortisone and cortisol, in children.[18] The coefficient remains negative, but loses significance, when the full set of extended controls is included. The result that care by non-kin is, if anything, negatively associated with child stress suggests that our vocalization result is unlikely to be driven by cries. Given that higher levels of cortisol and cortisone are associated with impaired brain development in children (Lupien et al., 1998, 2009) and, for adults in laboratory settings, increased cortisol is associated with lower prosociality (Haushofer et al., 2022), the result that care by non-kin is negatively associated with child stress suggests potential socio-emotional benefits that go beyond the socio-cognitive benefits that we document.

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[17]The correlation between performance on the cognitive task and emotional support is itself negative and small in magnitude (-0.10).

[18]The results also show that mother stress is positively correlated with child stress. More information on the empirical specifications used to generate these results is included in Section C.2 of the Appendix.

Table 3: Allomaternal care and child vocalizations

	(1)	(2)	(3)	(4)	(5)
Panel A: Vocalizations per hour − Basic controls					
Care: Mother (Ln(Hours/week))	3.444				5.258
	(6.562)				(6.813)
Care: Father (daily)		-9.565			-13.309
		(10.163)			(10.701)
Care: Other kin of child (weekly or more)			8.404		9.675
			(31.318)		(33.789)
Care: Non-kin (weekly or more)				26.803*	28.620*
				(14.633)	(14.612)
Panel B: Vocalizations per hour − Extended controls					
Care: Mother (Ln(Hours/week))	6.455				7.678
	(5.510)				(5.742)
Care: Father (daily)		-6.276			-9.563
		(8.847)			(8.718)
Care: Other kin of child (weekly or more)			6.040		5.305
			(29.617)		(32.411)
Care: Non-kin (weekly or more)				38.171**	38.909**
				(16.697)	(16.719)
Mother's cognitive ability	1.804**	1.903**	1.923**	1.966**	1.893**
	(0.867)	(0.932)	(0.886)	(0.891)	(0.832)
Consumer durables	1.578	1.257	0.719	0.772	1.976
	(4.485)	(4.576)	(4.224)	(4.794)	(4.291)
Emotional support	-11.232	-10.662	-11.484	-13.877*	-13.011*
	(7.461)	(7.326)	(7.642)	(7.600)	(7.634)
Small financial support	3.149	1.878	2.686	5.732	5.141
	(6.583)	(7.120)	(6.696)	(6.850)	(7.150)
Large financial support	-8.530	-7.866	-7.377	-9.767	-10.727
	(8.030)	(8.223)	(8.306)	(8.235)	(8.119)
Production support	2.264	3.381	2.366	1.740	2.284
	(7.427)	(7.738)	(7.301)	(7.469)	(7.277)
Church congregants	4.641	2.835	2.910	-0.585	0.354
	(8.716)	(8.728)	(9.052)	(9.579)	(9.124)
Witness violence (0/1)	-5.851	-6.800	-7.792	-2.380	0.135
	(12.448)	(12.226)	(12.360)	(13.932)	(14.158)
Time in gardens	6.702	7.863	7.808	9.750	9.048
	(9.939)	(10.168)	(9.876)	(10.038)	(9.763)
Time selling in other village	16.656***	16.464***	16.383***	16.635***	17.186***
	(5.323)	(5.151)	(5.235)	(5.103)	(5.218)
USB FE:	Y	Y	Y	Y	Y
Village FE:	Y	Y	Y	Y	Y
Observations	374	374	374	374	374
Mean DV	214.94	214.94	214.94	214.94	214.94
SD DV	87.90	87.90	87.90	87.90	87.90

* $p<0.10$, ** $p<0.05$, *** $p<0.01$. Unit of observation is a child recording. *Care* variables are indicators for whether the child receives care at the frequency indicated. All estimates include a fixed effect for the USB recording device and village fixed effects, and control the child's ln(age), gender, and mother's ln(age). Panel B includes the following additional controls: child BMI, whether the mother's spouse is the biological father of the child, total number of children in the household. Support variables, time working in gardens and time selling in other villages normalized to mean zero, standard deviation one. Standard errors in parentheses, two-way clustered for village and USB recording device. Missing observations imputed for control variables and all estimates include indicator variables for missing observations of control variables.

4.5 Evidence from the Standard Cross Cultural Sample

Our findings thus far provide evidence of a relationship between allomaternal care and cooperative behavior at the individual level, but only in a particular cultural context. Does this relationship generalize at a global scale? We uncover evidence in the Standard Cross Cultural Sample (SCCS) (Murdock and White, 1969), which suggests that societies where allomaternal care is more common also exhibit higher levels of prosociality.

The SCCS dataset contains detailed information on 186 cultural societies across the world that were originally selected from a list of 1,265 societies in the Ethnographic Atlas (EA). The goal of the SCCS is to represent the cultural diversity of human societies, which range from now extinct civilizations to contemporary hunter-gatherers. These societies are considered largely independent of one another and arguably representative of mutually distinct cultures (Murdock and White, 1969). We provide more information on the SCCS and our analysis in Section C.3 of the Appendix.

Information on child care practices is available for a subset of the societies in the SCCS. To proxy allomaternal care and best match the age range of children included in our sample, we use the SCCS measures of all non-maternal involvement in infancy (v51, N=161, scale of 1 – "almost exclusively by mother" to 5 – "mother minor but significant"–, mean: 2.52, s.d: 0.72[19]) and fathers' involvement specifically (v53, N=154, scale of 1 – "distant"– to 5 – "regularly close" – mean: 3.05, s.d.: 0.87). The SCCS also includes information on the importance of inculcating trust in children (v335, N=138, scale of 1 to 10, mean: 5.15, s.d.: 2.23), which we leverage as a proxy for prosocial norms.

The maps in Appendix Figure B1 show positive geographic correlations between the importance given by a society to the inculcation of trust in children and help with child care, either allomaternal (panel (a)) or specifically paternal (panel (b)). As shown in Figure 3 and Appendix Table A11, these correlations prove statistically robust, even when accounting for broad differences across regions and differences across societies in terms of climatic conditions and community size, as well as underlying variation in the epoch at which these societies were observed.

