Fertility Transitions

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Abstract

Demographic transitions in contemporary human societies have profound impacts on our social and economic lives (Dyson, 2010). Across the population sciences, there are abundant empirical observations, but few causal explanations, of fertility transition. The seeming contradiction between observed fertility patterns and fitness-maximization assumptions pose a significant challenge for evolutionary theorists. In this chapter, we explore evolutionary theories that can potentially help address this deep theoretical challenge. We argue that cultural evolutionary approaches can tackle aspects of fertility transitions that other approaches neglect. Finally, to bridge divides between evolutionary and non-evolutionary perspectives, we highlight intersections between cultural evolutionary theory and other social, economic, and political sciences.

Keywords: demographic transition, fertility decline, human reproduction, cultural evolution

1 Demographic Transition: An Overview

Demographic transition refers to the long-term population trends in human societies in which birth rates and death rates fall from high to low values along with "modernization" and economic development (Notestein, 1945; Thompson, 1929; Kirk, 1996). Together with the Industrial Revolution, these two historical phenomena are associated with tremendous economic growth and consequent social and political transformation, shaping the contours of the modern world. The sustained economic and income growth we are used to today was not possible before around the 19th century, when humans are assumed to have been in a "Malthusian trap" or fluctuating equilibrium (Malthus, 1798) under which any extra agricultural production was immediately consumed by the additional growth of population size, leading to "natural checks" on further population growth (though see Boserup, 1975; 1976 for an alternative explanation). New technologies and manufacturing processes brought about by the Industrial Revolution, combined with more saving and investment per capita brought by lower fertility (Coale and Hoover, 1958; Higgins and Williamson, 1997; Oppenheim Mason, 1997; Bloom and Canning, 2001) are argued to now exempt us from this trap.

Demographic transitions have immense social and economic implications for our world (Reher, 2011). For example, most of the global population now lives in countries where fertility rates will hardly replace the population. Shrinking, ageing and long-lived populations are expected to significantly increase labor shortages and impact pension systems, decreasing income and economic growth, social mobility, health care quality, and living standards in the future.

While "demographic transition theory" (Thompson, 1929; Notestein, 1945; Kirk, 1996) highlights several stages for this phenomenon, the transition is basically determined by two major forces: mortality decline and fertility decline. In the course of economic development and modernization, mortality drops first while fertility remains high, resulting in rapid population growth. Fertility rates then begin to fall, slowing down population growth and changing the age structure, from younger to older (Chesnais, 1990).

Mortality decline has received a great deal of attention (see Wilson, 2011) and we have a relatively good grasp of its causes: improvements of farming techniques, food production, and public sanitation contributed massively to the reduction of diseases and the increase of life expectancy. The reasons for fertility decline, on the other hand, remain complex despite appearing straightforward. At the macro level, indexes of development like HDI (human development index), are strongly and negatively associated with fertility rates (Lee, 2003; Bryant, 2007; Myrskylä et al., 2009), both across countries and over time within countries. It is therefore not surprising that the constituent measures in the HDI, namely, per capita income (Luci and Thévenon, 2011; Myrskylä et al., 2009; Barthold et al., 2012), education level (Lutz and Kc, 2011; Axinn and Barber, 2001), and life expectancy (Lutz et al., 2006; Luy et al., 2019) are all negatively correlated with fertility rates. Other correlates of fertility rates include child mortality, religiosity, urbanization and population density (Lutz et al., 2006), income inequality (de la Croix and Doepke, 2003), gender equality (Myrskylä et al., 2013; Feyrer et al., 2008; McDonald, 2000), and family planning uptake (Cleland and Wilson, 1987).

At the micro level, individual low fertility is correlated with high male and female education, in turn associated with lower mortality, longer life expectancy and higher child survival rates, and these effects are stronger in high fertility countries (Lutz and Kc, 2011; Basu, 2002). Fertility is also proximately regulated by later ages at first birth and greater control over reproductive spacing and stoping behavior. In many cases, these practices are facilitated by contraceptive use (Cleland, 2009) and constrained by some "intermediate" fertility variables such as induced and spontaneous abortion, fecundability (the ability to conceive), and marriage (Bongaarts, 1982). With greater autonomy granted by changes of either labor participation or contraception methods, women appear to exercise more "control" over their reproduction and their desired family size decreases as macro-level development proceeds (Goldstein et al., 2003; Pritchett, 1994).

But fertility decline is not solely driven by socioeconomic factors, it also diffuses like an epidemic (Rogers, 1995b; Rosero-Bixby and Casterline, 1993; Spolaore and Wacziarg, 2022, see Cleland, 2001 and Colleran, 2016 for review). There is overwhelming evidence to suggest that fertility decline is spread by social interactions, both between individuals and between neighboring countries and regions. Moreover, fertility decline is diffused between countries at increasingly lower levels of economic development (Bongaarts and Watkins, 1996; Montgomery and Casterline, 1996), with different cultural settings influencing the patterns of diffusion and onset of fertility decline (Knodel and van de Walle, 1979). Thus fertility levels can vary greatly between neighbouring areas with similar socioeconomic characteristics (Lesthaeghe, 1977, 1983; Alvergne and Lummaa, 2014; Colleran et al., 2014). Indeed, the patterning of contraceptive uptake cannot be understood without assuming that new ideas are diffused along established communication lines, by migration and the mass media, which can readily cross international borders (Barber and Axinn, 2004; Behrman et al., 2002; Watkins, 1991; Cleland and Wilson, 1987). Contraceptive uptake is especially linked to micro level social interactions within social networks (Montgomery and Casterline, 1996; Rogers and Kincaid, 1981; Mace and Colleran, 2009; Colleran and Mace, 2015; Alvergne et al., 2011; Colleran, 2020). The evident connections between sociocultural factors and demographic transition indicate that the process could be driven by the diffusion of new ideas and changes in perceptions (Axinn and Yabiku, 2001; Oppenheim Mason, 1997; Cleland and Wilson, 1987; Colleran, 2016).

Despite ample evidence for the above factors, they are mostly correlational indicators and few of them can be causally separated from one another. This means that what appear to be law-like patterns in fertility change across and within populations are associated with everything all at once. Our poor understanding of causality is clearer if we look at the temporal relationships of these factors. Although one of the major efforts by the Princeton European Fertility Project (Coale and Watkins, 1986) marks the historical fertility decline at around 1830s in France, several other studies in economic history consistently found even earlier records of the onset to be around 1770s in French rural areas (Spolaore and Wacziarg, 2022; Blanc and Wacziarg, 2020; Cummins, 2013; Hadeishi, 2003; Weir, 1995). However, none of the correlates for fertility decline mentioned above seemed to be operating during this earlier period. For example, child mortality is often argued to be the most important explanation for fertility transition (e.g., Notestein, 1945). But in historical France, it was net fertility (i.e., average number of births minus deaths) that was declining (Blanc and Wacziarg, 2020). And in the 19th Century U.S., there was no meaningful fall of mortality before fertility decline (Haines, 1994; Guinnane, 2011): this occurred only after 1900s when improved medical science led to greater longevity (McKeown, 1976; Fogel, 2004; Deaton, 2006). Overall, our understanding of the causes of fertility decline remains limited, particularly when we examine a multitude of complications at different levels of aggregation and the temporal relationships of various factors.

2 Evolutionary Perspectives

Fertility transitions are even more puzzling from an evolutionary perspective. Why does a great ape that outcompeted and out-reproduced its competitors, whose population size exploded with the advent of agriculture (the "Neolithic demographic transition", see Bocquet-Appel, 2011), reduce its fertility exactly when the environmental conditions for reproducing are the best in its entire history? Why does the process begin in the richest, most long-lived strata of society, and why is it more dramatic there (see Clark and Cummins, 2009; Livi-Bacci, 1986)? How can voluntary reductions in fertility be in line with Darwinian fitness (Borgerhoff Mulder, 1998; Colleran, 2016)?

In a 1986 paper, Vining suggested that this conundrum is an evolutionary paradox, the now oft-cited "central theoretical problem of human sociobiology" (Vining, 1986). Though this claim may be somewhat of an overstatement (see invited comments in Vining, 1986; Borgerhoff Mulder, 1998; Alvergne and Lummaa, 2014; Stulp and Barrett, 2016), Vining's clarion-call sparked debate about the fundamental causes of demographic transitions from an evolutionary perspective (Mace, 2000; Lawson and Mace, 2011; Shenk, 2009; Borgerhoff Mulder, 1998; Colleran, 2016). Standard demography, though empirically rich, has not produced a fundamental and unifying theoretical framework for understanding why fertility declines. Evolutionary researchers should therefore be well-positioned to fill this gap. Yet convergence on a single evolutionary explanation has not occurred, mainly because of differing assumptions about the mechanisms giving rise to low fertility, the question of whether fertility decline is adaptive or not, a tendency for researchers to focus on either socioeconomic or sociocultural factors and on individual versus population-level effects (Colleran, *Forthcoming*).

There are at least three starting points for an evolutionary approach to fertility decline. First, fertility decline could be the result of a mismatch between an evolved psychology and contemporary environments. Evolutionary Psychology (EP) asserts that our psychological biases evolved in ancestral environments over the last two million years, and that evolved strategies for achieving status and sex are therefore not adapted to the radical changes in modern industrialized economies (Cosmides and Tooby, 1987; Tooby and Cosmides, 1990; Buss, 2019). This "adaptive lag" (Laland et al., 2016) leads to low fertility when efficient contraceptives became available (Pérusse, 1993), cutting the link between sex and reproduction. From this perspective, fertility decline is simply a "maladaption", where our previously-adaptive psychology has not yet caught up with environmental change, and is not expected to maximize genetic fitness. This view, however, needs to demonstrate: (1) why fertility-limiting behavior has not been selected out of the population; (2) why fertility started to decline in historical Europe even before modern contraceptives emerged (e.g., Spolaore and Wacziarg, 2022; Blanc and Wacziarg, 2020), and (3) must reconcile the fact that the availability of contraceptives does not necessarily lead to their uptake (Polgar and Marshall, 1976; Marshall, 1977; Levine, 1983) and fertility decline (Alvergne et al., 2013; Mace and Colleran, 2009; Bledsoe, 2002).

A second approach views low fertility as an adaptive strategy under contemporary environments. Taken by many human behavioral ecologists (HBEs), this approach stresses analysis of the costs and benefits of reproductive behavior in any context, but also the potential maximization of genetic fitness over multiple generations. The currencies of fitness being maximized include future gene representation (i.e., the number of descendants), the "quality" of offspring, or the accumulation of wealth over generations (see more detail in next section).

A third approach views fertility behavior as fundamentally shaped by information that is socially acquired, and is therefore the outcome of cultural evolutionary (CE) processes in structured environments. Thus, cultural processes may follow Darwinian principles, but may nonetheless be maladaptive and not fitness-maximizing. In fact, asymmetric transmission of information, biases in the ways that individuals acquire social information, structural change in social interactions, or between-group competition, can all spread norms and values that lead to fitness-limiting behavior. Since both individual-level mechanisms and group-level dynamics are jointly considered, this approach offers a multi-level perspective that can engage both individual-level mechanisms and longer-term population dynamics.

Importantly, although most evolutionary research on demographic transition is concerned with comparing the explanatory weight of hypotheses from HBE and CE (Lawson and Mace, 2011; Shenk, 2009; Borgerhoff Mulder, 1998), many researchers now agree that socioeconomic and sociocultural factors are too deeply intertwined to be isolated from one other (Oppenheim Mason, 1997; Easterlin and Crimmins, 1985; Lesthaeghe, 1983; Caldwell, 1976). In fact, these two frameworks make overlapping assumptions and predictions, as others have pointed out (Shenk, 2009; Borgerhoff Mulder, 1998; Colleran, 2016; Colleran, *Forthcoming*), so they are not mutually exclusive (Smith, 2000). In many cases, the assumptions of HBE and

CE are complementary in explaining demographic transition to low fertility. In the next two sections, we explore these two theoretical frameworks in more detail.

