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# Human Female Longevity, Evolution of Menopause, and the Importance of Grandmothers

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Human Female Longevity, Evolution of Menopause,

and the Importance of Grandmothers

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# Introduction

One of the most captivating evolutionary puzzles is that women outlive fertility. Most mammals age in similar ways— there's a steady decline in function of all organ systems simultaneously (Kirkwood 2002). Human females are an exception. Their reproductive senescence (deterioration with age) does not line up with the rest of their bodies, meaning that they cease reproduction much earlier, relative to the rest of their body, than other species (Crews 2003). This phenomena, known as menopause, is nearly unique to humans. Since menopause occurs typically around the age of 50, women are able to live about a third of their lives postmenopausally. Menopause is a significant life stage, and its distinctiveness is often analyzed through life history theory, a framework that aims to explain how and why different species have evolved completely different patterns in their life courses. For example, human life history is especially unique from other species because we experience late puberty as well as menopause. Culture also plays a major role in altering human life histories by influencing women's decision making and access to resources.

While menopause itself can be generally explained by the depletion of eggs, an extensive life span after the eggs are depleted does not seem to follow the rules of natural selection and basic Darwinian principles. This assertion is flawed in its assumption that fertility is the ultimate coin in evolution. In reality, organisms with increased reproductive fitness leave the most genes behind. Could postmenopausal women be doing something to increase their reproductive fitness while foregoing fertility, and therefore, pass on the traits of their postmenopausal longevity? One theory that tackles this question is the Grandmother Hypothesis (Hawkes et al 1998). Developed in the 1990s by Kristen Hawkes, the hypothesis focuses on postmenopausal women's roles as grandmothers in hunter gatherer societies, and the significant contributions made by

grandmothers to their grandchildren. Upon discovering how much of the children's nutrition is provided by grandmothers, Hawkes theorized that throughout human evolution, women who experienced menopause and lived for a while past it, helped ensure the passing of their genes by investing into their children's children. Ceasing reproduction earlier during the lifespan relieves women from the risks of childbirth in older age and opens the window of opportunity for grandmothering. Whether early reproductive senescence evolved first or grandmothering was an adaptive strategy to use an existing trait, today we are aware of a multitude of various benefits that are associated with grandmothers (Hawkes 2013).

While there has been extensive research supporting the idea that grandmothers are important for the survival and well-being of their grandchildren, little attention has been paid to the question of *how* grandmothers are contributing to their grandchildren. This thesis not only provides a review of existing literature of the evolutionary significance of grandmothers, but adds current context to the behavior through in-depth interviews. The interviews serve as an exploration into possible grandmothers' roles in our society and as a pilot study into whether grandmothers could still be having an evolutionary impact today.

Interviews completed for this project were put in the context of both an evolutionary perspective and their cultural significance. The nature of grandmothering contains a web of social and biological influences and interactions, just like many other aspects of human life. Yet, the studies of these factors have long been divided and labeled as incompatible. The reality is that humans are neither simply a product of biological and evolutionary processes, nor an assembly of cultural practices. The integration of both is often referred to as the biocultural perspective, and is the framework for this investigation. This integrated perspective embodies the values of anthropology by exploring the interaction between culture and biology, offering the

most compelling and realistic window into the nature of humanness. Although biology has determined many traits in humans and has enabled culture, culture has been able to mitigate biology and impact the trajectory of human evolution. This thesis aims to provide a broad background exploring the connections between menopause, grandmothering, and the evolution of the later life stages of human female life. The biocultural approach provides the most complete picture of these connections since both culture and biology were likely responsible for the emergence of an elongated postmenopausal lifespan that made grandmothering possible.

## Background

<u>Life History Theory</u>

All living organisms vary in how they grow and develop. A fruit fly will live a little over a month, while a giant sequoia could live for thousands of years. How long an organism is genetically programmed to live is considered a life history trait, as it determines the trajectory of an individual's life (Kaplan and Gangestad 2005). How long it takes for an organism to become mature, how many offspring they produce and how often they reproduce are all significant traits that shape life histories. Life History Theory attempts to explain the diversity in life histories found in the animal kingdom by seeing development and reproduction traits characteristic of that species' life cycle as adaptations to their environment. Life History Theory works within the larger framework of evolutionary theory: variation in life history traits can be explained by different adaptations through natural selection (Hawkes 2006). Because there is naturally occurring variation in the Darwinian fitness of individuals within a population, life history traits become optimized for reproduction and survival.

In a world with limitless resources, organisms could potentially evolve to reproduce every second and live forever, achieving the ultimate reproductive fitness. These hypothetical organisms are called "Darwinian Demons" (Law 1979), which can maximize all aspects of fitness simultaneously and would exist if the evolution of species was entirely unconstrained. Such organisms would reproduce directly after being born, produce infinitely many offspring, and live indefinitely. Although Darwinian Demons exist only in thought experiments, they help us understand the variation in life histories that exists. In reality, environmental factors such as nutrition and predators place constraints on longevity and access to resources for individuals. The variation in life histories can be explained by the different ways that organisms balance between evolutionary constraints and optimizing fitness.

In addition to constraints, trade-offs are naturally occuring in life histories (Wootton 1993). Trade-offs occur when a beneficial change in one trait is linked to a detrimental change in another (Zera and Harshman 2001). For example, if a species tends to have a large number of offspring (such as rabbits), less time and fewer resources will be dedicated to each offspring. If there were no trade-offs, then selection would drive all traits correlated with fitness to the limits imposed by real world constraints (Stearns 1992). We find, however, that that many life-history traits do not reach their respectable limits, therefore, trade-offs must exist. Since reproductive fitness is the ultimate coin of natural selection, reproductive trade-offs have greatly impacted the development of life histories (Stearns 1989). The age at first reproduction carries an important trade-off to understanding a species' life history. Early reproduction lowers the chance of dying without offspring, but later reproduction may allow organisms to have more or healthier offspring or to provide better care. Because fecundity tends to be inversely related to the amount

of energy invested per offspring, some species choose to have many offspring in hopes of some surviving, while others opt out to invest in the quality of fewer offspring.

Even within non-human primates, there is a great amount of variation in life histories: gestation length varies from 60 days to 250 days (Ardito 1976), and birth weight varies from 10g to 2000g. In some species sexual maturity is reached in less than a year (such as mice), but in others, such as the great apes, it takes as long as 13. Lifespan varies significantly as well, from less than 10 years to over 50 for the apes (Fleagle 2000). However, there are still some similarities in life history among primates. Most primates give birth to one offspring at a time. In most species, the offspring is cared for by being carried around. Weaning weight seems to be fixed at 4 times the birth weight (similarly to almost all mammals). There are some general patterns in primate life history— larger primates have longer gestation, fewer and larger infants, longer weaning ages, and longer time to sexual maturity (Lee 2011). On average, larger primates live slower reproductive lives. Size is not the only thing that impacts life history variation however— environmental factors play a big role, such as age-specific mortality rates. Even accounting for size and environmental factors, primate life histories are still unusually slow (Street et al 2017). Two reasons that can explain this is low nutritional content of milk compared to other mammalian mothers and big brains that take up a lot of energy. This gives us less energy to use for reproduction, and thus slowing down our reproductive lives (Strier 2007). Another reason could be that primates have lower mortality rates during juvenile and adult lives— without the selective pressure of early death, reproductive process is not pushed to an earlier time (Fleagle 2000). These life history characteristics define primates as quality over quantity reproductive strategists, or K-strategists in population biology terms (Gould 1977). K-strategists typically occupy stable environments, are larger than the r-strategists (second category of

reproductive strategists found in the animal kingdom), typically have higher confidence in survival, and are more energy efficient. While they produce fewer offspring than r-strategists, they invest much more energy into them. Their reproductive strategy can be defined as "to grow slowly, live close to the carrying capacity of their habitat, and produce few progeny with a high probability of survival" (Gould 1977).