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[19]In only one society in the SCCS, Ancient Rome, maternal role in child care is coded as "minimal except for nursing". We exclude this outlier from our sample, although our results are insensitive to including it.
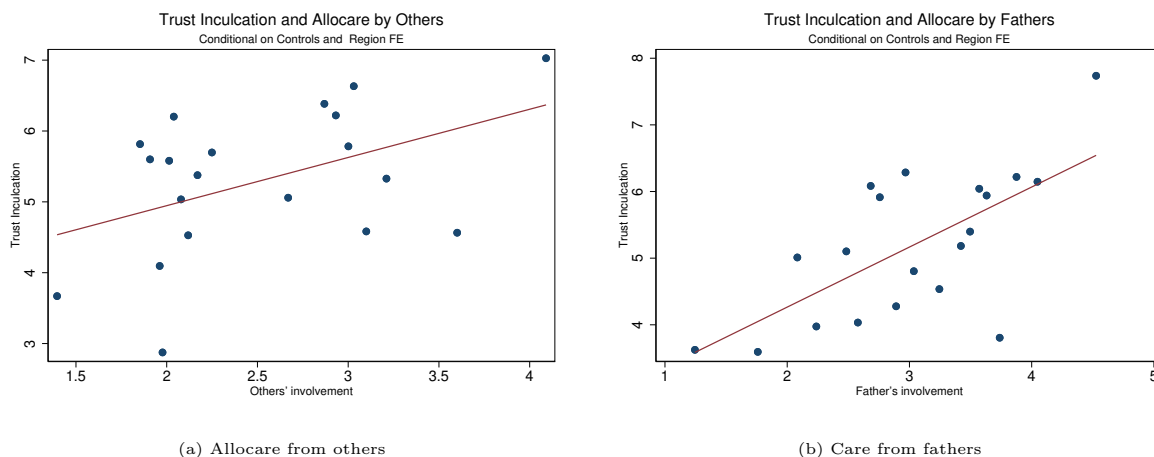
Figure 3: Correlations: Allomaternal care and trust in the Standard Cross-Cultural Sample (SCCS)

Note: Binned scatterplots of the relationship between societal trust orientation in the SCCS and in panel (a): care of infants by people other than mothers and in panel (b): care of infants by fathers; controlling for region fixed effects (v200 in the SCCS: Africa, Circum-Mediterranean, East Eurasia, Insular Pacific, North America, South America), log mean yearly average rainfall (v1913), log mean annual temperature (v186), mean size of local communities (v63). Care of infants by people other than mothers is measured by question v51 (non-maternal relationships in infancy), and care of infants by fathers by question v53 (role of fathers in infancy) of the SCCS. Measure of societal trust orientation: v335. Source: SCCS (Murdock and White, 1969).

In Figure 3, we examine the correlation between prosocial orientation and the prevalence of allocare by others and by fathers in the SCCS. Each panel in the Figure plots the conditional expectation function of societal orientation toward trust conditional on allomaternal care provision in infancy by others (Panel a) and specifically by fathers (Panel b). We control for region fixed effects, climatic conditions, and community size, which could influence both child care arrangements and social preferences. The figures indicate a strong and positive correlation between allomaternal care and trust across societies.

Table A11 in the Appendix presents the results of regressing societal orientation toward trust on the two alternative proxies of allomaternal care, controlling again for region fixed effects, climatic conditions, and community size (see estimation Equation 7 in Appendix Section C.3). The point estimates in Column 2 of Appendix Table A11 suggests that a one unit increase in allomaternal care (e.g. going from "almost exclusively mothers" to others having a "minor role", or from a "minor role" of others to a "major role") is associated with a 0.68 unit increase in the importance of inculcating trust, a 12.85% increase at the mean. The coefficient is statistically significant at the 5% level. A one unit increase in care by fathers (e.g. going from "rarely" to "occasionally" close or from "occasionally" to "frequently" close) is associated with

a 0.90 unit increase in the importance of inculcating trust, a 17.40% increase at the mean (Column 5). The coefficient is statistically significant at the 1% level.

To address potential criticisms of the SCCS related to the underlying variation in the time at which each society was observed and in the timing of publication of the different ethnographies and documents used to assemble the SCCS, we also present in Columns 3 and 6 of Appendix Table A11 the results of specifications in which we additionally include in X_{sr} the date at which the society was observed (variable *focyear*), and the publication date of the study dealing with a given society (*v802*). The results are unchanged. Uncontrolled estimates, displayed in Columns 1 and 4, are also very similar.

These results provide evidence of a robust statistical association between allomaternal care and prosociality at a societal level. Admittedly, cross-society correlations of this nature are not suggestive of any causal effect. Yet, they provide complementary evidence on a global scale to the rest of our individual-level analysis, which enables us to account for omitted variables and reverse causality, but in a particular society.

5   Conclusion

This work provides novel empirical evidence of a positive relationship between allomaternal care, especially by non-kin, and prosociality, and documents a range of socio-cognitive benefits that such care bestows on children. Our experimental evidence produces a precise calibration of the relationship between various dimensions of help and prosociality and supports the hypothesis that help with child care uniquely predicts reciprocity and altruism, not just toward kin and other network members, but to strangers as well, suggesting a specific foundation for the development of impersonal prosociality. We find that help with child care by non-kin is associated with enhanced prosociality toward strangers, highlighting the specificity of allomaternal care by non-kin as a crux of impersonal prosociality. Care by non-kin is also associated with enhanced socio-cognitive development in children, which we measure using a novel and easily scalable measure of vocalizations through daylong recordings analyzed using a multilingually-trained neural network that outperforms available alternatives.

Our framework, focusing on the need to elicit and maintain cooperation for the purpose of child rearing, and our findings, showing enhanced prosociality with greater allomaternal care, can be seen as complementary to the more widespread hypothesis

in the literature which roots prosociality in intergroup conflict. Although the role of gender has been somewhat overlooked in asexual models of representative agents (Choi and Bowles, 2007; Bowles, 2008), other strands of the social sciences literature have characterized the so-called "male warrior hypothesis" as principally predictive of male psychology (Vugt et al., 2007; Yuki and Yokota, 2009; McDonald et al., 2012). By contrast, our results are primarily predictive of women's prosociality.

A potential explanation for why our results hold specifically for women lies in gender differences in network formation and use, and in the more acute need for mothers to elicit and sustain networks of care for their offspring. As the network literature documents, men often rely on more transactional, loose-knit networks, while women benefit from a close-knit, supportive model (see, e.g., Yang et al., 2019). Consistent with a large body of literature describing patterns of help with child care, we document how genetic proximity to the child and repeated interactions with non-kin predict helping (Barrett et al., 2002; Kasper and Mulder, 2015), both for mothers and fathers. However, a crucial difference between women and men is that mothers provide significantly more care than fathers and rely considerably more on non-kin for help, compared to fathers. These patterns are also tied to female labor. Women who work more in their gardens or spend more time selling goods in markets outside of their village do not receive more help from their husbands and instead rely more on care by friends and neighbors. As such, our results highlight the feedback mechanisms between caregiving networks, female labor force participation, and prosociality. While the negative relationship between family ties and female labor force participation has been highlighted before (Alesina and Giuliano, 2010), our work connects these findings with those highlighting the negative relationship between family ties and prosociality. The link we establish between allomaternal care by *non-kin* and prosociality provides an explanation for the negative relationship between the strength of family ties and cooperative behavior famously observed in an ethnography of the Italian village of Montegrano (Banfield, 1958) and whose negative consequences for economic and political development have been established by several studies (Alesina and Giuliano, 2011, 2014; Alesina et al., 2015).