3 Human Behavioral Ecology

Human behavioral ecology (HBE) is concerned with the evolution of human behavior as a response to ecological conditions (Nettle et al., 2013). The area centers on the concept of fitness maximization and adaptation, and attempts to explain behavioral variations among and across human populations. The general questions human behavioral ecologists ask include: how behavior influences an individual's survival, why (in terms of evolutionary function) a particular behavior is present over others, and how the functions and outcomes of behavior are moderated by different environmental contexts.

HBE centers around the assumption that humans adapt to specific ecological contexts to maximize their genetic representation in future generations. According to life-history theory (Kirkwood et al., 1991; Roff, 1992; Stearns, 1992), individuals allocate their limited time and energy budgets into a series of life events — birth, maturation, reproduction, death, etc. This involves fundamental trade-offs. For example, reproducing reduces the energy available to spend on somatic maintenance, puts stress on maternal survival and nutritional condition (Tracer, 1991), or reduces lifespan (Lund et al., 1990; Westendorp and Kirkwood, 1998). Individuals must therefore make cost-benefit decisions when achieving their goals (Stearns, 1989; Lawson and Mace, 2011; Mace, 2000; Voland, 1998; Cronk, 1991; Borgerhoff Mulder, 1992), including parental investments in their own (Williams, 1957; Stearns, 1989) or their children's survival (Hobcraft et al., 1983), when and how often to have children (Blurton Jones, 1986), how many children to have, and how many resources to allocate to each of them (Lawson and Mace, 2011).

These fundamental trade-offs are reflected empirically in the facts that (1) humans almost never exhibit maximal biological fertility (Lawson et al., 2012; though see Strassmann and Gillespie, 2002 for an exception), (2) that very high fertility only appears to be sustainable in agricultural societies (Bentley et al., 1993; Bocquet-Appel, 2011) where the costs of reproduction can be partially compensated via food storage and reduced mobility (Bocquet-Appel, 2011), and (3) tight birth intervals (Blurton Jones, 1986) and high fertility (Strassmann and Gillespie, 2002; Lawson et al., 2012; Penn and Smith, 2007; Meij et al., 2009; Gillespie et al., 2008) are typically negatively associated with offspring survival, even though lowering fertility to improve child survival does not translate into greater lifetime reproductive output of parents (Lawson et al., 2012; Penn and Smith, 2007; Meij et al., 2009; Gillespie et al., 2008; see Strassmann and Gillespie, 2002 as an exception).

3.1 Reproductive Trade-offs

Given these considerations, many researchers, both in the evolutionary and social sciences like economics, view low fertility as a parental investment trade-off between offspring quality and quantity, where every unit decrease in quantity is assumed to lead to an increase in "quality" (Becker, 1960; Becker and Lewis, 1973). While quantity is easily measured, quality can refer to different things in different disciplines or even socio-ecological contexts.

In the evolutionary literature, "quality" usually refers to "expected reproductive success" (Grafen, 1998; Goodman et al., 2012), and some researchers measure this in terms of levels of individual capital (i.e., different forms of wealth). Borgerhoff Mulder and Beheim (2011) (see also Borgerhoff Mulder et al., 2009) categorize three types — embodied, material, and relational capital. Each could have different relationships with fertility and parental investment depending on the economic context.

For example, lowering fertility can potentially raise an individual's physical wellbeing, increasing their embodied capital (Kaplan et al., 1995; Kaplan, 1996). Somatic states like body mass, strength, and immune system could work as fitness-enhancing currencies (Kaplan et al., 1995) in a foraging niche. On the other hand, in market-based economies with low mortality and longer life expectancies, embodied capital such as knowledge and skills (which economists call "human capital") are more valuable, contributing to an individual's ability to thrive, find a partner, and potentially reproduce (Kaplan, 1996). This argument resonates strongly with economic theories on parents' fertility decisions (Becker, 1960; Becker and Lewis, 1973) in industrial societies, and is viewed as the main driving force of the fertility decline.

In contrast to both foraging and market-dependant environments, pastoral and agricultural societies might rely relatively more on "material capital" (e.g., land, livestock, consumption goods, money), which can be stored, accumulated, and transferred to children across generations. This creates a positive correlation between wealth and fertility in pre-demographic transition societies (Borgerhoff Mulder, 1987; von Rueden et al., 2011). Because of the differences in the nature and value of different wealth currencies, this positive association is weaker in industrial settings (Nettle and Pollet, 2008; Hopcroft, 2006, 2015; Colleran et al., 2015).

Embodied and material capital can be "rival", such that the amount of one type of capital transferred to one child is no longer available to another child. This might lead to diversification of offspring capital within a family. Such parental investment trade-offs could therefore diminish the benefits of having large numbers of children. In contrast, relational capital does not necessarily suffer this limitation. Parents' social networks — whether for food-sharing, hunting or foraging, or other forms of help — can be shared among siblings and do not necessarily diminish with the number of children.

3.2 Wealth Inheritance and Intergenerational Mobility

Depending on the context and production mode, having more or fewer children may be beneficial for parents in terms of wealth flows across generations. Caldwell (1976, 1978, 1982) highlighted that wealth does not always flow "down" the generations: it can in fact flow from children to parents via child labor, and that this is especially important under peasant farming or in traditional agricultural economies (Caldwell, 1978). High fertility can be beneficial in this context.

But when populations are becoming more market-integrated, both embodied and material capital can play different, complex roles in children's success — reproductively or socio-economically. Theoretical models have shown that low fertility could coevolve with (material) wealth accumulation if reproductive success is tied to the amount of heritable wealth (Hill and Kern Reeve, 2005; Mace, 1996, 1998; Rogers, 1990) — this is important in economies with wealth transfers (dowry, brideprice) at marriage. For example, Mace (1996, 1998) combined dynamic models with ethnographic data to show that the wealth requirements of both marriage and the costs of raising children can decrease optimal fertility to very low levels. Rogers (1990) similarly showed, assuming a different economic context, that long-term fitness could theoretically be increased by lowering fertility in the short-run, though he was unable to obtain the same result in a more realistic model (Rogers, 1995a). Following Lack (1968), Grafen (1998) showed that if individuals differ in their reproductive value (i.e., expected reproductive success), parents should exhibit reproductive restraint to maximize the "value" of their children instead of the absolute number. This pursuit of reproductive value generates a null or negative relationship between wealth and fertility in post-demographic transitions (Grafen, 1998).

Empirically, studies that have tried to find long-term fitness advantages for low fertility have not been successful, though they do typically find evidence for wealth accumulation over successive generations (Kaplan et al., 1995; Mueller, 2001; Goodman et al., 2012). Yet in order for low fertility to be genetically advantageous, there must be a fitness payoff to having high-quality children over multiple generations. It is unclear at present how many generations should be considered, and whether children really differ in their reproductive value.

Lowering fertility for long-term reproductive success may be further driven by social stratification. Since the dilution of resources between large numbers of children increases the chances of downward intergenerational social mobility (i.e., ending up in a "lower" social class than one's parents) in a stratified society, low fertility may be a strategy for avoiding this outcome and/or increasing the chances of upward social mobility (Lesthaeghe, 1977; Van Bavel, 2006; Van Bavel et al., 2011; Harpending and Rogers, 1990). Harpending and Rogers (1990) show that small family sizes have evolved to avoid downward social mobility when different social classes have differential reproductive outcomes. In their model, individuals in lower social strata could end up with lower long-term (i.e., multi-generational) fitness than individuals in higher strata, despite having more offspring in the first generation. Also, downward mobile individuals from the poorer stratum could end up in a "destitute" social class, or a "reproductive sink", at the bottom of the hierarchy, without being able to reproduce (Harpending and Rogers, 1990). Thus, relatively poorer individuals can achieve higher long-term fitness by getting even one of their offspring into a higher social class. As a result, natural selection should favor poorer individuals who reduce fertility to invest in their offspring's upward social mobility. In turn, the wealthy could reduce fertility to avoid downward social mobility due to the dilution of resources.

Harpending and Rogers (1990) claim that reproductive "destitution" of the sort assumed in their model would have existed in European cities during early demographic transitions, but individuals could have been removed from the reproductive pool via out-migration. Nevertheless, it is unclear whether such absolute destitution was or remains widespread in contemporary less developed countries, since the existence of modern social welfare systems may mitigate the risks of reproductive failure. Therefore, despite evidence of fertility limitation as a response to poverty (Gurmu and Mace, 2008), further data is needed to establish the existence of a "reproductive sink" and a fitness disadvantage to downward social mobility.

Notwithstanding this caveat, there is an empirical association between family size and intergenerational mobility. In two studies of nineteenth century Belgium, Van Bavel and colleagues (2006; 2011) found that larger families experienced greater dilution of resources, and individuals with larger numbers of siblings had higher chances of downward mobility, independent of parental social status and birth order. Although low fertility seems to be a way to avoid downward mobility for the wealthy and the middle classes, the same strategy is not used by the poor to gain upward mobility (Van Bavel et al., 2011).

Consistent with this, Skjærvø et al. (2011) show that among historical Norwegians in the early nineteenth century, women moving down a social class had significantly lower lifetime fertility than women who moved up from an initially lower social class. Also, women who maintain their position in the highest class had the highest lifetime fertility. In other words, downward mobility is more costly than upward mobility is beneficial. This fits with the well-documented phenomenon that the wealthy tend to initiate fertility decline earlier and often more dramatically than the poor (Livi-Bacci, 1986).

3.3 Environmental Risks

Reproductive trade-offs are always subject to environmental changes. For example, Winterhalder and Leslie (2002) and Leslie and Winterhalder (2002) argue that individual reproductive output is risk- or variance sensitive. That is, individuals may over-produce when mortality uncertainty is high and under-produce when it is low. Liu et al. (2012) similarly argue that fertility decline may be a response to the reduced risk of breeding failure (i.e., not raising any offspring to maturity) rather than a direct response to mortality declines. As uncertainty about offspring survival to reproductive age goes down, the "required" threshold of fertility to avoid maternal "breeding failure" is also reduced. Using historical multi-generational data from Finland, they show that the number of children raised to reproductive age per mother remained relatively constant from 1880 to 1970. But since the reductions in the risk of "breeding failure" preceded reductions in fertility, actual fertility was higher than "required" fertility in each decade. They estimated this risk to be extremely low even for women who began reproducing at a relatively late age and who had one child. This study suggests that reducing the risk of reproductive failure may play an important part in fertility decline.

Reduced fertility may also trade-off with greater survivorship under periodic environmental crises. Boone and Kessler (1999) show that if population history is characterised by climatic or other stochastic events, individuals can increase the probability of lineage survival by having fewer offspring and expending more on their surviving capacity or social status (see Low et al., 2002; Low et al., 2003, and Shenk et al., 2016 for similar arguments). It is easy to imagine when resources become scarce or limited in a population bottleneck, access to them is likely to be inequitable and favor the wealthy and/or high status individuals (Low et al., 2002; Low et al., 2003, see also Boone and Kessler, 1999). Given the extreme climatic and environmental variation experienced during the Pleistocene, such bottlenecks are plausible. However, stochastic fluctuations of such magnitude were unlikely since the Neolithic period, so the enormous increases in fertility during the Neolithic transition could represent a relaxation of this trade-off.

3.4 Social Interactions and Kinship

Reproductive decisions are not only about optimal energetic investments. They include strategic considerations within a social environment, and parents might adjust their fertility decisions based on others' behavior. For example, Shenk et al. (2016) show that under high inequality and intense competition for status, higher parental investment in embodied capital and social status may lead to lower fertility. A number of theoretical models have also shown that competition between lineages for survival, rather than individual maximization of fitness, may be responsible for the evolution of low fertility (Boone and Kessler, 1999; Grafen, 1998; Low et al., 2002; Hill and Kern Reeve, 2005). For example, Hill and Kern Reeve (2005) show that above the minimum threshold of investment (zero) needed to ensure offspring lineage success, a "snowballing resource competition" can develop between individuals within a population. This leads to ever-increased investment in the resource-earning potential of ever-decreasing numbers of children.