As all primates are K-strategists, humans also possess this reproductive strategy. There must be a genetic basis for life history traits if such traits are to evolve over time. While there is well established evidence for some life history markers such as timing of tooth development, puberty, and growth, the genetics for the timing of other human traits (weaning and age at first reproduction) is not yet clearly established (Towne et al 2002). Nonetheless, there is genetic evidence of these markers for other species, so it likely exists in humans as well (Stearns 1992, Leips and Mackay 2000). Additionally, hormones seem to play a large role in shaping life histories (Gray and Ellison 2009) in regulating growth, development, and maturation and interacting both with genes and the environment.

Although some human life history patterns can be explained by being K-strategists, there are some characteristics that are still highly unusual. We differ from other primates in a few major life history traits. For one, human age at first birth is four to six years older than other great apes (Alvarez 2000), yet our fertility is often higher. According to life history models, a primate with our late maturity should have half the number of offspring that humans do (Alvarez 2000). In a model based on live primate populations (16 primates) rather than theory, he found that human fertility was well outside the confidence interval of the expected range. The unusually high human fertility is curious because theoretically, organisms must trade-off current with future reproduction. So, if an organism has high fertility, they are typically less long-

living— faster reproductive life histories means that selection pressures organisms to put resources into quick and multiple offspring (such as rabbits), instead of into maintenance that promotes longevity. Primates, with their slow life histories, take a long time to raise their offspring but balance reproduction with maintenance for longevity— typically even spending less energy on lactation than other mammals (Oftedal 1984). Humans, even more so than other primates, put even less energy into current reproduction (Prentice and Whitehead 1987). Unlike primates however, they are still able to maintain high fecundity.

Such high fertility for significantly slow maturing offspring means that children often get "stacked" on top of each other (Hawkes and Blurton Jones in Voland et al 2005). Our babies are much more helpless and dependent than other apes, but we wean much earlier than most apes. The distinctively early weaning and having multiple dependent offspring at the same time characterize the uniqueness of human reproductive strategies (Robson, van Schaik, and Hawkes 2006). Most mammals, including primates, wean their infant when it has reached four times it's neonatal weight (Lee et al 1991). Humans, on the other hand, are able to wean much earlier. Human infants typically reach a quadrupling of their weight at around 30 months, or about 2.5 years (Dettwyler in Macadam and Dettwyler 1995). While cultural factors and abundance of resources greatly affect age at weaning for humans, it is not uncommon for babies to be weaned before 2 years old, even before the cultural advent of formula. Other foods are typically introduced, with some cultural variability, at around 6 months.

The last and the most mysterious puzzle in human life histories is the human female post-reproductive life stage. Humans have the longest life span of any terrestrial mammal, and yet women stop reproducing two-thirds through their life, often taking on the role of a grandmother (Hawkes and Paine 2006). The later life stage of human female life have been under careful

scientific scrutiny for many years, due to unusual post-reproductive longevity. Most other animals do not outlive their fertility— they keep reproducing until death (Hawkes and Blurton Jones in Voland et al 2005), with natural reproductive senescence occuring at the same time as the senescence of the other anatomical systems.  During human evolution, with the emergence of anatomically modern humans, something slowed rates of aging even further than the already slow ape aging. However, the number of fertile years did not increase much past our ancestors or our Chimpanzee relatives.

One of the most prevalent narratives within studies of aging is that extended aging is a contemporary phenomenon, made possible only with the coming of modern medicine and inventions. This narrative is reinforced by a misunderstanding of life expectancy calculations (Hawkes 2003). If we analyze life expectancy in a hunter gatherer population and a population in a developed nation, we see that life expectancy for hunter gatherers is much lower. Upon closer inspection of the numbers, it becomes evident that the life expectancy in the hunter gatherer population is brought down by high rates of infant mortality. Once an individual survives into adolescence, they have close to the same chances of living to old age as individuals in developed nations today. In fact, through studies focusing on national census data, it is known that even a tripling in life expectancy has a very small effect on the proportion of elders in the population (Hawkes 2003).

Although some have questioned the relevance of studying hunter gatherers as models of human evolution, osteological evidence of human longevity confirms that humans have been able to survive to old age prior to the advent of modern medicine. Although there have been limited paleodemographic studies done, the sites analyzed show that life history tables did not differ much from contemporary hunter gatherers and horticulturalists (Hawkes and Paine 2006).

While evidence is limited and should be taken with a grain of salt due to the fact that burials do not necessarily accurately represent population demographics, the model supports the idea that surviving to old age was not uncommon throughout the *Homo* lineage. Even with limited fossil evidence, we can at least safely conclude that life expectancy says little about adult age structure, and old age could have been a common occurrence for individuals who lived past adolescence.

Menopause

Human longevity likely increased at the latest during the emergence of anatomically modern humans, but some surmise as early as in the Pleistocene with the emergence of *Homo erectus* (Hawks, O'Connell and Blurton Jones 2000 in Cronk et al). While for men, reproductive senescence seems to align with somatic senescence, women's fertility is cut off two thirds through their expected lifespan. Because this thesis explores the possible adaptive benefits of menopause, it is important to review the process and the event of menopause.

Unlike men who continue making sex cells (sperm) throughout their entire lifespan, women do not make sex cells (eggs) past their fifth month while still in utero (Leidy Sievert 2006). At five months, a female fetus will develop up to seven million oocytes (Weir and Rowlands 1977, Heffner and Schust 2010). These oocytes are then covered with a protective layer of granulosa cells (Moore 1988). After being covered, they are referred to as primordial follicles and become the pool from which developing follicles emerge (Peters and McNatty 1980, Heffner and Schust 2010). Oocytes that were not covered by the granulosa cells degenerate before birth, cutting the number of sex cells a female is borth with to around two million. Both granulosa cells and follicles produce hormones (including estrogen, inhibin, and progesterone) controlling the pattern of changes throughout the menstrual cycle. During the reproductive life

stage, these hormones that are produced in the ovaries send signals to the brain and regulate the secretion of other hormones, such as FSH (follicle-stimulating hormone) and LH (luteinizing hormone) (Leidy Sievert 2006). Specifically, female gonads secrete inhibin, which controls the amount of FSH released by the pituitary in the brain. Across the female lifespan, the number of follicles decreases. With dropping secretions of inhibin, FSH becomes unregulated and therefore, rises (McKinlay et al 1992). This increase, along with an increase of LH, begins about five years before menopause (Rannevik et al 1995). At some point, as ovarian follicles continue to decline, they are no longer able to maintain menstrual regularity at which point there is a quick drop in estrone and estradiol and a quick rise in FSH and LH. This is when there is a full cessation of menses.

While every woman who lives past sixty experiences menopause, there is a large amount of individual variation in the timing and the symptoms of the phenomenon. The transition begins with a perimenopause stage typically between the ages of 40 and 60. The age at which the menopause transition begins is largely dependent on the rate of follicle loss across the lifespan. We do know that age at menopause is highly heritable— 63% of variation in age at menopause can be explained by genetics (Snieder et al 1998). The rest is influenced by the environment, such as smoking, chemotherapy, or ovarian surgery. Ethnicity may also affect age at menopause— an average Hispanic or African-American woman achieves menopause earlier than other populations, Caucasian women in the middle, (with an average of 51.5 years) and Asian women a bit later (Henderson et al 2008). This difference in ancestry is likely just a result of genetic heritability of age at menopause, rather than cultural differences. Contrary to common belief, age at menarche, reproductive history, and birth control use do not affect age at menopause significantly.

The large amount of variation in age at menopause that is observable in both within and between human populations is significant for adaptationist scenarios of the evolution of menopause. The variation plus the high heritability means there is room for natural selection to act on individuals' reproductive fitness and either increase or decrease mean age at menopause (Peccei 2001). Premature ovarian failure, or early onset menopause, is a perfect example of the influence of genes on age at menopause. Premature ovarian syndrome is defined as menopause prior to age 40, and has a variety of causes from immune system issues to a woman's body developing antiovarian antibodies (Chernyshov et al 2001). Women who reach menopause before the age of 40 are typically excluded from studies on menopause because it is considered pathological. However, some experts suggest that the premature ovarian failure trait could have been the mechanism which separated reproductive senescence from somatic senescence (Peccei 1995). This separation would give opportunity for natural selection to act on those individuals who began to have much early menopause. If during early human evolution women who had premature ovarian failure were able to contribute significantly more to their offspring and their offspring's offspring than women who continued procreating, menopause could have emerged.