Our work also provides a new mechanism and interpretation of the findings that, compared with exclusive care by parents, the provision of daycare is associated with long-term advantages in cognition, educational achievement, non-cognitive skills, earnings and social preferences (Heckman, 2013; Cunha and Heckman, 2007; Cappe-

len et al., 2020; Attanasio et al., 2022a,b; Bjorvatn et al., 2022). We indeed document that care by unrelated individuals promotes language development, a crucial socio-cognitive skills for cooperation and communication. A more careful examination of the allomaternal care hypothesis combined with experimental manipulation of the type of child care provision is an important and promising area for future research. Our findings are also relevant for the design of early childhood and parenting interventions, which should consider and potentially leverage networks of unrelated acquaintances who provide regular care to children without necessarily substituting for maternal care, such as mothers' groups.

Finally, we contribute to a large and growing literature in the social sciences on the role of social and economic networks in low income economies (Breza et al., 2019). This literature has documented the importance of family, acquaintance, friendship, economic and productive networks in facilitating the take-up and diffusion of important policy tools, such as micro-finance (Banerjee et al., 2013), agricultural technology (Beaman et al., 2021a), and public health interventions (Kim et al., 2015). Our finding that caregiving networks supersede other social, emotional, productive and economic networks as a source of prosociality suggests that these networks are a promising avenue to promote a number of policy interventions, in particular programs targeting women, and especially female empowerment and labor force participation programs.

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Appendix:

It M̲akes a Village: Allomaternal Care and Prosociality

Cassar, Cristia, Grosjean, and Walker

A Appendix Tables

Table A1: Summary statistics

	N	Mean	SD	Min	Max
Participant information					
Female	820	0.52	0.50	0.00	1.00
Age	817	30.85	7.83	16.00	54.00
Has children	820	0.77	0.42	0.00	1.00
Completed secondary school	820	0.38	0.49	0.00	1.00
Cognitive (Raven's test score)	820	12.79	6.32	0.00	24.00
Works in garden a couple times a week	820	0.75	0.44	0.00	1.00
Fishes a couple times a week	820	0.46	0.50	0.00	1.00
Number of own kin in village	820	2.96	2.64	0.00	15.00
Provides allocare to others	631	0.61	0.49	0.00	1.00
Number of own children	631	2.92	1.74	1.00	11.00
Cares for own children daily	631	0.71	0.45	0.00	1.00
Total number of allocarers	631	7.07	2.72	0.00	14.00
Daily allocare from spouse	631	0.52	0.50	0.00	1.00
Daily allocare (excl spouse)	631	0.62	0.49	0.00	1.00
Witness violence	819	0.47	0.50	0.00	1.00
Share sent in DG (Altruism)	818	0.39	0.18	0.00	1.00
Share sent in DG (Reciprocity)	818	0.40	0.18	0.00	1.00
Child information					
Age (months)	193	25.27	9.06	6.00	48.00
Female	194	0.48	0.50	0.00	1.00
Mother's partner not the biological father	193	0.17	0.38	0.00	1.00
Vocalizations (per hour)	196	217.04	83.80	45.64	530.50
Cortisol (pg/mg)	102	6.06	5.23	0.08	27.40
Cortisone (pg/mg)	102	23.10	15.57	1.91	101.70

Source: Authors' data.

Table A2: Help with child care

	Mothers	Fathers	Overall	p-value
	(1)	(2)	(3)	(1) vs. (2)
Spouse	4.115	5.209	4.606	**0.000**
s.e.	(0.075)	(0.057)	(0.054)	
N	305	249	554	
Mother	2.977	2.884	2.940	0.605
s.e.	(0.118)	(0.132)	(0.088)	
N	307	207	514	
Father	2.428	2.429	2.429	0.994
s.e.	(0.128)	(0.153)	(0.098)	
N	250	156	406	
Sister	2.262	2.518	2.367	0.122
s.e.	(0.108)	(0.123)	(0.081)	
N	325	226	551	
Brother	1.596	1.912	1.726	**0.038**
s.e.	(0.096)	(0.119)	(0.075)	
N	342	238	580	
Mother in law	2.226	2.528	2.366	0.118
s.e.	(0.132)	(0.141)	(0.096)	
N	226	197	423	
Father in law	1.808	2.044	1.924	0.272
s.e.	(0.151)	(0.151)	(0.107)	
N	167	160	327	
Friend	2.752	1.996	2.434	**0.000**
s.e.	(0.100)	(0.120)	(0.079)	
N	331	240	571	
Neighbor	2.821	2.320	2.617	**0.001**
s.e.	(0.095)	(0.122)	(0.076)	
N	336	231	567	

Entries represent average amount of help with care provided by named individual ranked as: (0) never, (1) less frequently than once a month, (2)more frequently than once a month, (3) once a week, (4) a few times a week, (5) every day, a little bit, or (6) every day, for a large part of the day. Standard errors in parentheses. T-tests p-values of differences between mothers and fathers averages.