Competition for heritable assets among siblings can also lead to low fertility (Kaplan, 1996; Kaplan et al., 2002; Lawson and Mace, 2009, 2010a, 2011). There is evidence that mental health (Lawson and Mace, 2010b), height (Lawson and Mace, 2008), educational achievement (Desai, 1995), and parental care (Lawson and Mace, 2009) are compromised by sibling competition in larger families. Producing fewer offspring may ensure survival (Hill and Kern Reeve, 2005; Boone and Kessler, 1999) and accommodate the increasing cost of having children in wealthier environments or post-transition societies (Mace, 1998). On this interpretation, low fertility becomes a strategy to reduce the dilution of resources and to alleviate sibling competition.

Sibling competition may also be exacerbated by the level of wealth or development in a society (Lawson and Mace, 2010a). HBEs have shown that in the early stages of demographic transition, wealthier families invest relatively more in "embodied" capital such as education, but they also begin to discriminate more between children in their allocation of resources (Gibson and Sear, 2010). Sudden changes in land availability or rural development initiatives can also create novel competition between siblings for parental investment (Gibson and Gurmu, 2011). In wealthy populations where uncontested "basic" cushions against absolute poverty such as medical care and social welfare are available, competition between offspring for the "surplus" resources in wealthy families may increase (Lawson and Mace, 2010a; Downey, 2001).

Reproductive outcomes are therefore often the result of negotiations between the conflicting reproductive interests of multiple kin, and should be understood within the "kinship ecology" (Leonetti et al., 2007; Leonetti and Nath, 2009) as a whole (see Grafen, 1984). For example, siblings may act as non-reproductive "helpers at the nest", forfeiting their own reproduction in assisting that of their siblings (Kramer, 2005, 2010; Crognier et al., 2001, 2002; Turke, 1988). Siblings may compete for limited parental resources that are necessary for their future reproductive success (Trivers, 1974), but this competition can be relaxed if extended kin step in to help (reviewed in Sear and Mace, 2008). There may also be reproductive conflict between different generations of females who trade off their own reproduction for their daughters' and daughters-in-law's reproduction. This pattern may have led to the evolution of human menopause and post-reproductive lifespans (Lahdenperå et al., 2012; Mace and Alvergne, 2012; Cant and Johnstone, 2008; Voland and Beise, 2005).

Various kin may have differential reproductive and investment strategies, which are observable in the fertility outcomes of reproducing women (Sear and Coall, 2011; Sear and Mace, 2008, see also Fox et al., 2010). The general patterns indicate that maternal kin tend to be associated with increases in offspring "quality" and paternal kin with increases in offspring "quantity" (for review see Sear and Coall, 2011; Sear and Mace, 2008).

Also, males and females may have evolved different reproductive and mating strategies (though see Moya et al., 2016 for a critique). A prominent explanation for these patterns centers on differences in paternity confidence and relatedness — they experience different costs to reproduction, and have different levels of confidence in their relatedness to their offspring, as a man can never be 100 percent certain that his offspring are his own (Trivers, 1972).

Inclusive fitness theory implies that both direct and indirect reproduction (i.e., enhancing the reproductive success of other related individuals) contribute to future genetic representation in a population (Hamilton, 1964; Grafen, 1984). Empirically, kin have been shown to have important effects on infant survival (reviewed in Sear and Mace, 2008), female fertility (reviewed in Sear and Coall, 2011), and to some extent, contraceptive use (Borgerhoff Mulder, 2009; Leonetti et al., 2007, though see Mace et al., 2006; Mace and Colleran, 2009; Alvergne et al., 2011). Kin interactions enable humans to outpace the reproduction of other great apes despite a shorter reproductive window, and give rise to uniquely human life history characteristics (elongated childhood, extensive allocare and lengthy post-reproductive lifespans). Undeniably, kinship appears so important to our success as a species that many now consider homo sapiens an obligate "cooperative breeder" (Alexander, 1974; Hrdy, 1999; Hrdy, 2007; Hrdy, 2009; Mace and Sear, 2005; Sear and Mace, 2008; though see Strassmann and Kurapati, 2010; Strassmann, 2011 for critique. See also Clutton-Brock, 1991).

3.5 Summary

HBE is a powerful framework that has contributed significantly to our understanding of reproductive behavior. At its core, the optimality model of human behavior assumes that individuals are rational actors who make reproductive trade-offs based on complete information and perfect cognitive capabilities (Colleran, *Forthcoming*). Despite its strengths, some of the predictions made by the optimality model have only limited empirical support (see Lawson and Mulder, 2016 for a review). For example, the trade-offs between fertility and offspring survival or long-term reproductive success may not always follow the patterns predicted by the model. Additionally, measuring key concepts like reproductive value remains challenging. To gain a deeper understanding of fertility transitions, future research needs to identify which factors come into effect only in post-transitional era. By accounting for the historical and cultural contexts that shape human behavior, researchers can build more comprehensive models that better capture the complexity of human reproductive decision-making.

4 Cultural Evolution

CE studies social and behavioral changes due to information acquired from conspecifics in a population. Defined as socially transmitted information, culture (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985), on this model, spreads via the interaction of various modes of transmission at the population level and learning biases at the individual level (Colleran, *Forthcoming*).

CE highlights different transmission modes, of which oblique and horizontal transmission is especially crucial in explaining low fertility behavior. Combined with learning biases such as indirect and conformist biases, these can in principle accelerate the spread of the genetically maladaptive behavior that does not promote Darwinian fitness.

Unlike models assuming optimality at the individual level in HBE or economics, CE theory does not necessarily assume specific forms of utility or payoff functions at the individual level. Instead, it looks at trait frequencies in the population and stresses more the structured (demographic or social) and constructed aspects of social environments (e.g., norms, values, and traditions) which operate at both the individual and group level.

4.1 Transmission Modes of Fertility Values

To illustrate how different modes of transmission affect demographic behaviour, we can consider that women probably inherit reproductive behavior, values and norms initially from their parents, especially their mothers, via vertical transmission. Empirically, fertility and its intermediate indicators such as age at marriage and age at last birth are positively correlated between mothers and daughters (Anderton et al., 1987; Murphy, 1999; Murphy and Wang, 2001; Reher et al., 2008; Jennings et al., 2012), and these associations are especially substantial in the post-demographic transition era (Murphy, 1999; Reher et al., 2008; Jennings et al., 2012). Although some argue this is a genetic process (Bocquet-Appel and Jakobi, 1993; Kohler et al., 1999; Madrigal et al., 2003; Blum et al., 2006; Pettay et al., 2005; Kosova et al., 2010), numerous studies suggest that transmissions of reproductive-related values (e.g., ideal family size, contraceptive use), childrearing practices (e.g., prolonged breastfeeding) and childrearing environments (e.g., help from mothers or other family members) are important social mechanisms increasing observed intergenerational similarities (Jennings et al., 2012; Reher et al., 2008).

On reaching maturity, women are often exposed, via their social interactions, to the reproductive norms of non-kin in their social environments (e.g., Balbo and Barban, 2014; Colleran, 2020). In contrast to genetic inheritance, this allows oblique and horizontal transmission of norms from non-parental individuals to additionally shape behaviour. Since non-kin have no genetic stake in a woman's reproductive success according to inclusive fitness theory (Hamilton, 1964), they may be less pronatal as compared to kin (Newson et al., 2005). Using a role-play experiment, Newson et al. (2007) finds empirical support for a "kin influence hypothesis" (Newson et al., 2005) — participants primed to role-play a mother were more pronatal than those who were not.

Apart from reproductive attitude, oblique and horizontal transmissions also act as channels for spreading knowledge and practices about contraceptive use (Gayen and Raeside, 2010; Colleran and Mace, 2015; Kendal et al., 2005), health services, childcare alternatives, or even the compatibility between parental roles and labor force participation (Montgomery and Casterline, 1996). For example, during the 1950s, U.S. women were not expected to work until their children reached school age. Along with industrialization and attitudinal change, it became more acceptable for a woman to balance family and employment, and the percentage of parents who believed "a pre-school kid is likely to suffer if his/her mother works" gradually decreased over time (Rindfuss and Brewster, 1996). Without sound family policies such as mandated paid leave, however, the incompatibility between labor participation and childrearing responsibilities drove down fertility. It was not until institutionalized childcare became widely available, allowing women to combine work and parenthood, that the fertility rates started to climb.

4.2 Modernization

In explaining fertility transitions, it is crucial to highlight the role of modernization, which brings tremendous structural change in social networks due to urbanization, mass communication, commercial activities, migration, education and employment. When non-kin/peers make up a higher proportion of individual social interactions, their relative influence becomes more prominent. Non-kin are assumed by evolutionary anthropologists to be less pronatal, opening up the possibility for them to be the driving force of low fertility behavior in contemporary social networks (Newson et al., 2005, 2007; Newson, 2009; Newson and Richerson, 2009; Colleran, 2020). Compared to vertical transmission, oblique and horizontal transmission between non-kin/peers have an asymmetric feature whereby one individual can transmit information to many individuals (Cavalli-Sforza and Feldman, 1981), and this can make the spread of new cultural traits even more efficient in modern societies.

Prestige bias (Henrich and Gil-White, 2001) may be particularly important in contemporary market economy, where individuals compete to attain higher social status. The competitive environment of modernization creates opportunities for individuals in high-prestige positions, such as teachers, to become "social models" that others imitate. This imitation is not limited to practices related to status-seeking, such as education, but also extends to fertility-reducing behaviors that these individuals engage in to achieve their high status. This "indirect bias" (Cavalli-Sforza and Feldman, 1981; Boyd and Richerson, 1985; Richerson and Boyd, 2005) indirectly generates associations between fertility-limiting behavior and motivations to attain high status, and becomes the driving force of the low-fertility norm. Combined with the asymmetric (one-to-many) nature of oblique and horizontal transmission described above, the prominence of these role models accelerates the effect even further (see also Colleran et al., 2014 on education).

4.3 Cultural Niche Construction

The above situation of prestige bias is a form of cultural niche construction, whereby organisms alter their environments and consequently change the selection pressure acting on them (Laland et al., 2001, 2007; Laland and Brown, 2006). Consider the situation where a first cultural trait, such as a preference for education, is a "background" factor, i.e., is distributed such that the mean is high. This background distribution can create the conditions for a second cultural trait, e.g., a fertility-reducing preference, to spread through the population even though the second trait might lead to lower average fitness (Ihara and W. Feldman, 2004). Kendal et al. (2005) developed a model examining how the adoption of contraceptives could evolve in such a "constructed" environment with a background preference among individuals for education.

"Constructed" cultural niches such as this could have influence on transmission probabilities even beyond local populations, which could lead to various onsets and dynamics of fertility transition in different regions. A prominent feature of modern demographic transition is that while fertility rates decrease with development (Notestein, 1953), the dynamics and pace vary substantially for different countries (Bongaarts and Watkins, 1996). Less developed countries are experiencing earlier onsets compared to historical context, due to the informational or ideational influence of neighboring more-developed countries, which have higher rates of acceptance of contraceptives or small-family norms (Bongaarts and Watkins, 1996; Amin et al., 2002). Extending Ihara and W. Feldman (2004), Borenstein et al. (2006) developed a metapopulation model to illustrate such a situation. In the metapopulation, each sub-population, or group, has its own background or context such as a particular average education level that can differentially facilitate the spread of low fertility in the group. In addition, the mean education in a group determined how sensitive the individuals were to the frequency of low fertility preferences in the metapopulation overall. In other words, the spread of low fertility in a particular group was influenced not only by the average education level in that group, but also by the overall education level and the prevalence of low fertility in the metapopulation as a whole. The model shows that because of the variation in education level between groups, low fertility spreads not only within but also between groups. This can explain why populations could experience fertility decline at different stages of economic development, even though the decline begins in wealthy populations at first (Bongaarts and Watkins, 1996; Borenstein et al., 2006).

These models advance our understanding of how contextual factors at the group level might influence the cultural transmission of low fertility. They highlight the interactive and multilevel quality of these dynamics, i.e., the feedback between individuals and higher levels of social organization. They also clearly show how group-level characteristics, such as average wealth or education, influence individual propensities to pursue a strategy of low fertility. These dynamics need to be reflected in empirical work (see Colleran et al., 2014; 2015 for example). While some models above assume structured populations (see also Fogarty et al., 2019; Deffner et al., 2022), socioeconomic strata might be impacted by the average wealth in a group differently, or individuals at different periods of life may use different learning strategies. Taking socioeconomic strata or age cohorts into account might further complicate the dynamics and probably alter the model outcomes.