There are a few adaptive scenarios for the appearance of menopause in human populations. Once menopause emerged, it could have ensured that mothers raise their young. Because human babies are dependent for much longer than other species, women ceasing childbirth can make sure that their last child is raised with maximum resources and at the same time avoid the increasing risks that come with later childbirth. Human childbirth is particularly difficult due to bipedalism and large infant heads, and older mothers are more likely to have difficulties in pregnancy (Sauer 2015). Menopause can allow older women to avoid high risk pregnancy and instead invest in already existing progeny. Menopause could also be adaptive as

an avoidance of unhealthy children. Because oocytes remain in the body from birth, older women's oocytes are more likely to have age-related chromosomal abnormalities (Sandin et al 2016). Again, menopause can help women avoid those risks and instead invest in existing children. Another hypothesis builds on the fact that menopause conserves maternal energy (Hall 2004). Due to the fact that menstrual cycling has high energetic costs, females who forego menses later in life can instead invest in existing offspring and their own longevity.

The Mate-Choice Hypothesis proposed in 2013 (Morton et al., 2013) takes on a slightly different perspective. Instead of looking at the fertility/reproduction evolutionary pressures, it considers sexual selection to be the reason behind menopause. The authors argue that a change in mating preferences provided a means for evolving the menopause phenotype. If adult males only mated with young adult females, there would be less selection on older females. The relaxed selection would enable an accumulation of mutant alleles over time (since nothing would be selecting against them) which would eventually lead to menstruation cessation. This argument however is circular, since it argues that men prefer younger women because younger women are better at reproducing, hence why older women are worse at reproduction.

While these scenarios contribute to explaining the emergence of menopause, they fail to explain the extremely long post-reproductive lives that women lead, and how it could be adaptive under Darwinian principles to live nearly 1/3rd of your life in the post-reproductive stage.

Grandmother Hypothesis

One of the most supported and accepted explanations of long postmenopausal female longevity is the Grandmother Hypothesis (Hawkes et al 1997). Developed in the 1990s by Dr. Kristin Hawkes, the hypothesis explains the evolution of female postmenopausal longevity by focusing on the contributions from grandmothers to grandchildren. Older women that underwent menopause can redirect their resources from risky and costly pregnancies to their offspring's offspring, ensuring the passing of a quarter of their genes per surviving grandchild. While the hypothesis in most simplistic terms is an explanation for the adaptive benefits of menopause, it actually addresses many puzzles of human life history (Hawkes et al 2005). The contributions of grandmothers likely enabled the long juvenile period essential for learning and overlapping of dependent children as grandmothers are able to take over providing resources to dependent offspring so their children can reproduce again sooner (Hawkes et al 2000).

Understanding the profound impacts of grandmotherhood is important for understanding all phases of human life history, as well as to gain insights on sociality and early emotional development (Hawkes and Coxworth 2013). While some critics of the Grandmother Hypothesis remain (Peccei 2001, Pavard 2008, Kachel et al 2011) it is a largely accepted framework of analyzing the evolution of human lives and behaviors. While tactics that heavily influence survival (such as providing subsistence to grandchildren) (Hawkes 1997) are emphasized within the grandmother hypothesis, less prominent strategies such as intellectual stimulation through play, emotional support, and grandmothers' helpful wisdom likely also play a role in selecting for long female longevity to this day (Kaplan et al 2010).

The earliest version of the grandmother hypothesis originated in 1950s when Dr. George Williams, an evolutionary biologist, suggested that menopause is an adaptive trait (Williams

1957). Williams proposed that menopause evolved because later in life women have more to gain from childcare than from continued fertility. This became known as the 'Good Mother Hypothesis'. The Good Mother Hypothesis argues that women are able to forego the risk of death due to childbirth complications, instead focusing her resources onto existing offspring. This is enough to compensate, in genetic terms, for stopping fertility early. Williams suggests that menopause does not happen earlier because the risk of childbirth that menopause helps offset is not as drastic for younger women, who can have children with relatively low risks of mortality. Therefore, menopause is at a perfect threshold. Williams also proposes that menopause has not evolved in other species because it is unique among the animal kingdom to have such intense, long-lasting parental care.  Hamilton furthered this discussion in the 1960s through elaboration on the difference between senescence and decline in fertility (Hamilton 1966). He acknowledged that declining fertility is a lot more complex than just demographic mortality studies, and elaborated on reproductive energetics that go into human female reproduction. His discussion further promoted Williams' argument that menopause is an adaptive trait, and reinforced the fact that senescence is impacted by natural selection just like many other life history traits. Hamilton's work was pivotal for many fields of biology as he first developed kin selection theory (Hamilton 1964). Kin selection theory helps us understand why altruism (benefiting others at a cost to your own fitness) can evolve. Altruism, similarly to post reproductive lifespan, goes seemingly against basic Darwinian principles, because individuals decrease their own fitness for the benefit of others. Altruistic behaviors are susceptible to cheating, because it would be easy for an organism to take advantage of altruism around them without giving anything back, which would result in a decrease of altruistic genes over time. Hamilton proposed that evolutionary strategy would favor the reproductive success of an

organism's relatives over organism's own survival and reproduction. Kin selection can be adjusted because individuals can choose how much they want to sacrifice for another individual based on degrees of relatedness, which makes this altruistic strategy less vulnerable to cheating. Kin selection theory is important for understanding why grandmothers would dedicate resources to their offspring's offspring.

Building upon the foundation of evolutionary biology by Williams and Hamilton, Kristin Hawkes was studying the behavioral ecology of the Hadza hunter gatherers in Tanzania through the 1980s and 1990s. The Hadza people are an indigenous ethnic group in north-central Tanzania with a population of around 1,200-1,300 individuals. Genetically, the Hadza are descendants of the aboriginal hunter gatherers of Tanzania and have likely resided in the same territory for thousands of years (Marlowe 2010). While since the 18th century they have had increasing contact with farming and herding people, they have retained a very similar way of living to their ancestors according to both the Hadza's own accounts and ethnographic records from the early 20th century (Ndagala 1994). Hawkes, along with many other scientists who are interested in human evolution, have studied hunter gatherer populations such as the Hadza for many years. This is because until very recently (about 10,000 years ago), all humans were hunter gatherers (Lee and Daly 1999). While we have adapted to a new way of life through the agricultural revolution and the industrial revolution, much of our biology was shaped during our existence as hunter gatherers. Scientists use hunter gatherer populations as models of past behavior. While this can be problematic— their culture and technology could be seen as reified instead of adaptable and dynamic— there are merits to this framework when used by behavioral ecologists. For one, human behavioral ecology sees behaviors as adaptations to the environment. Many of the Hadza's behaviors such as their social groups, and their reproductive and subsistence

strategies can be seen as adaptations to the climate around them (Hawkes et al 1997). The Hadza are a modern people, but just like our ancestors, they face constraints from the features of local ecology which they mitigate with behavioral trade-offs and optimal solutions over time (Hawkes et al 1997). If the relationships between the constraints, trade-offs, and variability in ecological adaptations can be taken as general frameworks, then these observations can help us form fundamental hypotheses about patterns of human behavior in the past (Hawkes et al 1997). Basically, direct ethnographic observations in hunting and gathering communities can help scientists test hypotheses that depend on fitness-related constraints imposed by dependence on wild foods and simple technology (Hawkes et al 1997). Further studies of different hunter gatherer groups that live in dramatically different environments help us understand differences and similarities between groups to be able to better tease apart which strategies are associated with the broad hunting/gathering subsistence and which are specific to populations (Stutz 2012).