Table A3: Determinants of allomaternal care

	(1) Ln(age)	(2) Cognitive	(3) Wealth	(4) School	(5) # Kids	(6) Kin in vill	(7) Care own	(8) Allo others	(9) Gardens	(10) Fishing	(11) Market	(12) Violence
Panel A: Mothers												
Total amount of help with child care												
Child care	-0.051***	0.039	0.051	-0.024	-0.141	0.685***	0.168***	0.057	0.158***	0.186***	0.168***	0.007
	(0.010)	(0.284)	(0.076)	(0.022)	(0.090)	(0.167)	(0.061)	(0.055)	(0.056)	(0.052)	(0.043)	(0.026)
Total amount of help with child care from spouse												
Child care from spouse	-0.025**	0.270	-0.023	0.031	-0.066	-0.008	0.103	-0.019	0.033	-0.087	0.081	-0.006
	(0.012)	(0.417)	(0.083)	(0.028)	(0.099)	(0.167)	(0.067)	(0.053)	(0.047)	(0.069)	(0.057)	(0.028)
Total amount of help with child care from kin of child												
Child care from kin	-0.061***	0.226	0.052	-0.007	-0.336***	0.914***	0.124**	0.023	0.091	0.180***	0.090**	0.018
	(0.010)	(0.291)	(0.080)	(0.023)	(0.091)	(0.138)	(0.057)	(0.053)	(0.063)	(0.047)	(0.044)	(0.024)
Total amount of help with child care from non-kin												
Child care from non-kin	-0.016	-0.134	0.007	-0.034	0.069	0.203	0.163***	0.164***	0.142**	0.129**	0.202***	0.003
	(0.013)	(0.279)	(0.079)	(0.021)	(0.083)	(0.147)	(0.053)	(0.048)	(0.068)	(0.060)	(0.047)	(0.030)
Observations	372	373	373	373	373	373	373	373	373	373	372	373
Panel B: Fathers												
Total amount of help with child care												
Child care	-0.066***	-0.573	0.017	0.019	-0.277**	0.694***	0.217**	0.201***	0.036	0.032	0.049	0.035
	(0.012)	(0.389)	(0.087)	(0.031)	(0.122)	(0.199)	(0.086)	(0.064)	(0.074)	(0.052)	(0.062)	(0.036)
Total amount of help with child care from spouse												
Child care from spouse	-0.019	-0.465	-0.087	0.067	0.058	0.118	0.182	-0.005	0.016	0.105	-0.140	-0.041
	(0.020)	(0.540)	(0.122)	(0.048)	(0.149)	(0.218)	(0.135)	(0.096)	(0.074)	(0.085)	(0.087)	(0.047)
Total amount of help with child care from kin of child												
Child care from kin	-0.060***	-0.163	-0.062	0.023	-0.300**	0.829***	0.131*	0.171**	0.045	0.019	0.061	0.019
	(0.012)	(0.445)	(0.085)	(0.024)	(0.118)	(0.182)	(0.067)	(0.066)	(0.067)	(0.051)	(0.060)	(0.033)
Total amount of help with child care from non-kin												
Child care from non-kin	-0.054***	-0.998**	0.219**	-0.002	-0.224	0.090	0.192**	0.193***	-0.007	0.031	0.032	0.076*
	(0.013)	(0.397)	(0.086)	(0.037)	(0.139)	(0.204)	(0.075)	(0.060)	(0.068)	(0.054)	(0.060)	(0.039)
Village FE:	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	253	255	255	255	255	255	255	255	255	255	255	255

* $p<0.10$, ** $p<0.05$, *** $p<0.01$. Unit of observation is a participant who has children. All esitmates control for village fixed effects and cluster standard errors at the village level in parentheses. Childare variables normalized to mean zero, standard deviation one.

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Table A4: Correlations between allomaternal care and other forms of support

DV: Amount of help with care	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			Mothers					Fathers		
Small financial support (0/1)	0.375*** (0.048)					0.197*** (0.057)				
Large financial support (0/1)		0.125** (0.057)					-0.007 (0.070)			
Help with production			0.462*** (0.024)					0.414*** (0.029)		
Emotional support				0.272*** (0.026)					0.288*** (0.028)	
Attend same church (0/1)					0.738*** (0.073)					0.713*** (0.075)
Participant FE:	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Receiver FE:	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	2347	2347	2347	2345	2342	1764	1764	1764	1764	1760

* p<0.10, ** p<0.05, *** p<0.01. Unit of observation is a participant-receiver dyad in the dictator game, excluding strangers. Standard errors clustered at the participant level in parentheses. Amount of help with child care, production, and emotional support standardized to mean zero, standard deviation one.

Table A5: Dictator game giving in anonymous (Altruism) and non-anonymous (Reciprocity) conditions, by mothers and fathers

| | Mothers | | | Fathers | | | | |
	Altruism (1)	Reciprocity (2)	Paired t-test (1)vs.(2) p-value	Altruism (3)	Reciprocity (4)	Paired t-test (3)vs.(4) p-value	Altruism (1)vs.(3) p-value	Reciprocity (2)vs.(4) p-value
Spouse	0.48 (0.016)	0.478 (0.017)	0.840 N=292	0.557 (0.017)	0.567 (0.017)	0.495 N=238	**0.001**	**0.000**
Mother	0.483 (0.016)	0.501 (0.017)	0.211 N=295	0.5 (0.019)	0.499 (0.019)	0.943 N=206	0.492	0.936
Father	0.484 (0.018)	0.519 (0.019)	**0.034** N=241	0.49 (0.022)	0.503 (0.022)	0.390 N=168	0.858	0.596
Sister	0.389 (0.014)	0.387 (0.014)	0.895 N=323	0.38 (0.015)	0.374 (0.014)	0.575 N=220	0.672	0.519
Brother	0.362 (0.013)	0.371 (0.014)	0.421 N=325	0.38 (0.016)	0.398 (0.015)	0.150 N=229	0.375	0.182
Mother in law	0.374 (0.018)	0.365 (0.018)	0.570 N=208	0.366 (0.018)	0.371 (0.018)	0.757 N=198	0.764	0.818
Father in law	0.324 (0.020)	0.36 (0.021)	**0.024** N=178	0.384 (0.021)	0.378 (0.020)	0.737 N=160	**0.040**	0.522
Friend	0.315 (0.013)	0.339 (0.013)	**0.018** N=324	0.315 (0.013)	0.324 (0.014)	0.360 N=233	0.974	0.455
Neighbor	0.309 (0.013)	0.321 (0.013)	0.327 N=319	0.316 (0.014)	0.314 (0.014)	0.830 N=223	0.700	0.739
Stranger same village	0.273 (0.012)	0.294 (0.012)	0.083 N=362	0.283 (0.014)	0.319 (0.015)	**0.013** N=249	0.610	0.191
Stranger distant village	0.25 (0.014)	0.256 (0.013)	0.639 N=360	0.267 (0.016)	0.268 (0.017)	0.947 N=235	0.430	0.559

Entries represent average share of endowment transferred to each receiver under anonymous (Altruism) and non-anonymous (Reciprocity) conditions. Standard errors in parentheses. Paired t-test p-values for testing differences between conditions by sender. Independent samples t-test p-values for testing differences between sexes, within condition.