4.4 Cultural Group Selection

An argument that is not yet explicitly made in the CE literature, is that low fertility could be culturally group selected (see Henrich, 2004). That is, low fertility, while maladaptive at the individual level, may be adaptive at the group level. For this to work, groups composed of individuals with low fertility should outcompete groups composed of individuals with high fertility, and the advantage should be at the group and not necessarily the individual level.

An instance of this group level benefit of low fertility is from global economic development. One of the fundamental socioecological differences between pre- and post-industrialized societies is the extent to which populations interact with and depend on each other in international trade and supply networks (see Dang and Bauch, 2010, and references therein). Thus macro level competition and cooperation between populations or countries may have created a selective pressure for individuals within groups to invest in "embodied capital" and market-oriented skills, which are needed for the continued growth of the economy (Becker, 1994). Variation in the resource base and developmental trajectory of different countries (see Sachs, 2000) would then result in country-level variation in "reproductive equilibria", on which cultural group selection could potentially act.

Lower fertility has been observed in wealthier (Bloom, 2011; Sinding, 2009, see also Mace, 2008) and market-dependent (Reher, 2012) groups, as the perceived investment needed for each child could be higher in those societies. For example, Moses and Brown (2003) find that there is a negative allometric relationship between national fertility rates and per capita energy consumption, coinciding with many biological laws (West et al., 1999; Peters, 1983). Increases in international trade have also been shown to have a negative effect on fertility rates within a country (Doces, 2011; Galor and Mountford, 2008). As countries become more dependent on technology and innovation for economic productivity, those that share international research and development (RD) and bilateral foreign direct investment (FDI) are more economically productive than those that do not cooperate in this way (Borensztein et al., 1998; Keller, 2000). The exchange of capital, technology, and labor thus effectively down-regulates each other's fertility rates, as shown in theoretical models of population biology (Bauch, 2008; Dang and Bauch, 2010).

Cultural group selection operating on such between-group competition and cooperation is a theoretical possibility, e.g., countries that offer better living conditions might be more successful in spreading their values and gaining influence through attracting more migration (Richerson and Boyd, 2008). However, this hypothesis is as yet an untested one. Empirical evidence would require establishing what exactly groups are competing for, and whether the benefits of reducing fertility at the group level outweigh individual costs. It is also important to decipher whether such phenomena are simply driven by individual level selection. If individuals with lower fertility simply do better on average than individuals with higher fertility, group level advantages would not be necessary to explain the phenomenon.

As Bongaarts and Watkins (1996) note, fertility decline is likely to be driven by a nested set of interactions. At the lowest level these would involve interactions between individuals living in social networks, kinship ecologies, socioeconomic classes, or communities, followed by interactions between communities themselves, and finally by interactions between countries in a global network. All of these levels should be investigated in future research.

5 Speaking with Social Sciences

5.1 The Divide

In the previous two sections, we have focused on how evolutionary theories offer first-principle explanations to fertility transition. And as we briefly mentioned in the beginning of the chapter, contemporary social sciences like demography, sociology, and economics have accumulated a huge amount of literature about the same topic, results which have appeared and been referenced in public discourse and policy. Evolutionary explanations for fertility transition are rarely referred to in traditional social sciences and public discussions. This evolutionary vs non-evolutionary divide (van den Berghe, 1990; Udry, 1995) is not unique to the topic of fertility transition, but extends to other subjects like socialization, social stratification, resource distribution, cooperation, warfare, etc (see for example Thayer, 2004; Takács, 2018). The reasons range from fears in many disciplines about the potential resurgence of Social Darwinism (Degler, 1991; Leyva, 2009) and/or misunderstandings about what contemporary evolutionary research concerns are (Colleran and Mace, 2011), resistance to evolutionary concepts (van den Berghe, 1990; Pinker, 2002; Ellis, 1996), limited exposure (Ellis, 1996; Thayer, 2004; Takács, 2018), and epistemological critiques (Bryant, 2004; Gould, 1981; Lewontin et al., 1984; Turner and Machalek, 2018).

There are two other reasons, as we view it, why the two sides do not speak to each other. First, the time scale of analysis and the level of resolution of research questions are distinctly different. Evolutionary theories, drawing on biological and anthropological research, consider humans as a species and often approach research questions from a cross-species comparative perspective. For evolutionary processes to operate, the considered time scale tends to be very long. In contrast, non-evolutionary fields study relatively short-term and sometimes transient phenomena embedded in various quite specific institutions, countries, and time periods. Although the human evolutionary sciences consider cross-cultural perspectives too, these tend to be studied either at a very low level of resolution in the case of phylogenetic studies, or are committed to focusing on subsistence societies that by definition exclude the vast majority of industrialised populations (e.g., the focus on non-Western-Educated-Industrialised-Rich and Democratic/WEIRD societies (Henrich et al., 2010)). These differing emphases mean the research objects for the two sides are also dissimilar, with evolutionary fields focusing on small-scale and historical societies and non-evolutionary social sciences focusing more on industrialized, contemporary societies.

Second, many traditional social sciences differ fundamentally from the evolutionary sciences in their research motivations. While generally natural and evolutionary sciences look for descriptive statements, traditional social sciences such as economics and political science, although claiming to be observational and value-free, are strongly interested in policy implications. This policy-orientation is reflected in the selection of research topics and questions. For example, a climate politics researcher might hope to mitigate global warming, and a labor economist who gauges effects of education or employment programs may be keen to give policy advice to governments to alleviate poverty. This shifts scholars' attention away from evolutionary, or purely theoretical, understandings of their research interests.

5.2 The Consequences

The consequences of this differentiation are parallel disciplines that do not engage each other. For example, (a)social learning and its macro-level outcomes is core business in cultural evolution. Theory specifies numerous learning mechanisms such as direct, indirect, or frequency-dependent biases. But in other fields like experimental economics and behavioral game theory (see Camerer, 2003; Fudenberg and Levine, 1998, for general introduction), learning mechanisms are elaborated differently. Individuals make strategic decisions and adjustments to others in interactive environments according to learning rules like emulation dynamics (Ellison and Fudenberg, 1993; Fudenberg and Levine, 1998), belief learning (Cournot, 1838; Meese and Rogoff, 1983; Engel and West, 2005), fictitious play (Brown, 1951; Robinson, 1951; Fudenberg and Kreps, 1995), weighted fictitious play (Cheung and Friedman, 1997), reinforcement learning (Bush and Mosteller, 1955; Luce, 1959; Suppes and Atkinson, 1960; Mookherjee and Sopher, 1997; Roth and Erev, 1995), experience-weighted attraction (EWA) Learning (Camerer and Hua Ho, 1999), imitation learning (Schlag, 1999), etc. These learning rules describe human cognition and decision-making in a more fine-grained way and could potentially offer complementary insights for cultural evolutionists.

The macro-patterns, e.g., of information transmission, that cultural evolutionists are interested in are also studied in adjacent fields. One of these is the s-shaped adoption curves generated (though not uniquely) by conformist transmission or positive frequency-dependence (Boyd and Richerson, 1985; Henrich and Gil-White, 2001), whereby individuals conform disproportionately as the majority trait in a population increases. A similar pattern is common in many other social and natural processes and is not unique to cultural change. Disease transmissions, the accumulation of crowd size in a social movement, the acceptance of international norms such as nuclear taboo, responsibility to protect (R2P), and human rights, all share the same dynamic, and have been discussed extensively in political science, sociology, public health, communication studies, etc. The literature we cited in the first section from economics, namely Spolaore and Wacziarg (2022) and Montgomery and Casterline (1996), attempt to describe this spreading process without referring to any evolutionary concept. By engaging in interdisciplinary conversations, cultural evolution could become a useful analytic framework for other research areas. Conversely, empirical case studies from a wide range of disciplines can also be harnessed to aid in the theoretical development of cultural evolution.

5.3 Scientific Implications

Social phenomena are notoriously difficult to measure, predict, and explain. When similar phenomena are triangulated via different scientific assumptions and disciplinary traditions, we can potentially be more confident in our general insights. However, isolated intellectual endeavors also create blind spots. Inter-disciplinary conversations are essential for identifying these. For example, reproductive decisions in HBE involve intergenerational fitness maximization and resource distribution concerns. But according to the "decision sciences" (e.g., psychology, behavioral economics, and neuroeconomics), humans discount benefits in the remote future and behave myopically (Frederick et al., 2002; Doyle, 2012; Odum, 2011), and there is a great deal of behavioral evidence for this (e.g., Thaler, 1981; Wang et al., 2016). The upshot is that, even were parents able to make optimized fertility plans, the revealed behavior might not be consistent with any calculation, regardless of what level rationality is operated on. Indeed, numerous studies have found a mismatch between people's fertility intentions and their actualized fertility (e.g., Müller et al., 2022). Figuring out how to reconcile findings from these areas might shed light on gaps as well as overlaps in different areas research on reproductive decisions.

There are benefits to going beyond disciplinary borders. Cultural evolution studies focus on culture transmissions that lead to aggregate changes. In modern societies, social media provides a great arena to study this kind of information spread. The blossoming studies of computational social science using digital trace data to track mis/disinformation, political opinion, and hate speech might offer the exact same methodological tools for studying spread of fertility norms or other reproductive practices (although see Acerbi, 2020). One important question is how this modern environment of information spread differs from other small-scale, agricultural, traditional, or developing societies, and what its implications are for fertility behavior. The challenge is to be specific about what exactly is being transmitted, given that we often can have multiple unmeasurable motivations for a single observed behavior (Colleran, 2016).

Being a theory oriented discipline, cultural evolution studies have generated quite a few excellent models for explaining fertility transition (e.g., Ihara and W. Feldman, 2004; Bongaarts and Watkins, 1996). However, these models are less useful when applied empirically to specific regions, periods, subgroups, policy context, or countries where people respond to incentives differently. For instance, how do cultural evolutionary processes interact with different economic conditions (e.g., economic growth and hardship, developmental trajectories, labor markets, wealth distribution and inequality), political factors (political systems, institutions, political stability (Feng et al., 2000), political attitude (Fieder and Huber, 2018)), social trends (e.g., migration), public policies (e.g., social welfare, parenting and childcare policy), and major historical events like pandemics, wars, baby booms, etc? While all of these events can be understood as culturally niche-constructed, they are nonetheless different social phenomena occurring over different time scales and under different economic and historical contexts. To what extent can they be captured by our models?

Finally, transdisciplinary approaches can provide non-obvious interpretations. Fertility transitions are bio-social processes, and severe endogeneity problem makes it extremely hard to parse causality from our observations. Fortunately, variations in institutions and policies (e.g., Gibson and Gurmu, 2011; Gibson and Lawson,

2011) that are implemented in different regions and subpopulations can also be seen as different treatment exposures in so-called "natural experiments". With counterfactual and causal inference tools already used in economics (e.g., Cunningham, 2021; Huntington-Klein, 2022) and political science (e.g., Fearon, 1991; Tetlock and Belkin, 1996), along with clear study designs and conditional comparisons, we can begin to analyze our questions within the broader ecosystem of the social sciences.

6 Conclusion

Fertility transition is a complex phenomenon, part of our biological processes but also deeply intertwined with our social institutions. We have reviewed studies from anthropology, demography, and economics to outline some of the patterns of fertility transition. We then focused on attempts from human evolutionary ecology and cultural evolution to understand the outlined patterns, stressing the importance of both socioeconomic and socio-cultural interpretations. We highlighted that cultural evolution, as a multilevel framework, incorporates not only factors at individual and group levels, but also the feedback between them.

Taking inspiration from population genetics, the theoretically rich discipline of cultural evolution has laid out a unifying analytical framework, and has much to offer for studying interactions between fertility behavior and trends in human history and societies. An important direction for future work though is to discern if the insights produced by those theoretical explorations are reflected in our empirical world. This includes collecting multi-level data on social learning processes, inspecting the dynamics outlined in the models of cultural niche construction, and validating the concepts of cultural group selection. Guided by theoretical models, finer-grained data can in turn inform or modify our theory development to avoid the problems of equifinality (Premo, 2010), or underdetermination (Lake, 2015), and to verify our inferences. Cross-disciplinary conversation with other non-evolutionary social sciences will help cultural evolutionists engage more with how contemporary social issues interact with our fertility behavior.