Like many behavioral ecologists, Hawkes specifically paid attention to subsistence strategies as she observed the Hadza in the 1990s. In particular, she noticed older women contributing a great deal of time to food acquisition, especially, hard to get tubers. Dr. Hawkes and her team hypothesize that the provisioning of these tubers is not only important to grandchildren today, but was instrumental in the evolution of human female longevity during *Homo erectus.* Towards the end of Pliocene, changes in climate drove *Homo erectus* precursors to look for more new food sources beyond fruit (O'Connell et al 1999). Tubers would be a widely available but difficult to obtain food source. Hawkes and others suggest that grandmothers began subsidizing their grandchildren's diet with this time consuming, novel food source (Laden and Wrangham 2005). The tubers have to be prepared a certain way, but even if consumed raw,  would have provided a benefit. Isotopic analysis of *Homo erectus's* teeth reflects

a diet containing underground roots (Yeakel et al 2007). This model of ancient grandmothers providing tubers for their grandchildren was gradually expanded to explain how humans have successfully combined an extended period of offspring dependency, late reproduction, and short breastfeeding.

The original proposals of the grandmother hypothesis were mostly based on the Hadza model. Subsequent work among other populations shows that grandmothers have a variable influence on infant mortality and child health (Jamison et al 2002 in Japan, Ragsdale 2004 in 19th century England). Expanding the grandmother hypothesis beyond the Hadza illuminated trends in grandmotherhood that were previously not seen. For example, many (but not all) studies showed a bias towards maternal grandmothering (Euler and Weitzel 1996), with some data showing that paternal grandmothers can have deleterious impacts on grandchildren (Sear et al 2000, Strassman et al 2006, Voland and Beise 2002; Kadir et al 2003; Schiefenhovel and Grabolle, Leonetti et al, Beise, Voland and Beise, Miller and Harwood  in Voland et al 2014). This makes sense in the light of kin selection theory. Since organisms can adjust to whom they donate the most resources, they can adjust their altruistic behaviors depending on degree of relatedness. Maternal grandmothers have a lot more certainty that their grandchildren are related to them because they know they gave birth to their daughter and can observe their daughter go through pregnancy. Paternal grandmothers on the other hand have less certainty that their grandchildren are closely related to them because there is less paternal certainty. Another difference between paternal and maternal grandparents could be that in most populations, paternal grandmothers end up being older than maternal grandmothers due to the tendency of women to reproduce at a younger age than men. For example, among the Masaai, the average age at first birth is 15 for women and 30 for men.

The role of maternal grandmothers is near ubiquitous cross-culturally on child survival, with data showing that their contributions generally equal or exceed that of fathers (Mace and Sear in Voland et al 2014). Interestingly though, when examining which kin influence female fertility, maternal grandmothers are not a significant factor. On the contrary, paternal grandmothers will play a role in increasing fertility in their daughters in law (Voland and Beise 2002, Sear et al 2003, Leonetti et al in Voland et al 2014). This too makes sense in the light of kin selection theory— while paternal grandmothers do not invest as much into grandchildren, the more they influence their daughters in law to reproduce, the greater the chance of paternal certainty. It is possible that the negative impact paternal grandmothers exert on their grandchildren are a result of their pushing for higher fertility in their daughters in law, thus favoring quantity over quality of grandchildren. The degree to which this happens is variable, because while paternal certainty is not as great as maternal certainty in any society, it is still largely culturally dependent. The degree to which a paternal grandmother will perceive genetic relationship with her grandchild will be largely dictated by the presence of institutionalized social control over women's behavior (Nosaka and Chasiotis in Voland 2014).

An important variable to consider when analyzing the difference between paternal and maternal grandmothering is the cultural relationship between grandmothering and gender preference. Studies of parent-adult child interactions suggest that mother-daughter relationships tend to be stronger than mother-son relationships (Silverstein and Bengston 1997). This analysis, done in the U.S, also showed that mother daughter relationships are stronger when the daughter has dependent children in the household. Another study, also completed in the U.S, not only demonstrated that adult children with offspring received more resources from their parents, but that daughters received more advice, services, and child care assistance (Cooney and Uhlenberg

1992). In populations where daughters move away to live with the husband's family, this tendency is harder to measure. However, in two instances (Germany and Turkey), we know that when distance is accounted for, mothers still tend to spend more face to face time with their daughters (Nosaka and Chasiotis in Voland et al 2014).

Another path of research is examining *when* grandmothers are most helpful. Some studies suggest that whether a grandmother is present or not is most important past toddlerhood (Sear et al 2002). Grandmothers have been particularly important at the time of weaning. A study from the Trobriand islands reflects on the traumatizing time of weaning— both psychologically and physically since there is no weaning foods, and the importance of having a grandmother around to receive comfort (Schiefenhovel and Grabolle in Voland et al 2014). During this time, recently weaned infants are also more vulnerable to upper respiratory infections and other diseases, and grandmothers' experience and medical knowledge becomes vital in preventing infant mortality.

While these trends may have biological and evolutionary explanations, the cultural factors also appear to be relevant. While there are many studies, such as described and cited above, that show the bigger impact of maternal grandmothers, this is not always the case. Grandmothering among the Ache of Paraguay for example did not show any benefit at all (Hill and Hurtado 1996). A study of grandchildren and grandmothers in rural Greece demonstrated a stronger tie and benefit between grandchildren and paternal grandmothers (Pashos 2000). This may reflect the influence of social organization on the dynamics of intergenerational relationships. In the case of Greece, the society places value on stronger patrilineal and patrilocal family structure, with little variation. Another interesting comparative analysis was done between two populations in India— the matrilineal Khasi and patrilineal Bengali (Leonetti et al in Voland 2014). The grandchildren in matrilineal families, raised by maternal grandmothers,

had a greater BMI, and the mothers had lower infant mortality rates as compared to patrilineal Bengali. However, the BMI measure was not a significant difference between the populations. The infant mortality rates and miscarriage rates were, on the other hand, significantly higher in the Bengali population. The authors hypothesize that paternal grandmothers put resources directly into the grandchildren after they reach a certain age. Maternal grandmothers in this community on the other hand dedicate resources to their daughters thus ensuring a healthy mother and subsequently healthier grandchildren. This study is an important insight into how social organization and culture impacts biology and provides a glimpse into the importance of studying culture in relation to human evolution.

**Interviews and Analysis**

<u>Introduction</u>

The evolutionary history of reproductive adaptations are very difficult to investigate, as they may leave little evidence in the fossil record. The extended post-reproductive lifespan in women could have evolved as far back as *Homo erectus* in the *Homo* lineage, and likely persisted largely due to grandmotherly helpfulness with subsistence, but also possibly midwifery and navigating landscapes in times of climate change. Even with the growth of the Grandmother Hypothesis and application of it to different populations, our understanding of the roles, behaviors, and identities of grandmothers is not complete. Globalization and social justice movements are moving us away from traditional societies that have remained strictly matrilocal and patrilocal. Grandmotherhood itself is variable not just globally, but within communities as well. To explore the contemporary variation in grandmothering and their intergenerational reproductive strategies, I conducted 15 in-depth interviews with grandmothers, mothers, and grandchildren to begin untangling these complex questions. The interviews explored the roles and behaviors of grandmothers to examine whether some of the same pressures that may have influenced the emergence of extended female longevity are still in play in the modern world. The interviews provided a glimpse into the workings of the Grandmother Hypothesis and reflected some of the associated variables in our society, as well as provided crucial insight into the grandmother identity. I found common themes of grandmothers being helpful both to their grandchildren and their daughters, as well as explored what the grandmother identity means to grandmothers themselves. These themes provide a better understanding of the proximal mechanisms of grandmothers' reproductive strategies.