Table A6: Dictator game giving to strangers, by help from non-kin (low, high), non-anonymous (reciprocity) and anonymous (altruism) conditions, and type of stranger, for mothers and fathers

	Help from non-kin	Mothers			Fathers		
		Altruism (1)	Reciprocity (2)	Paired t-test (1)vs.(2) p-value	Altruism (3)	Reciprocity (4)	Paired t-test (3)vs.(4) p-value
Stranger distant village	Low help	0.204 (0.018)	0.211 (0.018)	0.687 N=181	0.250 (0.021)	0.230 (0.020)	0.315 N=141
	High help	0.296 (0.020)	0.300 (0.020)	0.799 N=179	0.293 (0.025)	0.324 (0.027)	0.241 N=94
	t-test p-value (low) vs. (high)	**0.001**	**0.001**		0.203	**0.005**	
Stranger same village	Low help	0.232 (0.017)	0.264 (0.017)	0.068 N=184	0.252 (0.018)	0.290 (0.018)	0.026 N=150
	High help	0.316 (0.017)	0.326 (0.018)	0.557 N=178	0.331 (0.023)	0.364 (0.023)	0.206 N=99
	t-test p-value (low) vs. (high)	**0.001**	**0.012**		**0.007**	**0.013**	

Entries represent average share of endowment transferred by help (low, high) under anonymous (altruism) and non-anomymous (reciprocity) conditions. Standard errors in parentheses. Paired t-test p-values for differences between conditions. Independent samples t-test p-values for differences between levels of help.

Table A7: Allomaternal care and cooperation toward strangers (full controls)

DV: Share sent in DG	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
			Mothers			Fathers		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Care from: Spouse	-0.004	-0.005	-0.004	-0.005	0.005	-0.001	0.019	0.012
	(0.008)	(0.010)	(0.010)	(0.012)	(0.018)	(0.019)	(0.021)	(0.020)
Care from: Kin of child	-0.014	-0.013	-0.011	-0.009	0.021*	0.021	0.013	0.013
	(0.010)	(0.014)	(0.014)	(0.017)	(0.012)	(0.017)	(0.016)	(0.019)
Care from: Non-kin	0.024**	0.025**	0.024*	0.025*	0.013	0.019	0.014	0.021
	(0.011)	(0.011)	(0.013)	(0.014)	(0.015)	(0.015)	(0.019)	(0.019)
Same village × Care from: Spouse			0.003	0.003			-0.024	-0.023
			(0.010)	(0.010)			(0.019)	(0.019)
Same village × Care from: Kin of child			0.009	0.008			0.003	0.005
			(0.009)	(0.009)			(0.015)	(0.015)
Same village × Care from: Non-kin			-0.005	-0.005			-0.004	-0.006
			(0.008)	(0.008)			(0.016)	(0.015)
Reciprocity × Care from: Spouse			-0.003	-0.003			-0.003	-0.003
			(0.009)	(0.009)			(0.016)	(0.016)
Reciprocity × Care from: Kin of child			-0.016	-0.016			0.011	0.011
			(0.010)	(0.010)			(0.012)	(0.012)
Reciprocity × Care from: Non-kin			0.005	0.005			0.003	0.003
			(0.008)	(0.008)			(0.014)	(0.014)
Same village	0.030**	0.030**	0.033**	0.032**	0.034***	0.034***	0.045***	0.044**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.011)	(0.011)	(0.016)	(0.016)
Reciprocity	0.013	0.013	0.010	0.010	0.019	0.019	0.020	0.020
	(0.010)	(0.010)	(0.012)	(0.012)	(0.015)	(0.015)	(0.019)	(0.019)
Emotional support		-0.000		-0.000		-0.031**		-0.031**
		(0.013)		(0.013)		(0.014)		(0.014)
Small financial support		0.005		0.005		0.004		0.004
		(0.012)		(0.012)		(0.015)		(0.015)
Large financial support		-0.009		-0.009		-0.014		-0.014
		(0.010)		(0.010)		(0.013)		(0.013)
Production support		-0.021		-0.021		0.023		0.023
		(0.016)		(0.016)		(0.018)		(0.018)
Church congregants		0.012		0.012		0.014		0.014
		(0.013)		(0.013)		(0.014)		(0.014)
Ln(age)		-0.032		-0.032		0.108		0.108
		(0.042)		(0.042)		(0.071)		(0.071)
Cognitive ability		-0.019		-0.019		-0.035***		-0.035***
		(0.013)		(0.013)		(0.011)		(0.011)
Consumer durables		-0.011		-0.011		-0.028*		-0.028*
		(0.010)		(0.010)		(0.016)		(0.016)
Number of kin in village		0.004		0.004		-0.000		-0.000
		(0.005)		(0.005)		(0.005)		(0.005)
Time in gardens		0.029***		0.029***		-0.022		-0.022
		(0.009)		(0.009)		(0.016)		(0.016)
Time selling in other village		-0.007		-0.007		0.001		0.001
		(0.012)		(0.012)		(0.012)		(0.012)
Witness violence (0/1)		-0.042*		-0.042*		-0.016		-0.016
		(0.021)		(0.021)		(0.029)		(0.029)
Village FE:	Y	Y	Y	Y	Y	Y	Y	Y
Villages	44	44	44	44	44	44	44	44
Observations	1444	1444	1444	1444	968	968	968	968
R^2	0.247	0.273	0.249	0.274	0.218	0.262	0.220	0.264
δ Care from: Non-kin		1.73		-2.75		3.79		-2.76
Mean DV	0.27	0.27	0.27	0.27	0.28	0.28	0.28	0.28
SD DV	0.25	0.25	0.25	0.25	0.24	0.24	0.24	0.24

* p<0.10, ** p<0.05, *** p<0.01. Unit of observation is a participant-receiver dyad in the dictator game, restricted to strangers, only. All estimates include village fixed effects. *Care* variables represent the amount of help with child care that each group provides to the participant standardized to mean zero, standard deviation one. *Reciprocity* is an indicator variable taking value one for the non-anonymous giving condition. Support variables represent the total amount of support received from the various individuals in a participant's network, normalized to mean zero, standard deviation one. Standard errors clustered at the village level in parentheses. The coefficients δ are calculated using the *psacalc* function in Stata assuming an R-max = 1.3 ∗ R^2 and represent the proportional degree of selection on unobservables needed to overturn the estimated effects. Missing observations imputed to the sample mean for control variables and all estimates include indicator variables for missing observations.

Table A8: Allomaternal care and cooperation toward strangers (people without children

DV: Share sent in DG	(1)	(2)	(3)	(4)
Child care	0.022**	0.024**		
	(0.010)	(0.011)		
Women × Child care		-0.006		
		(0.015)		
Child care from non-kin			0.004	-0.012
			(0.010)	(0.013)
Women × Child care from non-kin				0.039**
				(0.017)
Women	-0.018	-0.017	-0.017	-0.020
	(0.020)	(0.020)	(0.020)	(0.020)
Same village	0.044**	0.044**	0.043**	0.044**
	(0.017)	(0.017)	(0.018)	(0.017)
Reciprocity	0.013	0.013	0.013	0.013
	(0.017)	(0.017)	(0.017)	(0.017)
Recipient FE:	Y	Y	Y	Y
Observations	710	710	710	710
Mean DV	0.30	0.30	0.30	0.30
SD DV	0.23	0.23	0.23	0.23

* $p<0.10$, ** $p<0.05$, *** $p<0.01$. Unit of observation is a participant-recipient dyad in the dictator game, restricted to strangers. Participant sample is restricted to participants who do not have children. All estimates control for a province fixed effect, as well as whether the stranger is from a distant village and whether the transfer was anonymous (altruism) or non-anonymous (reciprocity). *Child care* represents the average amount of help with child care that parents receive in the participant's village, standardized to mean zero, standard deviation one. *Reciprocity* is an indicator variable taking value one for the non-anonymous giving condition. Robust standard errors in parentheses.