References

Acerbi, A. (2020). *Cultural evolution in the digital age.* Oxford University Press, Oxford, first edition.

Alexander, R. D. (1974). The Evolution of Social Behavior. *Annual Review of Ecology and Systematics*, 5:325–383.

Alvergne, A., Gibson, M. A., Gurmu, E., and Mace, R. (2011). Social Transmission and the Spread of Modern Contraception in Rural Ethiopia. *PLoS ONE*, 6(7):e22515.

Alvergne, A., Lawson, D. W., Clarke, P. M., Gurmu, E., and Mace, R. (2013). Fertility, parental investment, and the early adoption of modern contraception in rural ethiopia. *American Journal of Human Biology*, 25(1):107–115.

Alvergne, A. and Lummaa, V. (2014). Ecological variation in wealth–fertility relationships in Mongolia: the 'central theoretical problem of sociobiology' not a problem after all? *Proceedings of the Royal Society B: Biological Sciences*, 281(1796):20141733. Publisher: Royal Society.

Amin, S., Basu, A. M., and Stephenson, R. (2002). Spatial variation in contraceptive use in Bangladesh: Looking Beyond the borders. *Demography*, 39(2):251–267.

Anderton, D. L., Tsuya, N. O., Bean, L. L., and Mineau, G. P. (1987). Intergenerational transmission of relative fertility and life course patterns. *Demography*, 24(4):467–480.

Axinn, W. and Yabiku, S. (2001). Social Change, the Social Organization of Families, and Fertility Limitation. *American Journal of Sociology*, 106(5):1219–1261.

Axinn, W. G. and Barber, J. S. (2001). Mass Education and Fertility Transition. *American Sociological Review*, 66(4):481.

Balbo, N. and Barban, N. (2014). Does Fertility Behavior Spread among Friends? *American Sociological Review*, 79(3):412–431.

Barber, J. S. and Axinn, W. G. (2004). New ideas and fertility limitation: The role of mass media. *Journal of Marriage and Family*, 66(5):1180–1200.

Barthold, J. A., Myrskylä, M., and Jones, O. R. (2012). Childlessness drives the sex difference in the association between income and reproductive success of modern Europeans. *Evolution and Human Behavior*, 33(6):628–638.

Basu, A. M. (2002). Why does Education Lead to Lower Fertility? A Critical Review of Some of the Possibilities. *World Development*, 30(10):1779–1790.

Bauch, C. T. (2008). Wealth as a source of density dependence in human population growth. *Oikos*, 117(12):1824–1832.

Becker, G. S. (1960). An Economic Analysis of Fertility. In *Demographic and Economic Change in Developed Countries*, pages 209–240. National Bureau of Economic Research. Columbia University Press.

Becker, G. S. (1994). *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*. The University of Chicago Press, Chicago, third edition.

Becker, G. S. and Lewis, H. G. (1973). On the Interaction between the Quantity and Quality of Children. *Journal of Political Economy*, 81(2, Part 2):S279–S288. Publisher: The University of Chicago Press.

Behrman, J. R., Kohler, H.-P., and Watkins, S. C. (2002). Social networks and changes in contraceptive use over time: Evidence from a longitudinal study in rural Kenya. *Demography*, 39(4):713–738.

Bentley, G. R., Goldberg, T., and Jasieńska, G. (1993). The Fertility of Agricultural and Non-Agricultural Traditional Societies. *Population Studies*, 47(2):269–281.

Blanc, G. and Wacziarg, R. (2020). Change and persistence in the Age of Modernization: Saint-Germain-d'Anxure, 1730–1895. *Explorations in Economic History*, 78:101352.

Bledsoe, C. H. (2002). *Contingent lives: fertility, time, and aging in West Africa*. Number 1999 in The Lewis Henry Morgan lectures. University of Chicago Press, Chicago.

Bloom, D. and Canning, D. (2001). Cumulative Causality, Economic Growth, and the Demographic Transition. In Nancy Birdsall, Kelley, A. C., and Sinding, S., editors, *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World*, pages 165–198. Oxford University Press, first edition.

Bloom, D. E. (2011). 7 Billion and Counting. *Science*, 333(6042):562–569.

Blum, M. G. B., Heyer, E., François, O., and Austerlitz, F. (2006). Matrilineal Fertility Inheritance Detected in Hunter–Gatherer Populations Using the Imbalance of Gene Genealogies. *PLoS Genetics*, 2(8):e122.

Blurton Jones, N. (1986). Bushman birth spacing: A test for optimal interbirth intervals. *Ethology and Sociobiology*, 7(2):91–105.

Bocquet-Appel, J.-P. (2011). When the World's Population Took Off: The Springboard of the Neolithic Demographic Transition. *Science*, 333(6042):560–561.

Bocquet-Appel, J.-P. and Jakobi, L. (1993). A test of a path model of biocultural transmission of fertility. *Annals of Human Biology*, 20(4):335–347.

Bongaarts, J. (1982). The Fertility-Inhibiting Effects of the Intermediate Fertility Variables. *Studies in Family Planning*, 13(6/7):179.

Bongaarts, J. and Watkins, S. C. (1996). Social Interactions and Contemporary Fertility Transitions. *Population and Development Review*, 22(4):639–682. Publisher: [Population Council, Wiley].

Boone, J. L. and Kessler, K. L. (1999). More Status or More Children? Social Status, Fertility Reduction, and Long-Term Fitness. *Evolution and Human Behavior*, 20(4):257–277.

Borenstein, E., Kendal, J., and Feldman, M. (2006). Cultural niche construction in a metapopulation. *Theoretical Population Biology*, 70(1):92–104.

Borensztein, E., De Gregorio, J., and Lee, J.-W. (1998). How does foreign direct investment affect economic growth? *Journal of International Economics*, 45(1):115–135.

Borgerhoff Mulder, M. (1987). On Cultural and Reproductive Success: Kipsigis Evidence. *American Anthropologist*, 89(3):617–634.

Borgerhoff Mulder, M. (1992). Demography of pastoralists: Preliminary data on the Datoga of Tanzania. *Human Ecology*, 20(4):383–405.

Borgerhoff Mulder, M. (1998). The demographic transition: are we any closer to an evolutionary explanation? *Trends in Ecology & Evolution*, 13(7):266–270.

Borgerhoff Mulder, M. (2009). Tradeoffs and sexual conflict over women's fertility preferences in Mpimbwe. *American Journal of Human Biology*, 21(4):478–487.

Borgerhoff Mulder, M. and Beheim, B. A. (2011). Understanding the nature of wealth and its effects on human fitness. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1563):344–356. Publisher: Royal Society.

Borgerhoff Mulder, M., Bowles, S., Hertz, T., Bell, A., Beise, J., Clark, G., Fazzio, I., Gurven, M., Hill, K., Hooper, P. L., Irons, W., Kaplan, H., Leonetti, D., Low, B., Marlowe, F., McElreath, R., Naidu, S., Nolin, D., Piraino, P., Quinlan, R., Schniter, E., Sear, R., Shenk, M., Smith, E. A., von Rueden, C., and Wiessner, P. (2009). Intergenerational Wealth Transmission and the Dynamics of Inequality in Small-Scale Societies. *Science (New York, N.Y.)*, 326(5953):682–688.

Boserup, E. (1975). The Impact of Population Growth on Agricultural Output. *The Quarterly Journal of Economics*, 89(2):257.

Boserup, E. (1976). Environment, Population, and Technology in Primitive Societies. *Population and Development Review*, 2(1):21.

Boyd, R. and Richerson, P. J. (1985). *Culture and the evolutionary process*. University of Chicago Press, Chicago.

Brown, G. W. (1951). Iterative Solutions of Games by Fictitious Play. In Koopmans, T. C., editor, *Activity Analysis of Production and Allocation*, pages 374–376. New York: Wiley.

Bryant, J. (2007). Theories of Fertility Decline and the Evidence from Development Indicators. *Population and Development Review*, 33(1):101–127.

Bryant, J. M. (2004). An Evolutionary Social Science? A Skeptic's Brief, Theoretical and Substantive. *Philosophy of the Social Sciences*, 34(4):451–492.

Bush, R. R. and Mosteller, F. (1955). *Stochastic models for learning*. New York: Wiley.

Buss, D. M. (2019). *Evolutionary psychology: the new science of the mind*. Routledge, New York, 6th edition.

Caldwell, J. C. (1976). Toward A Restatement of Demographic Transition Theory. *Population and Development Review*, 2(3/4):321–366. Publisher: [Population Council, Wiley].

Caldwell, J. C. (1978). A Theory of Fertility: From High Plateau to Destabilization. *Population and Development Review*, 4(4):553.

Caldwell, J. C. (1982). *Theory of fertility decline*. Population and social structure. Academic Press, London ; New York.

Camerer, C. (2003). *Behavioral game theory: experiments in strategic interaction*. The roundtable series in behavioral economics. Russell Sage Foundation ; Princeton University Press, New York, N.Y. : Princeton, N.J.

Camerer, C. and Hua Ho, T. (1999). Experience-weighted Attraction Learning in Normal Form Games. *Econometrica*, 67(4):827–874.

Cant, M. A. and Johnstone, R. A. (2008). Reproductive conflict and the separation of reproductive generations in humans. *Proceedings of the National Academy of Sciences*, 105(14):5332–5336.

Cavalli-Sforza, L. L. and Feldman, M. W. (1981). *Cultural transmission and evolution: a quantitative approach*. Number 16 in Monographs in population biology. Princeton University Press, Princeton, N.J.

Chesnais, J.-C. (1990). Demographic Transition Patterns and Their Impact on the Age Structure. *Population and Development Review*, 16(2):327.

Cheung, Y.-W. and Friedman, D. (1997). Individual Learning in Normal Form Games: Some Laboratory Results. *Games and Economic Behavior*, 19(1):46–76.

Clark, G. and Cummins, N. (2009). Urbanization, Mortality, and Fertility in Malthusian England. *American Economic Review*, 99(2):242–247.

Cleland, J. (2001). The Effects of Improved Survival on Fertility: A Reassessment. *Population and Development Review*, 27:60–92.

Cleland, J. (2009). Contraception in historical and global perspective. *Best Practice & Research Clinical Obstetrics & Gynaecology*, 23(2):165–176.

Cleland, J. and Wilson, C. (1987). Demand Theories of the Fertility Transition: An Iconoclastic View. *Population Studies*, 41(1):5–30.

Clutton-Brock, T. H. (1991). *The evolution of parental care*. Monographs in behavior and ecology. Princeton University Press, Princeton, N.J.

Coale, A. J. and Hoover, E. M. (1958). *Population growth and economic development: a case study of India's prospects*. Princeton University press, Princeton, reproduction en fac-similé edition.

Coale, A. J. and Watkins, S. C., editors (1986). *The decline of fertility in Europe: the revised proceedings of a Conference on the Princeton European Fertility Project*. Princeton University Press, Princeton, N.J. Meeting Name: Conference on the Princeton European Fertility Project.

Colleran, H. (2016). The cultural evolution of fertility decline. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1692):20150152.

Colleran, H. (2020). Market integration reduces kin density in women's ego-networks in rural Poland. *Nature Communications*, 11(1):266.

Colleran, H. (2023). A Theory of Culture for Evolutionary Demography (Forthcoming). *Human Evolutionary Demography.*

Colleran, H., Jasienska, G., Nenko, I., Galbarczyk, A., and Mace, R. (2014). Community-level education accelerates the cultural evolution of fertility decline. *Proceedings of the Royal Society B: Biological Sciences*, 281(1779):20132732.

Colleran, H., Jasienska, G., Nenko, I., Galbarczyk, A., and Mace, R. (2015). Fertility decline and the changing dynamics of wealth, status and inequality. *Proceedings of the Royal Society B: Biological Sciences*, 282(1806):20150287. Publisher: Royal Society.