It is impossible to study grandmotherhood and not reinforce the biocultural approach. This approach embodies the value of the anthropological perspective by exploring the interaction between culture and biology. This synthesis is often lost within the divide of subdisciplines within anthropology, but it offers the most compelling and rigorous window into the nature of humanness. It is not enough to see post-reproductive lifespan as a strictly biological, adaptive trait with a specific purpose. In fact, most characteristics that make humans unique should be seen as inextricably bound to a multitude of features. Human dependence on culture and culture's influence on our biology makes it difficult to untangle the web of interconnectedness surrounding grandmothers— and I do not think it is necessary to see them as separate. Human behavioral ecology is in itself both cultural and biological. While undoubtedly there is a scope of variation to this, humans manipulate culture to maximize their reproductive fitness (Cronk 1995). While it is known that grandmothers increase the reproductive output of their children (Nath et al 2000, Hawkes 2015) and decrease infant mortality (Sear et al 2000, Beise and Voland 2002, Lahdenpera et al 2004, Gibson and Mace 2005, Sear and Mace 2008), the proximal mechanisms of these strategies are not yet thoroughly explored.

Methods

Data were collected through in-depth interviews completed over a span of two months with 15 informants. Six of the informants were grandmothers, 4 were mothers, and 5 were grandchildren. Interviews were completed in various locations throughout southern Massachusetts and recorded with the permission of the informant to be transcribed and analyzed. Each interview provided me with a unique perspective on the variation in grandmaternal care and the meaning of grandmotherhood in our society. The purpose of interviewing different age

groups and generations was to collect unique perspectives that each generation may have on grandmothering behavior and to search for patterns across various generations. Four families contributed interviews to my research, providing me with a unique, intra-familial perspective.

The interviews were performed in a semi-structured format, with a question list guiding the conversation (Appendix A). In semi-structured interviews, the interviewer adjusts the questions based on the insights that the informant is providing, depending on what train of thought they wish to follow. The questions are designed in a narrative method: they are open ended and allow for a wide range of responses. Some examples of questions are: Were your grandmothers involved in your life while you were growing up and how? What kind of a grandmother do you envision yourself to be? How does this compare to your experience with your own grandmother? This style of interviewing allows the participants to share a wealth of information while not being influenced by overly specific questions. The style of my research was designed to flow as a natural conversation.

The questions are not asked in a given order but rather kept as a checklist and asked at the interviewer's discretion depending on the flow of conversation. The older the informant is, the more intergenerational layers can be uncover through the interview. For example, for the grandchildren generation, questions focus on their grandmothers, what role they played in their lives, what kind of resources they provided, if they lived near or far, if they helped their parents with babysitting and what their parents did while the grandmothers babysat, etc. For the 'mothers' generation, focus was in the role their grandparents played in their life and if their parents played a role in their children's lives and what support was provided. With the grandmothers generation, more information can be obtained about their grandmothers, their experience as parents, and their own role as grandmother. The qualifying questions to select

informants were purposely vague to not limit the research to a specific question— "Are you a grandmother?" for grandmothers, "Did a grandmother play a role in the lives of your children?" for mothers, and "Did a grandmother play a role in your life?" for grandchildren. At the beginning of each interview, a consent form was given to the informant for signature (Appendix B). The consent form was thoroughly explained, the topic of my research discussed, and any questions answered. At the end of the interview, the informant received a small token of appreciation consisting of a thank you note, tea, and cookies. At the completion of the interview process, interviews were transcribed into a password protected google document file with the use of Philips transcription pedal and software. Interviews were coded for repeating themes/behaviors.

<u>Participants</u>

*Grandmothers:*

|  | G1 | G2 | G3 | G4 | G5 | G6 |
|---|---|---|---|---|---|---|
| Maternal or paternal? | P | M | M | M + P | M | M |
| Lives? | With spouse (but very close to GC) | With spouse (but very close to GC) | With child + grandchild | With child + grandchild | ½ time alone ½ with child and grandchild | With child + grandchild |
| How many kids? | 4 (3 boys 1 girl) | 2 (1 boy 1 girl) | 2 (1 boy 1 girl) | 4 (3 boys 1 girl) | 2 (1 boy 1 girl) | 1 (girl) |
| How many grandkids? | 1 (boy) | 1 (girl) | 1 (boy) | 5 (4 boys 1 girl) | 1 (girl) | 2 (2 girls) |
| Grandkids age? | 20 months | 12 months | 2.5 years | 6,8,16,23, 25 | 1.5 years | 15, 20 |

G1 became a grandmother two years before when her son's wife gave birth to a baby boy. She has four children (3 boys and 1 girl), but so far only one grandchild. Her son's wife is pregnant with a second child. G1 lives with her spouse and two of her adult youngest children, a boy and a girl. Her two oldest sons live in separate houses in the same neighborhood. Her 2nd oldest son lives with his wife and G1's grandchild across the street from G1. G1 works full time but sees her grandson multiple times a week.

G2's granddaughter is a year and a half, and lives down the street with G2's daughter and son in law. G2 has two children, a boy and a girl, but only her son does not have children. She lives with her spouse, but visits her daughter's house nearly everyday. G2 works full time.

G3 also works full time, and takes on a role as a second parent for her grandchild. She lives with her spouse, her mother, her daughter (M1), her son, and her grandchild who is three

years old. Everyone in the family participates in caretaking of the little boy, including sometimes his great-grandmother.

G4 has four children (3 boys and 1 girl) and five grandchildren (4 boys and 1 girl). She lives with her daughter's (M2) family and her paternal granddaughter who she's been raising since she was a baby. Her sons visit often (nearly everyday). She no longer works, but is an active participant of her church.

G5 has two children, 1 boy and 1 girl. Her daughter (M3) had a baby girl two years ago. She lives in Florida by herself, but flies up to Massachusetts several times a year to spend time with her granddaughter and help her daughter and son in law with caretaking. She is retired, but is an active participant in community groups such as a singing in a Performing Arts Group.

G6 has one daughter (M2) and two granddaughters. She lives nearby her daughter's family, but until very recently lived with her daughter to provide childcare. She frequently visits her spouse overseas. She raised both of her granddaughters so her daughter could focus on her career. She no longer works but is an active member of her church and an avid gardener.

*Mothers:*

|  | M1 | M2 | M3 | M4 |
|---|---|---|---|---|
| Children? | 1 | 2 | 1 | 2 |
| Age? | 25 | 52 | 40 | 42 |
| Age at 1st Child? | 23 | 27 | 38 | 20 |

| Raised kids? | Raising alone | With spouse | With spouse | 1st alone, 2nd with spouse |
|---|---|---|---|---|
| Lives with? | Mom | Mom+spouse | Spouse +½ of the time Mom | Spouse |

M1 was a single senior in college when she found out she is pregnant. She gave birth to a baby boy two months after graduation (now 3 years old) and moved in with her mother. M1's mother (G3) quickly took on a role as a second guardian and is very active in raising and supporting the child. M1 is raising the child without a partner and works full time. She lives with her mother, her grandmother, her father, and her brother all of whom actively participate in watching M1's son. Her partner's mother has not participated in M1's child's life.

M2 has two children— both adult boys, and both no longer live with her. She lives with her mother (G4), her niece, and her husband. Her mother played an active role in raising her children and she did not trust anyone else with babysitting when they were growing up. M2's mother in law was not alive long enough to play an active role in M2's children's lives.

M3 has a two year old daughter. She lives with her daughter and her spouse. Her mother (G5) visits a few times a year if M3 has a particularly busy time or needs her mom's help. Her husband's mother does not play as active of a role in her child's upbringing.

M4 lives with her two daughters and her husband. Her mother (G6) has lived with her for most of her children's lives and engaged in active caretaking, but has recently moved to a nearby apartment. Her husband's mother also helped with grandchildren through weekend babysitting and financial help.

*Grandchildren:*

|  | C1 | C2 | C3 | C4 | C5 |
|---|---|---|---|---|---|
| M/F? | F | M | F | M | F |
| Age? | 23 | 22 | 20 | 23 | 22 |
| Which GM? | maternal/ some paternal | maternal | maternal | paternal/ some maternal | maternal |
| Grandma lives? | Mat. with M1/ pat. deceased | With M2 | With M3 | With spouse, close by for mat./close by for pat. | With spouse, close by |
| Siblings? | 1 | 1 | 2 | 1 | 0 |

C1 lives with her mother (M4), sister, and father. She vividly remembers her time with her maternal grandmother (G6) and all of the activities they did together. She also has many fond memories of her paternal grandmother, whom she saw primarily on the weekends.