Table A9: Robustness: Allomaternal care and child vocalizations, controlling for mother stress

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Vocalizations per hour – Cortisol									
Care: Mother (Ln(Hours/week))	11.581	-1.975							-0.169
	(9.610)	(10.727)							(11.778)
Care: Father (daily)			4.279	11.970					12.196
			(12.873)	(15.223)					(16.338)
Care: Other kin of child (weekly or more)					-40.079	-39.942			-42.207
					(23.882)	(27.485)			(31.737)
Care: Non-kin (weekly or more)							48.974*	64.244*	66.063*
							(27.788)	(32.456)	(33.346)
Ln(Mother's cortisol)	-8.014	-9.723	-7.741	-10.667	-7.767	-9.757	-10.050	-11.396	-12.469
	(10.695)	(12.489)	(10.154)	(12.017)	(10.556)	(12.508)	(10.700)	(11.327)	(10.663)
Panel B: Vocalizations per hour – Cortisone									
Care: Mother (Ln(Hours/week))	8.495	-5.477							-4.229
	(8.220)	(9.771)							(11.272)
Care: Father (daily)			9.744	16.349					17.078
			(14.194)	(15.876)					(16.621)
Care: Other kin of child (weekly or more)					-35.770	-32.249			-35.620
					(22.295)	(27.173)			(32.686)
Care: Non-kin (weekly or more)							50.436*	58.975*	58.919*
							(26.026)	(30.112)	(31.746)
Ln(Mother's cortisone)	-41.991***	-33.092***	-43.925***	-33.810***	-42.608***	-31.459***	-44.378***	-30.247***	-31.489***
	(8.343)	(9.197)	(8.912)	(9.663)	(8.305)	(9.549)	(9.583)	(9.639)	(8.771)
Extended controls:	N	Y	N	Y	N	Y	N	Y	Y
USB FE:	Y	Y	Y	Y	Y	Y	Y	Y	Y
Village FE:	Y	Y	Y	Y	Y	Y	Y	Y	Y
Observations	193	193	193	193	193	193	193	193	193

* p<0.10, ** p<0.05, *** p<0.01. Unit of observation is a child recording, restricted to the sample of children for whom cortisol and cortisone measures are available for the mother. *Care* variables are indicators for whether the child receives care at the frequency indicated. All estimates include a fixed effect for the USB recording device and village fixed effects, and control the child's ln(age), gender, and mother's ln(age). Extended controls includes: child BMI, whether the mother's spouse is the biological father of the child, total number of children in the household, and the following controls for the mother: cognitive ability, number of consumer durables owned, amount of time spent working in the gardens, amount of time spent selling goods in another village, whether she has witnessed inter-village violence, and the amount of various forms of support (i.e., small and large financial, help with production, emotional support, and attend the same church) that she receives from all individuals in her network. Support variables and time working in gardens and selling goods normalized to mean zero, standard deviation one. Standard errors in parentheses, two-way clustered for village and USB recording device. Missing observations imputed for control variables and all estimates include indicator variables for missing observations of control variables.

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Table A10: Robustness: Allomaternal care and child stress

|	(1)	(2)	(3)	(4)	(5)
Panel A: ln(Cortisol) − Basic controls					
Care: Mother (Ln(Hours/week))	-0.036				-0.080
	(0.172)				(0.166)
Care: Father (daily)		-0.604*			-0.570*
		(0.337)			(0.329)
Care: Other kin of child (weekly or more)			-0.172		-0.320
			(0.379)		(0.411)
Care: Non-kin (weekly or more)				-0.662**	-0.607**
				(0.273)	(0.260)
Panel B: ln(Cortisol) − Extended controls					
Care: Mother (Ln(Hours/week))	-0.101				-0.073
	(0.113)				(0.125)
Care: Father (daily)		-0.458			-0.489
		(0.284)			(0.311)
Care: Other kin of child (weekly or more)			-0.259		-0.410
			(0.250)		(0.297)
Care: Non-kin (weekly or more)				-0.196	-0.275
				(0.288)	(0.322)
Ln(Mother's cortisol)	0.364*	0.410**	0.359*	0.370*	0.419**
	(0.188)	(0.175)	(0.183)	(0.186)	(0.185)
Panel C: ln(Cortisone) − Basic controls					
Care: Mother (Ln(Hours/week))	-0.028				-0.039
	(0.128)				(0.129)
Care: Father (daily)		0.116			0.153
		(0.167)			(0.168)
Care: Other kin of child (weekly or more)			0.162		0.161
			(0.341)		(0.350)
Care: Non-kin (weekly or more)				-0.316**	-0.345**
				(0.137)	(0.148)
Panel D: ln(Cortisone) − Extended controls					
Care: Mother (Ln(Hours/week))	-0.042				-0.068
	(0.109)				(0.114)
Care: Father (daily)		0.281*			0.312*
		(0.153)			(0.168)
Care: Other kin of child (weekly or more)			0.154		0.202
			(0.320)		(0.323)
Care: Non-kin (weekly or more)				-0.166	-0.129
				(0.200)	(0.198)
Ln(Mother's cortisone)	0.160*	0.128	0.158*	0.166*	0.121
	(0.087)	(0.089)	(0.084)	(0.089)	(0.086)
Village FE:	Y	Y	Y	Y	Y
Observations	102	102	102	102	102

* p<0.10, ** p<0.05, *** p<0.01. Unit of observation is a child. *Care* variables are indicators for whether the child receives care at the frequency indicated. All estimates include village fixed effects, and control the child's ln(age), gender, and mother's ln(age). Panels B and D include the following additional controls: child BMI, whether the mother's spouse is the biological father of the child, total number of children in the household, and the following controls for the mother: ln(cortisol/ne), cognitive ability, number of consumer durables owned, amount of time spent working in the gardens, amount of time spent selling goods in another village, whether she has witnessed inter-village violence, and the amount of various forms of support (i.e., small and large financial, help with production, emotional support, and attend the same church) that she receives from all individuals in her network. Standard errors in parentheses clustered at the village level. Missing observations imputed for control variables and all estimates include indicator variables for missing observations of control variables.