Colleran, H. and Mace, R. (2011). Contrasts and Conflicts in Anthropology and Archaeology: The Evolutionary/Interpretive Dichotomy in Human Behavioural Research. In Cochrane, E. E. and Gardner, A., editors, *Evolutionary and interpretive archaeologies: a dialogue*. Routledge, London. OCLC: 972086471.

Colleran, H. and Mace, R. (2015). Social network- and community-level influences on contraceptive use: evidence from rural Poland. *Proceedings of the Royal Society B: Biological Sciences*, 282(1807):20150398.

Cosmides, L. and Tooby, J. (1987). From evolution to behavior: evolutionary psychology as the missing link. In Dupré, J., editor, *The Latest on the best: essays on evolution and optimality*. MIT Press, Cambridge, Mass.

Cournot, A. A. (1838). *Recherches sur les principes mathématiques de la théorie des richesses*. L. Hachette, Paris.

Crognier, E., Baali, A., and Hilali, M.-K. (2001). Do "helpers at the nest" increase their parents' reproductive success? *American Journal of Human Biology*, 13(3):365–373.

Crognier, E., Villena, M., and Vargas, E. (2002). Helping patterns and reproductive success in Aymara communities. *American Journal of Human Biology*, 14(3):372–379.

Cronk, L. (1991). Human Behavioral Ecology. *Annual Review of Anthropology*, 20:25–53.

Cummins, N. (2013). Marital fertility and wealth during the fertility transition: rural France, 1750-1850: Fertility and Wealth in Transition-Era France. *The Economic History Review*, 66(2):449–476.

Cunningham, S. (2021). *Causal inference: the mixtape*. Yale University Press, New Haven London.

Dang, U. and Bauch, C. T. (2010). A population biological approach to the collective dynamics of countries undergoing demographic transition. *Journal of Theoretical Biology*, 265(2):167–176.

de la Croix, D. and Doepke, M. (2003). Inequality and Growth: Why Differential Fertility Matters. *American Economic Review*, 93(4):1091–1113.

Deaton, A. (2006). The Great Escape: A Review of Robert Fogel's *The Escape from Hunger and Premature Death, 1700–2100*. *Journal of Economic Literature*, 44(1):106–114.

Deffner, D., Kandler, A., and Fogarty, L. (2022). Effective population size for culturally evolving traits. *PLOS Computational Biology*, 18(4):e1009430.

Degler, C. N. (1991). *In search of human nature: the decline and revival of Darwinism in American social thought*. Oxford University Press, New York.

Desai, S. (1995). When Are Children from Large Families Disadvantaged? Evidence from Cross-National Analyses. *Population Studies*, 49(2):195–210.

Doces, J. A. (2011). Globalization and Population: International Trade and the Demographic Transition. *International Interactions*, 37(2):127–146.

Downey, D. B. (2001). Number of siblings and intellectual development: The resource dilution explanation. *American Psychologist*, 56(6-7):497–504.

Doyle, J. R. (2012). Survey of Time Preference, Delay Discounting Models. *SSRN Electronic Journal*.

Dyson, T. (2010). *Population and Development: The Demographic Transition*. Bloomsbury Publishing.

Easterlin, R. A. and Crimmins, E. M. (1985). *The fertility revolution: a supply-demand analysis*. University of Chicago Press, Chicago.

Ellis, L. (1996). A discipline in peril: Sociology's future hinges on curing its biophobia. *The American Sociologist*, 27(2):21–41.

Ellison, G. and Fudenberg, D. (1993). Rules of Thumb for Social Learning. *Journal of Political Economy*, 101(4):612–643.

Engel, C. and West, K. (2005). Exchange Rates and Fundamentals. *Journal of Political Economy*, 113(3):485–517.

Fearon, J. D. (1991). Counterfactuals and Hypothesis Testing in Political Science. *World Politics*, 43(2):169–195.

Feng, Y., Kugler, J., and Zak, P. J. (2000). The Politics of Fertility and Economic Development. *International Studies Quarterly*, 44(4):667–693.

Feyrer, J., Sacerdote, B., and Stern, A. D. (2008). Will the Stork Return to Europe and Japan? Understanding Fertility within Developed Nations. *Journal of Economic Perspectives*, 22(3):3–22.

Fieder, M. and Huber, S. (2018). Political Attitude and Fertility: Is There a Selection for the Political Extreme? *Frontiers in Psychology*, 9:2343.

Fogarty, L., Creanza, N., and Feldman, M. W. (2019). The life history of learning: Demographic structure changes cultural outcomes. *PLOS Computational Biology*, 15(4):e1006821. Publisher: Public Library of Science.

Fogel, R. W. (2004). *The Escape from Hunger and Premature Death, 1700–2100: Europe, America, and the Third World*. Cambridge University Press, first edition.

Fox, M., Sear, R., Beise, J., Ragsdale, G., Voland, E., and Knapp, L. A. (2010). Grandma plays favourites: X-chromosome relatedness and sex-specific childhood mortality. *Proceedings of the Royal Society B: Biological Sciences*, 277(1681):567–573.

Frederick, S., Loewenstein, G., and O'donoghue, T. (2002). Time Discounting and Time Preference: A Critical Review. *Journal of Economic Literature*, 40(2):351–401.

Fudenberg, D. and Kreps, D. M. (1995). Learning in extensive-form games I. Self-confirming equilibria. *Games and Economic Behavior*, 8(1):20–55.

Fudenberg, D. and Levine, D. K. (1998). *The theory of learning in games*. Number 2 in MIT Press series on economic learning and social evolution. The MIT Press, Cambridge, Mass.

Galor, O. and Mountford, A. (2008). Trading Population for Productivity: Theory and Evidence. *Review of Economic Studies*, 75(4):1143–1179.

Gayen, K. and Raeside, R. (2010). Social networks and contraception practice of women in rural Bangladesh. *Social Science & Medicine*, 71(9):1584–1592.

Gibson, M. A. and Gurmu, E. (2011). Land inheritance establishes sibling competition for marriage and reproduction in rural Ethiopia. *Proceedings of the National Academy of Sciences*, 108(6):2200–2204.

Gibson, M. A. and Lawson, D. W. (2011). "Modernization" increases parental investment and sibling resource competition: evidence from a rural development initiative in Ethiopia. *Evolution and Human Behavior*, 32(2):97–105.

Gibson, M. A. and Sear, R. (2010). Does Wealth Increase Parental Investment Biases in Child Education?: Evidence from Two African Populations on the Cusp of the Fertility Transition. *Current Anthropology*, 51(5):693–701.

Gillespie, D. O., Russell, A. F., and Lummaa, V. (2008). When fecundity does not equal fitness: evidence of an offspring quantity versus quality trade-off in pre-industrial humans. *Proceedings of the Royal Society B: Biological Sciences*, 275(1635):713–722.

Goldstein, J., Lutz, W., and Testa, M. R. (2003). The emergence of Sub-Replacement Family Size Ideals in Europe. *Population Research and Policy Review*, 22(5/6):479–496.

Goodman, A., Koupil, I., and Lawson, D. W. (2012). Low fertility increases descendant socioeconomic position but reduces long-term fitness in a modern post-industrial society. *Proceedings of the Royal Society B: Biological Sciences*, 279(1746):4342–4351. Publisher: Royal Society.

Gould, S. J. (1981). *The mismeasure of man*. Norton, New York, first edition.

Grafen, A. (1984). Natural selection, kin selection and group selection [Polistes fuscatus, wasps]. In Krebs, J. R. and Davies, N. B., editors, *Behavioural ecology: an evolutionary approach*. Sinauer Associates.

Grafen, A. (1998). Fertility and Labour Supply inFemina economica. *Journal of Theoretical Biology*, 194(3):429–455.

Guinnane, T. W. (2011). The Historical Fertility Transition: A Guide for Economists. *Journal of Economic Literature*, 49(3):589–614.

Gurmu, E. and Mace, R. (2008). Fertility Decline Driven by Poverty: the Case of Addis Ababa, Ethiopia. *Journal of Biosocial Science*, 40(3):339–358. Publisher: Cambridge University Press.

Hadeishi, H. (2003). Economic Well-Being and Fertility in France: Nuits, 1744–1792. *The Journal of Economic History*, 63(02).

Haines, M. (1994). "The Population of the United States, 1790-1920". Technical Report h0056, National Bureau of Economic Research, Cambridge, MA.

Hamilton, W. (1964). The genetical evolution of social behaviour. I. *Journal of Theoretical Biology*, 7(1):1–16.

Harpending, H. and Rogers, A. (1990). Fitness in stratified societies. *Ethology and Sociobiology*, 11(6):497–509.

Henrich, J. (2004). Cultural group selection, coevolutionary processes and large-scale cooperation. *Journal of Economic Behavior & Organization*, 53(1):3–35.

Henrich, J. and Gil-White, F. J. (2001). The evolution of prestige: freely conferred deference as a mechanism for enhancing the benefits of cultural transmission. *Evolution and Human Behavior*, 22(3):165–196.

Henrich, J., Heine, S. J., and Norenzayan, A. (2010). The weirdest people in the world? *Behavioral and Brain Sciences*, 33(2-3):61–83.

Higgins, M. and Williamson, J. G. (1997). Age Structure Dynamics in Asia and Dependence on Foreign Capital. *Population and Development Review*, 23(2):261.

Hill, S. E. and Kern Reeve, H. (2005). Low fertility in humans as the evolutionary outcome of snowballing resource games. *Behavioral Ecology*, 16(2):398–402.

Hobcraft, J., McDonald, J. W., and Rutstein, S. (1983). Child-Spacing Effects on Infant and Early Child Mortality. *Population Index*, 49(4):585.

Hopcroft, R. L. (2006). Sex, status, and reproductive success in the contemporary United States. *Evolution and Human Behavior*, 27(2):104–120.

Hopcroft, R. L. (2015). Sex differences in the relationship between status and number of offspring in the contemporary U.S. *Evolution and Human Behavior*, 36(2):146–151.

Hrdy, S. B. (1999). *Mother nature: a history of mothers, infants, and natural selection*. Pantheon Books, New York, first edition.

Hrdy, S. B. (2007). Evolutionary Context of Human Development: The Cooperative Breeding Model. In Salmon, C. A. and Shackelford, T. K., editors, *Family Relationships*, pages 39–68. Oxford University PressNew York, first edition.

Hrdy, S. B. (2009). *Mothers and others: the evolutionary origins of mutual understanding*. Harvard University Press, Cambridge.

Huntington-Klein, N. (2022). *The effect: an introduction to research design and causality*. A Chapman & Hall book. CRC Press, Taylor & Francis Group, Boca Raton London New York, first edition.

Ihara, Y. and W. Feldman, M. (2004). Cultural niche construction and the evolution of small family size. *Theoretical Population Biology*, 65(1):105–111.

Jennings, J. A., Sullivan, A. R., and Hacker, J. D. (2012). Intergenerational Transmission of Reproductive Behavior during the Demographic Transition. *The Journal of Interdisciplinary History*, 42(4):543–569.

Kaplan, H. (1996). A theory of fertility and parental investment in traditional and modern human societies. *American Journal of Physical Anthropology*, 101(S23):91–135.

Kaplan, H., Lancaster, J. B., Tucker, W. T., and Anderson, K. (2002). Evolutionary approach to below replacement fertility. *American Journal of Human Biology*, 14(2):233–256.

Kaplan, H. S., Lancaster, J. B., Johnson, S. E., and Bock, J. A. (1995). Does observed fertility maximize fitness among New Mexican men? *Human Nature*, 6(4):325–360.

Keller, W. (2000). Do Trade Patterns and Technology Flows Affect Productivity Growth? *The World Bank Economic Review*, 14(1):17–47.

Kendal, J., Ihara, Y., and Feldman, M. (2005). Cultural niche construction with application to fertility control: a model for education and social transmission of contraceptive use. *Math Popul Stud.*

Kirk, D. (1996). Demographic Transition Theory. *Population Studies*, 50(3):361–387.

Kirkwood, T. B. L., Rose, M. R., Harvey, P. H., Partridge, L., and Southwood, S. R. (1991). Evolution of senescence: late survival sacrificed for reproduction. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 332(1262):15–24. Publisher: Royal Society.

Knodel, J. and van de Walle, E. (1979). Lessons from the Past: Policy Implications of Historical Fertility Studies. *Population and Development Review*, 5(2):217.