C2 lives with his father and step-mother. During his childhood, he spent a lot of time with his paternal grandmother, whose house was a childcare for her nine grandchildren. He does remember his maternal grandmother, but she did not play as big of a role in his life.

C3 lives with her paternal grandmother (G4), aunt (M2), and uncle. She had a difficult childhood and both her mother and her father lost custody over her. Her grandmother has been raising her since she was a little girl. After her grandmother got severe arthritis and was not able to work anymore, she moved in with her daughter, C3's aunt. C3 has only met her maternal grandmother a handful of times.

C4 lives alone, but until recently lived with his mother (M2), grandmother (G4), cousin (C3), and father. His maternal grandmother (G3) played a significant role in raising him, but he barely remembers his paternal grandmother.

C5 lives with a partner, but has lived with her parents until very recently. Her maternal grandparents played a large role in her upbringing, and she barely remembers the grandparents on her father's side. Her grandmother lives nearby with her spouse. She has spent at least a few days a week with her while C5 was growing up. C5 has vivid memories of her grandmother nurturing her in times of sickness in particular, because she had poor health growing up. C5 is her grandmother's only grandchild.

Results

My findings are divided into three parts: alloparenting, proximal mechanisms, and the grandmother identity. Benefits for grandchildren included grandmothers acting as step-in caretakers, and providers of time consuming care. Grandmothers were often very important to their daughters as intermittent relief from childcare, support when the mother has a new child, and advice on pregnancy and child rearing. A few of the themes grandmothers touched upon when discussing their identity as grandmothers were continuity, centrality, cultural/social passing, re-living adulthood, and nurturers. There was also a noticeable bias towards maternal grandmothers, which was discussed by half of the interviewees.

*Intermittent and Constant Grandmaternal Alloparenting*

It is not easy raising a human child— as discussed in the Life History section, we have particularly needy offspring that require our assistance for an extended period of time ( Kramer 2005, Hrdy 2009). Alloparenting plays a big role in human development and is one of the adaptive strategies that humans use to counteract the trade offs that come with extended child

rearing. The involvement of others into child rearing is not a result of carelessness or neglect by the mother— that would not make sense since human children are so costly (Trevathan and Rosenberg 2016). Research shows that humans are just as hypervigilant as other apes— human babies are nearly always being held, just not necessarily strictly by their mother (Konner 2005). The patrilineality observed in other great apes leaves little opportunity for alloparenting since mothers come into unfamiliar groups and infanticide is common (Hrdy 1979, Van Noordwijk and van Schaik 2005, Townsend et al 2007). In other primates, alloparenting may be frequently observed and has measurable benefits for reproductive fitness of mothers. For example, colobine monkeys that live in tight knit matrilineal kin groups and have relaxed female dominance relations breed faster than other monkeys (Hrdy 2009). Their 'daycare' oriented cooperative breeding allows them to wean earlier and reproduce faster while still having confidence that their offspring will not starve.

Cooperative breeding makes a difference in human decision making and birth intervals as well— availability of support from matrilineal kin has been shown to be more decisive than income in a mother's decision to keep or abandon her baby (Kertzer 1993, Hrdy 1999). Furthermore, studies have shown that if women in industrial nations perceive that they will not have much childcare support, they often choose to postpone childbirth (Critterden 2001, Olds et al 2007). The presence of grandmothers plays an especially important role in these decisions. For example, grandmothers are particularly important to adolescent mothers and play a key role in helping infants and inexperienced mothers bond (Spieker and Bensley 1994). The interviews touched upon two categories of alloparenting— grandmothers taking on the role of primary caretakers and intermittent care through babysitting.

1) Step-In/ Insurance

One of the most evolutionarily significant themes found in this research is the importance of grandmothers as back-up caretakers in case something happens to the primary caretakers. Having a backup caretaker for young children provides an "insurance" and greatly improves the likelihood of the child surviving into adulthood in the case of parental death or abandonment. While the death of a mother within the child's first two years is catastrophic for its survival, the outlook greatly improves past the second year (Sear and Mace 2008). In foraging societies, grandmothers make the biggest difference as step-in caretakers, even more so than fathers, and their presence is most correlated with increased child survival. In the Trobriand islands for example, a study reflects on the frequency of maternal grandmothers taking on the role of adoptive parents when a couple is not ready to take care of a child. Over 40% of all adoptions are to maternal grandmothers (Schudenhovel and Grabolle in Voland et al 2014). As grandmothers take on a primary caregiver role, they are also beneficial in moderating high cortisol levels associated with childhood trauma (Flinn and Leone 2006). High cortisol levels in children that experienced high stress are linked with numerous health and behavioral problems later on in life, such as low immune responses (Ruttle et al 2011, Pervanidou and Chrousos 2012). While grandmothers will often have many grandchildren to distribute resources to, research shows that they allocate resources based on who needs them the most (Blurton Jones et al 2005). Interview examples can be found in Appendix C.


2) Babysitting/Daycare

Having an insurance caretaker for a child in case of an unforeseen event is a clear adaptive advantage. However, the intermittent care that grandmothers provide is also crucial. In

my interviews, every single grandmother was an active babysitter if not the primary caretaker. Every mother described in detail the importance of having a grandmother around while raising her child. Every grandchild reflected on the long hours their grandmothers have spent with them. While this sample is limited and results possibly biased (would an individual whose grandmother did not spend time with them want to be interviewed?), demographic data supports the notion that a large number of grandparents are providing care and at a growing rate (Baydar and Brooks-Gunn 1998). The National Survey of Families and Households estimates that in the U.S, 43% of grandparents, mostly grandmothers, provide childcare at least once monthly. National field poll data found that 32% of grandparents provide care at least once a week, with the average amount of time dedicated to this activity being 13.6 hours (Bass and Caro 1996). In a more up to date European sample of 35,000 individuals, almost 60% of grandmothers provide some type of regular care (Hank and Buber 2009). There is little comprehensive research on the quality and quantity of care grandmothers provide because there is a high amount of variation both within and between populations. Nonetheless, researchers have focused on the presence of grandmothers in the same community to show that babysitting/intermittent care still plays a role in the survival of children. An overview of European and North American farming communities showed through demographic analysis of written records that reproductive success of a woman who lived near-by her mother is significantly higher than women who do not have their mother in their community (Voland and Beise 2005). Records of Canadian and Finnish women who lived in the same communities as their mother lost significantly fewer children (Lahdenpera et al 2004). On average, post-reproductive women gain about two grandchildren per each decade that they are alive (Hrdy 2009).

Interview Examples can be found in Appendix C.

<u>Proximal Mechanisms</u>



*Fig. 1 lists activities performed by grandmothers for grandchildren by the # of individuals that mentioned this activity.*

The purpose of the interviews was not only to understand how much time grandmothers spend with their grandchildren, but also what they do during this time. I was curious about the different ways grandmothers can contribute to their children's reproductive fitness. Some of these interactions that arose during my interviews were participating in time consuming activities, one-on-one time, significant food contribution, and guidance for mothers through pregnancy and child rearing. The classic Grandmother Hypothesis centers around subsistence strategies as grandmotherhood likely became adaptive as older women helped young children acquire elusive foods such as tubers. The nutritional benefits of grandmothers (Hawkes 1989, Sear et al 2000, Aubel et al 2004, Kerr et al 2008, Sear and Mace 2008, Aubel 2012) are more studied than the cognitive/behavioral benefits because they are easier to observe and quantify. However, there is enough research to suggest that grandmothers play a positive role in

grandchildren's cognitive and socioemotional development (Furstenberg 1976, Tinsley and Park 1987, Coall and Herwigg 2010, Tanskanen and Danielsbacka 2017).