Table A11: Societal trust in the SCCS and Allomaternal care

	Societal Trust Orientation in the SCCS					
	(1)	(2)	(3)	(4)	(5)	(6)
Care by Others	0.703**	0.680**	0.677**			
	(0.283)	(0.286)	(0.294)			
Care by Fathers				0.965***	0.901***	0.901***
				(0.234)	(0.255)	(0.255)
Regional Area Fixed Effects	N	Y	Y	N	Y	Y
Geographic Controls	N	Y	Y	N	Y	Y
Community Size	N	Y	Y	N	Y	Y
Dates Pub.	N	N	Y	N	N	Y
R-squared	0.05	0.14	0.15	0.13	0.19	0.19
Observations	121	121	121	114	114	114
Mean DepVar	5.29	5.29	5.29	5.17	5.17	5.17
Sd DepVar	2.25	2.25	2.25	2.32	2.32	2.32

Notes: An observation is a society in the SCCS. Columns 2, 3, 5 and 6 report OLS estimates of Equation 7. Columns 1 and 2 report OLS estimates of Equation 7 without including X_{sr} or δ_r in the estimation. Robust standard errors are reported in parentheses (*** p<0.01, ** p<0.05, * p<0.10).

B   Appendix Figures
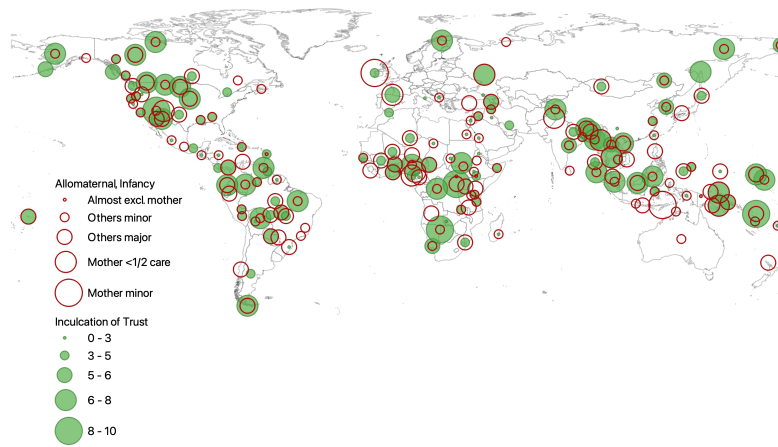
(a) Inculcation of trust and allocare from others
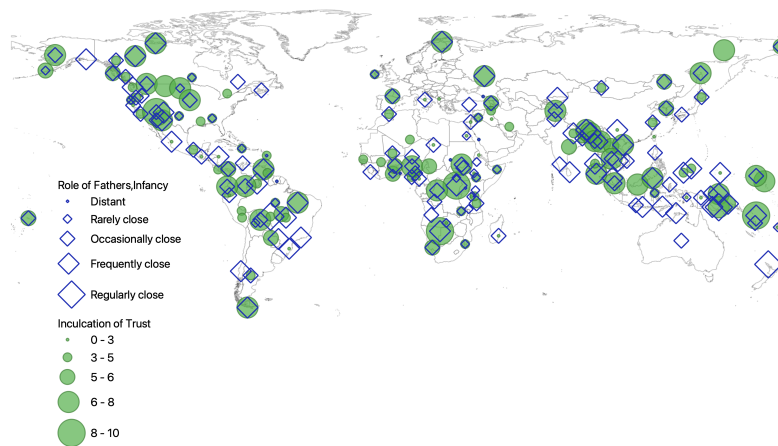
(b) Inculcation of trust and care from fathers

Figure B1: Allocare and trust in the Standard Cross-Cultural Sample (SCCS)

Notes: Allocare question come from questions v51 and v53 in the SCCS. Trust questions come from question v335 in the SCCS: importance of inculcation of trust in childhood. The Figure maps the quantiles of the distribution of this variable across the world. Source: SSCS (Murdock and White, 1969).

C Empirical specifications and robustness

C.1 Summary figures for help with child care and dictator game giving

To construct Figure 1, we limit the sample to participants with children (N=631). In panel (a), we calculate the average amount of reported help with child care from each individual in the participant's network (spouse, mother, father, sister, brother, mother-in-law, father-in-law, friend, neighbor). We conduct t-tests for differences in means between mothers' and fathers' reported help with child care, separately for each individual in their network, and report stars, which correspond to p-values, above the bars.

In panel (b) of Figure 1 we calculate the average share sent in the dictator game, both anonymously (altruism) and non-anonymously (reciprocity), to each individual in the participant's network, including strangers. We conduct t-tests for differences in altruism vs. reciprocity, for mothers and fathers separately, and report stars, which correspond to p-values, above the bars.

C.2 Regressions for child socio-cognitive and socio-emotional benefits

Our sample of child vocalizations includes 196 children. Because each child had 2 USB devices, most children have 2 observations of vocalizations. There are 18 children for whom only 1 recording is available, therefore the total sample of child recordings is N=374.

We estimate the following equation at the level of a child-recording (cr), and include controls for the mother (m) and the amount of child care provided by various kin and non-kin (k):

$$y_{cr} = \alpha + \sum_{k=1}^{4} \beta_k Care_{kc} + X'_{cm}\Gamma + \psi_r + \mu_v + \varepsilon_{cr} \tag{3}$$

where y_{cr} is the number of vocalizations per hour by child c on USB recording device r. We first introduce the amount of care from various kin and non-kin $(Care_{kc})$ separately to avoid potential issues with multicollinearity across care from different people, and then together. In all specifications, we control for the child's ln(age) and gender, as well as the mother's ln(age) in X_{cm}. We then include an extended set of controls in X_{cm}, as described in the main text: chid BMI, total number of children in the household, whether the mother's spouse is the child's biological father, the usual set of mother-level characteristics: proxy for cognitive ability, wealth, social, emotional, productive, and economic support, as well as presence of kin in the village, time spent in gardens and participation in market, and conflict exposure. We include a fixed effect for the USB device (ψ_r) to account for systematic patterns in measurement from specific USBs, as well as village fixed effects (μ_v) to account for unobservable factors that influence care and child speech at the village level. We two-way cluster standard errors by village and USB.