Kohler, H.-P., Rodgers, J. L., and Christensen, K. (1999). Is Fertility Behavior in Our Genes? Findings from a Danish Twin Study. *Population and Development Review*, 25(2):253–288.

Kosova, G., Abney, M., and Ober, C. (2010). Heritability of reproductive fitness traits in a human population. *Proceedings of the National Academy of Sciences*, 107(suppl_1):1772–1778.

Kramer, K. L. (2005). Children's Help and the Pace of Reproduction: Cooperative Breeding in Humans. *Evolutionary Anthropology: Issues, News, and Reviews*, 14(6):224–237.

Kramer, K. L. (2010). Cooperative Breeding and its Significance to the Demographic Success of Humans. *Annual Review of Anthropology*, 39(1):417–436.

Lahdenperä, M., Gillespie, D. O. S., Lummaa, V., and Russell, A. F. (2012). Severe intergenerational reproductive conflict and the evolution of menopause. *Ecology Letters*, 15(11):1283–1290.

Lake, M. W. (2015). Explaining the Past with ABM: On Modelling Philosophy. In Wurzer, G., Kowarik, K., and Reschreiter, H., editors, *Agent-based Modeling and Simulation in Archaeology*, pages 3–35. Springer International Publishing, Cham. Series Title: Advances in Geographic Information Science.

Laland, K., Matthews, B., and Feldman, M. W. (2016). An introduction to niche construction theory. *Evolutionary Ecology*, 30(2):191–202.

Laland, K. N. and Brown, G. R. (2006). Niche construction, human behavior, and the adaptive-lag hypothesis. *Evolutionary Anthropology: Issues, News, and Reviews*, 15(3):95–104.

Laland, K. N., Kendal, J. R., and Brown, G. R. (2007). The niche construction perspective: Implications for evolution and human behaviour. *Journal of Evolutionary Psychology*, 5(1):51–66.

Laland, K. N., Odling-Smee, J., and Feldman, M. W. (2001). Cultural niche construction and human evolution: Niche construction and human evolution. *Journal of Evolutionary Biology*, 14(1):22–33.

Lawson, D. W., Alvergne, A., and Gibson, M. A. (2012). The life-history trade-off between fertility and child survival. *Proceedings of the Royal Society B: Biological Sciences*, 279(1748):4755–4764.

Lawson, D. W. and Mace, R. (2008). Sibling configuration and childhood growth in contemporary British families. *International Journal of Epidemiology*, 37(6):1408–1421.

Lawson, D. W. and Mace, R. (2009). Trade-offs in modern parenting: a longitudinal study of sibling competition for parental care. *Evolution and Human Behavior*, 30(3):170–183.

Lawson, D. W. and Mace, R. (2010a). Optimizing Modern Family Size: Trade-offs between Fertility and the Economic Costs of Reproduction. *Human Nature*, 21(1):39–61.

Lawson, D. W. and Mace, R. (2010b). Siblings and childhood mental health: Evidence for a later-born advantage. *Social Science & Medicine*, 70(12):2061–2069.

Lawson, D. W. and Mace, R. (2011). Parental investment and the optimization of human family size. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 366(1563):333–343.

Lawson, D. W. and Mulder, M. B. (2016). The offspring quantity–quality trade-off and human fertility variation. *Philosophical Transactions of the Royal Society B: Biological Sciences*. Publisher: The Royal Society.

Lee, R. (2003). The Demographic Transition: Three Centuries of Fundamental Change. *Journal of Economic Perspectives*, 17(4):167–190.

Leonetti, D., Nath, D., and Hemam, N. (2007). In-law Conflict: Women's Reproductive Lives and the Roles of Their Mothers and Husbands among the Matrilineal Khasi. *Current Anthropology*, 48(6):861–890.

Leonetti, D. L. and Nath, D. C. (2009). Age at first reproduction and economic change in the context of differing kinship ecologies. *American Journal of Human Biology*, 21(4):438–447.

Leslie, P. and Winterhalder, B. (2002). Demographic consequences of unpredictability in fertility outcomes. *American Journal of Human Biology*, 14(2):168–183.

Lesthaeghe, R. (1983). A Century of Demographic and Cultural Change in Western Europe: An Exploration of Underlying Dimensions. *Population and Development Review*, 9(3):411.

Lesthaeghe, R. J. (1977). *The decline of Belgian fertility, 1800-1970*. Princeton University Press, Princeton, N.J.

Levine, R. A. (1983). Effects of culture on fertility: Anthropological contributions. In Bulatao, R. A. and Lee, R. D., editors, *Determinants of fertility in developing countries, Vol. 2: Fertility regulation and institutional influences*, pages 666–695. Academic Pres, New York.

Lewontin, R. C., Rose, S., and Kamin, L. (1984). *Not in our genes: biology, ideology, and human nature*. Penguin Books, London, 3. aufl. edition.

Leyva, R. (2009). No Child Left Behind: A Neoliberal Repackaging of Social Darwinism. *Journal for Critical Education Policy Studies*, 7(1):365–381.

Liu, J., Rotkirch, A., and Lummaa, V. (2012). Maternal Risk of Breeding Failure Remained Low throughout the Demographic Transitions in Fertility and Age at First Reproduction in Finland. *PLoS ONE*, 7(4):e34898.

Livi-Bacci, M. (1986). Fertility, Nutrition, and Pellagra: Italy during the Vital Revolution. *Journal of Interdisciplinary History*, 16(3):431.

Low, B. S., Simon, C. P., and Anderson, K. G. (2002). An evolutionary ecological perspective on demographic transitions: Modeling multiple currencies. *American Journal of Human Biology*, 14(2):149–167.

Low, B. S., Simon, C. S., and Anderson, K. G. (2003). The Biodemography of Modern Women: Tradeoffs When Resources Become Limiting. In Rodgers, J. L. and Kohler, H.-P., editors, *The Biodemography of Human Reproduction and Fertility*, pages 105–134. Springer US, Boston, MA.

Luce, R. (1959). *Individual Choice Behavior: A Theoretical Analysis*. Wiley, New York.

Luci, A. and Thévenon, O. (2011). Does economic development explain the fertility rebound in OECD countries? *Population & Societies*, 481(8):1–4.

Lund, E., Arnesen, E., and Borgan, J. K. (1990). Pattern of childbearing and mortality in married women–a national prospective study from Norway. *Journal of Epidemiology & Community Health*, 44(3):237–240.

Lutz, W. and Kc, S. (2011). Global Human Capital: Integrating Education and Population. *Science*, 333(6042):587–592.

Lutz, W., Skirbekk, V., and Testa, M. R. (2006). The Low-Fertility Trap Hypothesis: Forces that May Lead to Further Postponement and Fewer Births in Europe. *Vienna Yearbook of Population Research*, 4:167–192. Publisher: Austrian Academy of Sciences Press.

Luy, M., Zannella, M., Wegner-Siegmundt, C., Minagawa, Y., Lutz, W., and Caselli, G. (2019). The impact of increasing education levels on rising life expectancy: a decomposition analysis for Italy, Denmark, and the USA. *Genus*, 75(1):11.

Mace, R. (1996). When to have another baby: A dynamic model of reproductive decision-making and evidence from Gabbra pastoralists. *Ethology and Sociobiology*, 17(4):263–273.

Mace, R. (1998). The co-evolution of human fertility and wealth inheritance strategies. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 353(1367):389–397.

Mace, R. (2000). Evolutionary ecology of human life history. *Animal Behaviour*, 59(1):1–10.

Mace, R. (2008). Reproducing in Cities. *Science*, 319(5864):764–766.

Mace, R., Allal, N., Sear, R., and Prentice, A. (2006). The uptake of modern contraception in a Gambian community: the diffusion of an innovation over 25 years. In Wells, J. C. K., Strickland, S. S., and Laland, K. N., editors, *Social information transmission and human biology*, number 46 in Society for the Study of Human Biology series. CRC/Taylor & Francis, Boca Raton, FL.

Mace, R. and Alvergne, A. (2012). Female reproductive competition within families in rural Gambia. *Proceedings of the Royal Society B: Biological Sciences*, 279(1736):2219–2227.

Mace, R. and Colleran, H. (2009). Kin influence on the decision to start using modern contraception: A longitudinal study from rural Gambia. *American Journal of Human Biology*, 21(4):472–477.

Mace, R. and Sear, R. (2005). Are humans cooperative breeders. In Voland, E., Chasiotis, A., and Schiefenhövel, W., editors, *Grandmotherhood: the evolutionary significance of the second half of female life*, pages 143–159. Rutgers University Press, New Brunswick, N.J.

Madrigal, L., Relethford, J. H., and Crawford, M. H. (2003). Heritability and anthropometric influences on human fertility. *American Journal of Human Biology*, 15(1):16–22.

Malthus, T. R. (1798). *An Essay on the Principle of Population.* London: J. Johnson.

Marshall, J. (1977). Acceptability of fertility regulating methods: Designing technology to fit people. *Preventive Medicine*, 6(1):65–73.

McDonald, P. (2000). Gender Equity in Theories of Fertility Transition. *Population and Development Review*, 26(3):427–439.

McKeown, T. (1976). *The modern rise of population.* Arnold, London, reprinted edition.

Meese, R. A. and Rogoff, K. (1983). Empirical exchange rate models of the seventies. *Journal of International Economics*, 14(1-2):3–24.

Meij, J. J., Van Bodegom, D., Ziem, J. B., Amankwa, J., Polderman, A. M., Kirkwood, T. B. L., De Craen, A. J. M., Zwaan, B. J., and Westendorp, R. G. J. (2009). Quality-quantity trade-off of human offspring under adverse environmental conditions. *Journal of Evolutionary Biology*, 22(5):1014–1023.

Montgomery, M. R. and Casterline, J. B. (1996). Social Learning, Social Influence, and New Models of Fertility. *Population and Development Review*, 22:151–175.

Mookherjee, D. and Sopher, B. (1997). Learning and Decision Costs in Experimental Constant Sum Games. *Games and Economic Behavior*, 19(1):97–132.

Moses, M. E. and Brown, J. H. (2003). Allometry of human fertility and energy use. *Ecology Letters*, 6(4):295–300.

Moya, C., Snopkowski, K., and Sear, R. (2016). What do men want? Re-examining whether men benefit from higher fertility than is optimal for women. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1692):20150149.

Mueller, U. (2001). Is There a Stabilizing Selection Around Average Fertility in Modern Human Populations? *Population and Development Review*, 27(3):469–498.

Murphy, M. (1999). Is the relationship between fertility of parents and children really weak? *Biodemography and Social Biology*, 46(1-2):122–145.

Murphy, M. and Wang, D. (2001). Family-Level Continuities in Childbearing in Low-Fertility Societies. *European Journal of Population*, 17(1):75–96.

Myrskylä, M., Goldstein, J. R., and Cheng, Y.-h. A. (2013). New Cohort Fertility Forecasts for the Developed World: Rises, Falls, and Reversals. *Population and Development Review*, 39(1):31–56.

Myrskylä, M., Kohler, H.-P., and Billari, F. C. (2009). Advances in development reverse fertility declines. *Nature*, 460(7256):741–743.

Müller, M. W., Hamory, J., Johnson-Hanks, J., and Miguel, E. (2022). The illusion of stable fertility preferences. *Population Studies*, 0(0):1–21.

Nettle, D., Gibson, M. A., Lawson, D. W., and Sear, R. (2013). Human behavioral ecology: current research and future prospects. *Behavioral Ecology*, 24(5):1031–1040.

Nettle, D. and Pollet, T. (2008). Natural Selection on Male Wealth in Humans. *The American Naturalist*, 172(5):658–666.

Newson, L. (2009). Cultural versus reproductive success: Why does economic development bring new tradeoffs? *American Journal of Human Biology*, 21(4):464–471.

Newson, L., Postmes, T., Lea, S. E. G., and Webley, P. (2005). Why Are Modern Families Small? Toward an Evolutionary and Cultural Explanation for the Demographic Transition. *Personality and Social Psychology Review*, 9(4):360–375.