The interviews elucidated on the mechanisms of these processes through themes of time-consuming activities that many parents do not have time for, and intensive one-on-one time. I categorized both of these overarching themes as "mind-molding". Grandmothers that are active in caretaking put a lot of time and effort into interactive activities with their grandchildren, thus increasing their social skills and improving their cognitive function. This could be influenced by retirement and having a lot of extra time, and developing a more patient approach to caregiving through the years. Activities such as reading, long walks, singing, cooking, storytelling, and board games were all reported to be done at a higher level by grandmothers rather than parents or other caretakers. Primates have a similar pattern of investing more into quality of upbringing as they age (Nicolson 1987, Borries 1988, Paul et al 1993). It makes sense for older primate mothers to be investing more into their last offspring, and the intervals between birth will typically increase with age. In humans, there is a positive relationship between age of the mother and psychological commitment to offspring (Gregory 2007). Interview examples can be found in Appendix C.

Guidance and Emotional Support:

Each interview with mothers and grandmothers touched upon providing/asking for guidance and emotional support through pregnancy and the upbringing of the child. This ranged from M3 calling with questions about physical changes during pregnancy to M2 staying at her mother's house for 2 months due to a paralyzing fear of not knowing what to do with a newborn. The beneficial wisdom of older females is not limited to humans. Non-human primates that

practice female philopatry, such as baboons or macaques, reap the benefits of having matrilineal kin around. This is particularly important for first time mothers who have a lot to learn in order to become competent mothers (Cockburn 1996, Russell 2000, Ekan and Ericson 2006). Interview examples can be found in Appendix C.

The Grandmother Identity:

Throughout my interviews with grandmothers, we would often discuss what grandmotherhood means to them, how it became a part of their identity, and what that identity actually is. The following list is composed of themes that were touched upon the most by the 6 grandmothers. Examples from the interviews can be found in Appendix C.

*Continuity*

The theme of continuity was central to most grandmothers as they attempted to describe to me *why* grandchildren were such a joy to them. As individuals get older, mortality becomes a more prevalent thought with declining health and the passing of one's own elders and friends. Grandmotherhood helps counteract the decrease in morale that often comes with old age and highlights the continuity of life.

*Centrality*

Centrality was the extent to which grandmotherhood became the main identity of the woman. Four out of the six grandmothers interviewed saw themselves as first and foremost grandmothers, describing a shift in identity with the birth of their grandchild.

*Cultural/Social Passing*

The passing of cultural heritage seemed to strongly fall into a grandmother's responsibility. Three out of four mothers I interviewed expressed strong desire and encouragement for their mothers to pass family/cultural traditions to their grandchildren. 4 out of 6 grandmothers expressed passing their cultural heritage as something they deemed central to their identity as a grandmother. Activities that fostered cultural/social passing included: singing, reading, cooking, storytelling, and sharing life lessons.

## Discussion

The results of my interviews are consistent with existing literature in that there are trends in grandmothering, but they are highly variable. Presence of grandmothers tends to make the most difference under conditions of risk— as step-in caretakers and as advice providers. In the absence of a father, maternal grandmothers seem to take on a role of a second parent. They also provide important guidance to young mothers that may contribute to lower infant mortality. All grandchildren reported resource contribution from their maternal grandmother, most through food and emotional support, but some through direct financial support. While my focus was on the benefits grandmothers may provide, it is not possible to blanket all grandmaternal influence as positive. C4 in particular comes to mind, as he remembers being babysat by his grandmother and having cultural conflicts with her— she would try to push religion on him, and he would resist. M1, whose mother is like a second parent to M1's son, reflects on conflicts with her mother about how her son is being raised and describes a power struggle between them.

Like all human relationships, relationships between grandmothers and their children and grandchildren can not be simplified to an all positive or all negative. As my interviews reflect, they are complex and guided by many cultural factors. The most important variable that impacted the strength of grandmaternal influence is location and family structure. Single unit families (mother, father, and children) that lived far away from grandmothers had less grandmaternal input. However, most of the grandmothers in this interview series mitigated low access to grandchildren by choosing to live close by, offering a lot of care, and moving in for some period of time to provide all of the childcare while in the house. While the maternal grandmothers with both sons and daughters expressed that they feel a lot more comfortable being present in their daughter's families, the paternal grandmother reflected on trying harder to be a

part of her son's family to make up for the fact that she is a paternal grandmother. This level of self-awareness was an interesting insight into seeing how grandmothers control access to grandchildren and their perception of power over those grandchildren. The paternal grandmother and mother that only had sons both reflected on high levels of anxiety about losing touch with their children and grandchildren if they move away, which means they likely perceive a low level of security in their relationships.

The maternal grandmothers and mothers who had daughters, on the other hand, had no such anxiety. One of the maternal grandmothers lived in Florida, and came up with an arrangement in which she lives a quarter of the year with her daughter and her child. Mothers with daughters discussed a close relationship with their daughter and confidence that when they become a grandmother, they will be helping raise the grandchildren and playing an active role in their daughter's family life. These anxieties may not reflect realistic future scenarios, but rather cultural ideas of a stronger bond between a mother and a daughter rather than mothers and sons, which elevates the anxieties of paternal grandmothers.

Overall, while the interviews confirmed trends seen in previous literature, a larger study sample is needed to explore grandmothering in our society. For example, little research has been done on grandmothering in different economic strata. However, a few of my interviewees (a mother and two grandchildren) mentioned a grandmother that did not play a role in their lives at all because the grandmother was wealthy. Intuitively, it makes sense that families that can not afford the extra help will have to rely more closely on kin. However, it would be interesting to explore if/why wealthy grandmothers do not contribute as much emotionally to their grandchildren. Additional intersectional identities of race, ethnicity, and age would also be important to consider.

It is evident from current research and my interviews that grandmothers are still playing an important role in the continuation of their lineage as allomothers. Therefore, the Grandmother Hypothesis remains a relevant path of research. It can help us better understand many aspects of human lives— intergenerational passing of cultural knowledge and if cultural loss is speeding up due to low frequency of intergenerational families; the roles of grandmothers in shaping child rearing and development through encouragement or discouragement of practices such as breastfeeding or swaddling; and the roles of grandmothers in decreasing infant mortality and thus decreasing population growth. There are many contemporary implications of the grandmother hypothesis because its assumptions are so broad in nature— it is more of an umbrella theory now. Taking the assumptions of the grandmother hypothesis allows scientists to explore many implications of it, from paternal/maternal differences to the roles of intergenerational families, and the impacts of cultural variation.

The Grandmother Hypothesis emerged at a time when the focus of reproductive ecology and evolution studies in general was on men, because the studies were largely done by men. The frame of selection and human adaptation was pointed towards sexual selection— as in, human female biology is the way it is because men selected for the traits that they preferred in mates. This largely took away the role of women in human evolution. More recent studies show that women, too, had control over sexual selection and the shaping of their lineage. Grandmother Hypothesis is important because not only does it shift control from men to women, but it focuses on older women in particular, who were often rendered voiceless in evolutionary studies due to their inability to reproduce.

However, this thesis does not address the problematic associations of the Grandmother Hypothesis. A facet of these studies that is important to note is the implications of suggesting

that grandmothers are important to the preservation and success of the human lineage. In a way, the Grandmother Hypothesis reinforces biological determinism by suggesting that older women exist because they engage in childcare. Anthropologists need to be aware how they frame their research as to not be seen as arguing that women are born to be nurturing caretakers. This is especially important today as women are gaining more and more access to the work field and choosing to forego motherhood. Similarly, grandmothers may choose to refrain from being active in their grandchildren's lives and participate in leadership positions or various projects instead. The concepts of "femininity" and "womanhood", often so narrowly defined in terms of evolutionary biology, are complex and dynamic ideas that will often change with time and throughout different cultures. There is a need to continue trying to reconcile evolutionary perspectives that focus on reproduction with understanding power dynamics that surround women's issues. Although biology has determined many traits in humans and has enabled culture, culture has been able to mitigate biology and impact the trajectory of human evolution. Both culture and biology were likely responsible for the emergence of an elongated postmenopausal lifespan that made grandmothering possible. At these early stages of human evolution (around the time of *Homo erectus*), small populations were most likely egalitarian and matrilineal (women stayed around their kin, and men migrated out resulting in a well balanced gene pool). This environment kept mothers and daughters close, which gave the opportunity for maternal grandmothering to arise. Land ownership and the agricultural revolution likely reorganized human kin systems making way for patriarchy.