Our sample of child-mother pairs for whom cortisol and cortisone were measured consists of N=102 children. We estimate the following equation at the level of the child (c), and include controls for the mother (m) and the amount of child care provided by various kin and non-kin (k):

$$y_c = \alpha + \sum_{k=1}^{4} \beta_k Care_{kc} + X'_{cm}\Gamma + \mu_v + \varepsilon_c \tag{4}$$

where y_c is the natural log of the child's hormone level and $Care_{kc}$ is the amount of care provided by various kin and non-kin, including: (i) the mother (log of hours per week); (ii) biological father (indicator equal to 1 if care provided on a daily basis); (iii) other kin of the child, including the maternal and paternal grandparents, as well as the brother and sister of the mother (indicator equal to 1 if care provided on a weekly or more frequent basis); and (iv) non-kin (indicator equal to 1 if care provided on a weekly or more frequent basis). We first introduce the amount of care from various kin and non-kin separately to avoid potential issues with multicollinearity across care from different people, and then together. In all specifications, we control for the child's ln(age) and gender, as well as the mother's ln(age) in X_{cm}, and then include the set of extended controls described above, as well as mother's stress. We include village fixed effects to account for unobservable factors at the village level that influence both child care and child stress. We cluster standard errors at the village level.

C.3 Results from the Standard Cross-Cultural Sample

We use the Standard Cross-Cultural Sample (SCCS; Murdock and White (1969)) to explore whether our finding of a positive relationship between allomaternal care and prosociality generalizes at global scale.

The SCCS dataset contains close to 1,400 variables that capture various ethnographic and cultural elements. We use information on the provision of child care, which indicates the involvement of various people, including mothers, fathers, and others, in child rearing across societies. Information on child care practices is available for a subset of the societies in the SCCS.

The best proxy of allomaternal care is a question that deals with non-maternal relations' involvement in child care. To match the age range of children included in our sample, we focus on the question on the role of non-maternal relations in infancy (v51, N=162). Answers are coded from 1 to 6, with 1 capturing care "almost exclusively by mother" (in 5 societies: Azande, Callinago, Fon, Konso, and Kwoma), 5 describing societies in which the care by mothers is "minor but significant" (in 2 societies: Alorese and Irish) and 6 capturing mothers having a minimal role "except nursing" (in 1 society: Ancient Rome, a single outlier that we exclude from our analysis). Roughly half of societies have "almost exclusively" or "principally mothers" involved in infancy.

The SCCS includes a specific question on the role of fathers. We focus on the question on the role of fathers in infancy (v53, N=150). This question is coded from "distant" (in 8 societies) to "regularly close" (in 3 societies: Trobianders, Maori, and Nambicuara), with the mode of the distribution consisting in "occasionally close contact" (72 societies).

SI Figure B1 maps the distribution of responses to these two questions across the world. Involvement of others in infancy is highest in the Insular Pacific region (mean of v53: 3.5, P-value difference in means with rest of the world: 0.003) and lowest in the Circum Mediterrean area (mean: 2.5). Involvement by fathers shows less distinct geographic patterns. It is highest on average in the Insular Pacific regional area (mean: 2.66) but not statistically significantly different from the rest of the world (P-value difference in means: 0.27), and lowest in the Americas (2.43).

The SCCS also includes information on the importance of inculcating trust in children (v335, N=138, scale of 1 to 10, mean: 5.15, s.d.: 2.23), which we leverage as

a proxy for prosocial norms. SI Figure B1 overlays the quantiles of this variable with the prevalence of allomaternal care across the world. Inculcation of trust is most important in East Eurasia (mean: 6.16), followed by Africa (5.5) and the Insular Pacific (5.35), and lowest in the Circum-Mediterranean region (mean: 3.88).

Each panel in Figure 3 plots the conditional expectation function of societal trust orientation conditional on allomaternal care provision in infancy by others (Panel a) and specifically by fathers (Panel b), controlling for region fixed effects (v200 in the SCCS: Africa, Circum-Mediterranean, East Eurasia, Insular Pacific, North America, South America), log mean yearly average rainfall (v1913), log mean annual temperature (v186), and mean size of local communities (v63), which could influence both child care arrangements and social preferences.

In other words, we estimate the following multivariate OLS regressions at the level of a society (s) in the SCCS:

$$Trust_{sr} = \alpha_1 + X'_{sr}\Gamma_1 + \delta_{1r} + \varepsilon_{1sr} \tag{5}$$

$$CareInfancy_{ksr} = \alpha_{2k} + X'_{sr}\Gamma_{2k} + \delta_{2kr} + \varepsilon_{2ksr} \tag{6}$$

where $Trust_{sr}$ is the average trust orientation of society s in region r, and $CareInfancy_{ksr}$ for $k = 1, 2$ measures, alternatively, the involvement of others ($k = 1$) and of fathers ($k = 2$) in infancy. X_{sr} is a vector of society-level characteristics that could be correlated both with child care practices and with societal trust orientation, such as climatic conditions or community size; and δ_r is a set of regional area fixed effects.

Figure 3 plots the mean estimated residuals $\varepsilon_1 sr$ against, alternatively, the mean estimated residuals ε_{21sr} (Panel (a)) and the mean estimated residuals ε_{22sr} (Panel (b)), averaged in equal-sized bins. The Figure also displays the best linear fit line, constructed from an OLS regression of the y-residuals $\varepsilon_1 sr$ on the x-residuals ε_{21sr} (Panel (a)) or ε_{22sr} (Panel (b)). The slope of the fit line matches the coefficient of the following multivariate OLS regression:

$$Trust_{sr} = \alpha + \beta CareInfancy_{ksr} + X'_{sr}\Gamma + \delta_r + \varepsilon_{sr} \tag{7}$$

of societal trust orientation on the corresponding $CareInfancy_{ksr}$ variable for $k = 1, 2$, controlling for the same set of controls and fixed effects as in equations (5) and (6). To address potential criticisms of the SCCS related to the underlying variation in the time at which each society was observed and in the timing of publication of the different ethnographies and documents used to assemble the SCCS, we also present the results of specifications in which we additionally include in X_{sr} the date at which the society was observed (variable *focyear*), and the publication date of the study dealing with a given society (*v802*).[20]

Controlling for region fixed effects δ_r, climatic conditions, and community size, the point estimates suggests that a one unit increase in allomaternal care (e.g. going from "almost exclusively mothers" to others having a "minor role", or from a "minor role" of others to a "major role") is associated with a 0.68 unit increase in the importance of inculcating trust, a 12.85% increase at the mean. The coefficient is statistically significant at the 5% level. A one unit increase in care by fathers e.g. going from "rarely" to "occasionally" close or from "occasionally" to "frequently" close) is associated with a 0.90 unit increase in the importance of inculcating trust, a 17.40% increase at the mean. The coefficient is statistically significant at the 1% level. These estimates, which correspond to the estimates obtained from estimating equation (7), are displayed in Columns 2 and 4 Table A11 below. Estimates without regional areas fixed effects or any other controls, which are displayed in Columns 1 and 3, are very similar.

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[20]For missing values of *v802*, we impute 0 values and include a an indicator variable for missing observations as an additional regressor in X_{sr}.