Newson, L., Postmes, T., Lea, S. E. G., Webley, P., Richerson, P. J., and Mcelreath, R. (2007). Influences on communication about reproduction: the cultural evolution of low fertility. *Evolution and Human Behavior*, 28(3):199–210.

Newson, L. and Richerson, P. J. (2009). Why Do People Become Modern? A Darwinian Explanation. *Population and Development Review*, 35(1):117–158.

Notestein, F. W. (1945). Population—The long view. In *Food for the World, Theodore W. Schultz (ed.)*, pages 36–57. University of Chicago Press, Chicago.

Notestein, F. W. (1953). Economic Problems of Population Change. In *Proceedings of the Eighth International Conference of Agricultural Economics*, pages 13–31. Oxford University Press, London.

Odum, A. L. (2011). Delay Discounting: I'm a k, You're a k. *Journal of the Experimental Analysis of Behavior*, 96(3):427–439.

Oppenheim Mason, K. (1997). Explaining fertility transitions. *Demography*, 34(4):443–454.

Penn, D. J. and Smith, K. R. (2007). Differential fitness costs of reproduction between the sexes. *Proceedings of the National Academy of Sciences*, 104(2):553–558.

Peters, R. H. (1983). *The ecological implications of body size*. Cambridge University Press, Cambridge.

Pettay, J. E., Kruuk, L. E. B., Jokela, J., and Lummaa, V. (2005). Heritability and genetic constraints of life-history trait evolution in preindustrial humans. *Proceedings of the National Academy of Sciences*, 102(8):2838–2843.

Pinker, S. (2002). *The blank slate: the modern denial of human nature*. Viking, New York.

Polgar, S. and Marshall, J. F. (1976). The search for culturally acceptable fertility regulating methods. In Marshall, J. F. and Polgar, S., editors, *Culture, Natality and Family Planning*. Carolina Population Center, U of North Carolina.

Premo, L. S. (2010). Equifinality and Explanation: The Role of Agent-Based Modeling in Postposi- tivist Archaeology. In Costopoulos, A. and Lake, M., editors, *Simulating change: archaeology into the twenty-first century*, Foundations of archaeological inquiry, pages 28–37. University of Utah Press, Salt Lake City.

Pritchett, L. H. (1994). Desired Fertility and the Impact of Population Policies. *Population and Development Review*, 20(1):1.

Pérusse, D. (1993). Cultural and reproductive success in industrial societies: Testing the relationship at the proximate and ultimate levels. *Behavioral and Brain Sciences*, 16(2):267–283. Publisher: Cambridge University Press.

Reher, D. (2012). Population and the Economy During the Demographic Transition. *Economic Affairs*, 32(1):10–16.

Reher, D. S. (2011). Economic and Social Implications of the Demographic Transition. *Population and Development Review*, 37:11–33.

Reher, D. S., Ortega, J. A., and Sanz-Gimeno, A. (2008). Intergenerational Transmission of Reproductive Traits in Spain during the Demographic Transition. *Human Nature*, 19(1):23–43.

Richerson, P. J. and Boyd, R. (2005). *Not by genes alone: how culture transformed human evolution*. University of Chicago Press, Chicago, Ill., paperback ed., [nachdr.] edition.

Richerson, P. J. and Boyd, R. (2008). Migration: An engine for social change. *Nature*, 456(7224):877–877.

Rindfuss, R. R. and Brewster, K. L. (1996). Childrearing and Fertility. *Population and Development Review*, 22:258.

Robinson, J. (1951). An Iterative Method of Solving a Game. *The Annals of Mathematics*, 54(2):296.

Roff, D. A. (1992). *The evolution of life histories: theory and analysis*. Chapman & Hall, New York.

Rogers, A. R. (1990). Evolutionary economics of human reproduction. *Ethology and Sociobiology*, 11(6):479–495.

Rogers, A. R. (1995a). For Love or Money: the Evolution of Reproductive and Material Motivations. In Dunbar, R. I. M., editor, *Human Reproductive Decisions: Biological and Social Perspectives*, Studies in Biology, Economy and Society, pages 76–95. Macmillan Education UK, London.

Rogers, E. M. (1995b). Diffusion of Innovations: Modifications of a Model for Telecommunications. In Stoetzer, M.-W. and Mahler, A., editors, *Die Diffusion* *von Innovationen in der Telekommunikation*, pages 25–38. Springer Berlin Heidelberg, Berlin, Heidelberg.

Rogers, E. M. and Kincaid, D. L. (1981). *Communication networks: toward a new paradigm for research.* Free Press ; Collier Macmillan, New York : London.

Rosero-Bixby, L. and Casterline, J. B. (1993). Modelling Diffusion Effects in Fertility Transition. *Population Studies*, 47(1):147–167.

Roth, A. E. and Erev, I. (1995). Learning in extensive-form games: Experimental data and simple dynamic models in the intermediate term. *Games and Economic Behavior*, 8(1):164–212.

Sachs, J. D. (2000). Globalization and patterns of economic development. *Review of World Economics*, 136(4):579–600.

Schlag, K. H. (1999). Which one should I imitate? *Journal of Mathematical Economics*, 31(4):493–522.

Sear, R. and Coall, D. (2011). How Much Does Family Matter? Cooperative Breeding and the Demographic Transition. *Population and Development Review*, 37:81–112.

Sear, R. and Mace, R. (2008). Who keeps children alive? A review of the effects of kin on child survival. *Evolution and Human Behavior*, 29(1):1–18.

Shenk, M. K. (2009). Testing three evolutionary models of the demographic transition: Patterns of fertility and age at marriage in urban South India. *American Journal of Human Biology*, 21(4):501–511.

Shenk, M. K., Kaplan, H. S., and Hooper, P. L. (2016). Status competition, inequality, and fertility: implications for the demographic transition. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1692):20150150. Publisher: Royal Society.

Sinding, S. W. (2009). Population, poverty and economic development. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1532):3023–3030.

Skjærvø, G. R., Bongard, T., Viken, Å., Stokke, B. G., and Røskaft, E. (2011). Wealth, status, and fitness: a historical study of Norwegians in variable environments. *Evolution and Human Behavior*, 32(5):305–314.

Smith, E. A. (2000). Three styles in the evolutionary analysis of human behavior. In Cronk, L., Chagnon, N. A., and Irons, W., editors, *Adaptation and human behavior: an anthropological perspective*, Evolutionary foundations of human behavior. Aldine de Gruyter, New York.

Spolaore, E. and Wacziarg, R. (2022). Fertility and Modernity. *The Economic Journal*, 132(642):796–833.

Stearns, S. C. (1989). Trade-Offs in Life-History Evolution. *Functional Ecology*, 3(3):259–268.

Stearns, S. C. (1992). *The evolution of life histories.* Oxford University Press, New York.

Strassmann, B. I. (2011). Cooperation and competition in a cliff-dwelling people. *Proceedings of the National Academy of Sciences*, 108(supplement_2):10894–10901. Publisher: Proceedings of the National Academy of Sciences.

Strassmann, B. I. and Gillespie, B. (2002). Life–history theory, fertility and reproductive success in humans. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 269(1491):553–562.

Strassmann, B. I. and Kurapati, N. T. (2010). Are humans cooperative breeders?: Most studies of natural fertility populations do not support the grandmother hypothesis. *Behavioral and Brain Sciences*, 33(1):35–39.

Stulp, G. and Barrett, L. (2016). Wealth, fertility and adaptive behaviour in industrial populations. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 371(1692):20150153.

Suppes, P. and Atkinson, R. C. (1960). *Markov learning models for multiperson interactions.* Stanford University Press.

Takács, K. (2018). Discounting of Evolutionary Explanations in Sociology Textbooks and Curricula. *Frontiers in Sociology*, 3:24.

Tetlock, P. E. and Belkin, A., editors (1996). *Counterfactual Thought Experiments in World Politics: Logical, Methodological, and Psychological Perspectives.* Princeton Univ. Press, Princeton, NJ.

Thaler, R. (1981). Some empirical evidence on dynamic inconsistency. *Economics Letters*, 8(3):201–207.

Thayer, B. A. (2004). Evolution and the American social sciences: An evolutionary social scientist's view. *Politics and the Life Sciences*, 23(1):2–11.

Thompson, W. S. (1929). Population. *American Journal of Sociology*, 34(6):959–975.

Tooby, J. and Cosmides, L. (1990). The past explains the present. *Ethology and Sociobiology*, 11(4-5):375–424.

Tracer, D. P. (1991). Fertility-related changes in maternal body composition among the au of Papua New Guinea. *American Journal of Physical Anthropology*, 85(4):393–405.

Trivers, R. L. (1972). Parental Investment and Sexual Selection. In Campbell, B. G., editor, *Sexual Selection and the Descent of Man: The Darwinian Pivot*. Aldine, Chicago.

Trivers, R. L. (1974). Parent-Offspring Conflict. *American Zoologist*, 14(1):249–264.

Turke, P. W. (1988). Helpers at the nest: childcare networks on Ifaluk. In *Human reproductive behavior: A Darwinian perspective*, pages 173–188. Cambridge University Press.

Turner, J. H. and Machalek, R. (2018). *The new evolutionary sociology: recent and revitalized theoretical and methodological approaches*. Evolutionary analysis in the social sciences. Routledge, Taylor & Francis Group, New York, first edition.

Udry, J. R. (1995). Sociology and Biology: What Biology Do Sociologists Need to Know? *Social Forces*, 73(4):1267.

Van Bavel, J. (2006). The effect of fertility limitation on intergenerational social mobility/ the quality–quantity trade-off during the demographic transition. *Journal of Biosocial Science*, 38(4):553–569.

Van Bavel, J., Moreels, S., Van de Putte, B., and Matthijs, K. (2011). Family size and intergenerational social mobility during the fertility transition: Evidence of resource dilution from the city of Antwerp in nineteenth century Belgium. *Demographic Research*, 24:313–344.

van den Berghe, P. L. (1990). Why most sociologists don't (and won't) think evolutionarily. *Sociological Forum*, 5(2):173–185.

Vining, D. R. (1986). Social versus reproductive success: The central theoretical problem of human sociobiology. *Behavioral and Brain Sciences*, 9(1):167–187.

Voland, E. (1998). Evolutionary Ecology of Human Reproduction. *Annual Review of Anthropology*, 27:347–374.

Voland, E. and Beise, J. (2005). The husband's mother is the devil in the house.'Data on the impact of the mother-in-law on stillbirth mortality in historical Krummhörn (1750-1874) and some thoughts on the evolution of postgenerative female life. In Voland, E., Chasiotis, A., and Schiefenhövel, W., editors, *Grandmotherhood: the evolutionary significance of the second half of female life*, pages 239–255. Rutgers University Press, New Brunswick, N.J.

von Rueden, C., Gurven, M., and Kaplan, H. (2011). Why do men seek status? Fitness payoffs to dominance and prestige. *Proceedings of the Royal Society B: Biological Sciences*, 278(1715):2223–2232.

Wang, M., Rieger, M. O., and Hens, T. (2016). How time preferences differ: Evidence from 53 countries. *Journal of Economic Psychology*, 52:115–135.

Watkins, S. C. (1991). *From provinces into nations: demographic integration in Western Europe, 1870-1960.* Princeton University Press, Princeton, N.J.

Weir, D. R. (1995). Family Income, Mortality, and Fertility on the Eve of the Demographic Transition: A Case Study of Rosny-Sous-Bois. *The Journal of Economic History*, 55(1):1–26.

West, G. B., Brown, J. H., and Enquist, B. J. (1999). The Fourth Dimension of Life: Fractal Geometry and Allometric Scaling of Organisms. *Science*, 284(5420):1677–1679.

Westendorp, R. G. J. and Kirkwood, T. B. L. (1998). Human longevity at the cost of reproductive success. *Nature*, 396(6713):743–746.

Williams, G. C. (1957). Pleiotropy, Natural Selection, and the Evolution of Senescence. *Evolution*, 11(4):398.

Wilson, C. (2011). Understanding Global Demographic Convergence since 1950. *Population and Development Review*, 37(2):375–388.

Winterhalder, B. and Leslie, P. (2002). Risk-sensitive fertility: The variance compensation hypothesis. *Evolution and Human Behavior*, 23(1):59–82.