While the Grandmother Hypothesis can be interpreted as seeing early grandmothers as specifically subsistence helpers, they help in many other ways. The interviews in this thesis provide a glimpse into the variation of grandmotherhood— coaching their daughters through

pregnancy and breastfeeding, passing on their mom's wisdom, and influencing their grandchildren to read and play more. Today, we live in a complex world with much variation in kin systems and social structures. Understanding the variation and fluidity in femininity and womanhood enriches our understanding of grandmotherhood.  Grandmotherhood should not be viewed as a necessary nor a static social expectation. However, studying the evolutionary foundation of grandmothering is still significant. While we may live modern lives, our bodies are products of evolutionary biological processes. We retain adaptations that were beneficial thousands of years ago. For example, understanding the hormonal response in grandmothers to caretaking has implications on elder health and well-being since long term exposure to certain hormones have specific effects on the body. It is vital to not impose grandmotherhood as the only way for women to find meaning in the postmenopausal stages of their lives, because people find meaning in different ways. Many women choose to not have children, or forego grandmother activities in lieu of other opportunities. Research under the Grandmother Hypothesis needs to continue contributing to the evolutionary importance of grandmothers and figuring out what those findings mean for the modern woman, support their life choices, and ensure a happy and healthy aging process.

Power dynamics are especially important in understanding human biocultural evolution. Human evolution studies have long been plagued by androcentric assumptions and absence of research into women's roles. This research into grandmotherhood demands a rare but necessary discourse on biases and cultural assumptions that shape evaluation of postmenopausal women. Often, women's evolutionary impact as nurturers is discussed  in terms of reproductive fitness. However, this framework disregards women's accomplishments as providers, creators of language, story tellers, inventors, and artists. While this perspective maintains the importance of

understanding human biology, biological essentialism can reinforce that caretaking is the ultimate woman's role. While this thesis did not address the cultural implications of this work, it is necessary to emphasize that science itself is not pure, and even the questions we ask are often tainted by cultural biases. As the research on grandmothers expands, we must aim to not only explore the biological perspectives of grandmothers, but their feelings and self-evaluations within a context of a patriarchal, binary, hegemonic society as well as expand and re-evaluate past evidence that this hypothesis uses as its fundamentals.

# Appendix A.

**Question Guide**

For Grandchildren:

Were your grandmothers involved in your life while you were growing up?
Are they still involved?
Do you have siblings?
Were your grandmothers involved in their lives as well?

For Mothers:

How many kids do you have? What are their ages?
Was your mother around when you started your family? Was she around and involved with your family and in what ways?
What about your partner's mother? Was she around and involved with your family and in what ways?
When you were growing up, was either or both your grandmothers involved with your family?
What kind of a grandmother do you envision yourself to be?

For Grandmothers:

How many children and grandchildren do you have?
As a grandmother, how have you been involved in their lives?
How does this compare to your experience with your own grandmother?
Was your own mother involved when you began to have children?
How do you view the changing roles of grandmothers in our society?

# Appendix B.

**Bridgewater State University Informed Consent Document**

**Title of Research**: Female Longevity and the Importance of Grandmothers
**Researchers**: Sofiya Shreyer, Anthropology, 857-869-0704
**Research Advisor**: Dr Ellen Ingmanson, Anthropology, eingmanson@bridgew.edu

You are being asked to participate in a project conducted through Bridgewater State University. The University requires that you give your signed agreement to participate in this project. The investigator will explain to you in detail the purpose of the project, the procedures to be used, and the potential benefits and possible risks of participation. You may ask him/her any questions you have to help you understand the project. A basic explanation of the project is written below. Please read this explanation and discuss with the researcher any questions you may have. If you then decide to participate in the project, please sign on the bottom of this form in the presence of the person who explained the project to you. You should be given a copy of this form to keep. If you would like to know the results of the study upon it's completion, please let the interviewer know.

1. **Nature and purpose of the Project:** The purpose of this study is to explore the role of grandmothers in our society.
2. **Explanation of the Procedures:** You will be asked to dedicate a maximum of an hour of your time for an in-depth interview regarding the role of grandmothering in your life.
3. **Discomfort and Risks:** There are no anticipated discomforts or risks. If you wish to stop the interview you may do so at any time.
4. **Benefits:** This study is important to science and society because not a lot of research has been done on grandmothering, meanwhile it remains a very important behavior in humans and a very influential part of our lives.
5. **Confidentiality:** Your information will be kept safe by never identifying your full name with the notes, data sets, or recordings. After transcription, the recordings will be deleted.

**Refusal/Withdrawal**: Refusal to participate in this study will have no effect on any future services you may be entitled to from the University. Anyone who agrees to participate in this study is free to withdraw from the study at any time without penalty.

By signing below I am indicating that I understand that it is not possible to identify all potential risks in a research protocol, and I believe that reasonable safeguards have been taken to minimize both the known and potential but unknown risks.

**Participant Signature**                                                                 Date

Witness/Interviewer Signature                                                    Date

Any questions regarding the conduct of the project, questions pertaining to your rights as a research subject, or research related to injury, should be brought to the attention of the IRB Administrator at (508) 531-1242.

Any questions about the conduct of this research project should be brought to the attention of the principal investigator: Dr Ellen Ingmanson at eingmanson@bridgew.edu

## Appendix C.

Interview Examples for Intermittent and Constant Grandmaternal Alloparenting

1) Step-In/Insurance

- M4's first child was born when she was in college, and her mother, (G6) provided extensive support until graduation. Later in life, M4 suddenly lost her husband and went through an emotionally and financially difficult time. Her mother stepped in and completely took care of the child until M4 was back on her feet.

- G3 took on the role of a second parent when her daughter became a single mother right after graduating college. She lives with her daughter and they are raising the grandchild together.

- C4's grandmother's house was a daycare for her 9 grandchildren and was often a safe-house from parental conflicts. When one of her grandchildren was kicked out of his house, the grandmother provided food and shelter for years until he was able to get on his feet.

- G4 became the primary caretaker for her granddaughter after her son lost custody of his children. She has raised her as her own daughter and has done everything in her power to provide for her.

2) Babysitting/Daycare

2 of the grandmothers (G1 and G2) interviewed were occasional babysitters when needed to

relieve the parents for appointments, an evening away, or for vacation. 4 of the grandmothers

(G3, G4, G5, G6) interviewed provided near constant care for an extended period of time as the

grandchildren were growing up. 2 out of the mothers (M1 and M4) interviewed reported their

mother being the second primary caretaker for their child/children. All 4 of the mothers

interviewed reported being wary of trusting anyone but their mothers to watch their children.

<u>Mind-Molding Interview Examples:</u>

- G5: When G5 spends time with her toddler granddaughter, it is non-interrupted quality

  time during which they do a variety of activities together including singing, reading, and

  walking. G5 tells me, *"It's just me and her one-on-one you know… we do everything*

  *together… A. is a young mother and J. is a young father so they are still working and*

  *trying to make do with raising the child and doing work just like I had, so they don't have*

  *the time to really give their whole selves to her…"*

- C1: When C1 was growing up, her grandmother was retired and C1 spent a lot more time

  with her than her working mother. C1 remembers: *"Oh wow.. The adventures my*

  *grandma and I used to have! She would take me all over the place.. Museums, concerts,*

  *whenever there was something new and cool going on in town, we were there. She taught*

  *me so many things. Our experiences together really enriched my childhood.. I was never*

*in front of the tv. I'm a better person today because of it. I understand things. I want to be*

*and stay involved and active. I have her to thank for that."*

- C3: *"I'm still close with her, but when I was a little kid I was like, very close to her.*

  *When I didn't live with her and I would sleepover I would cry when my dad came and*

  *picked me up like I didn't want to leave her. And when she would come to my house I*

  *would be like no you can't leave!.. We were inseparable. She just paid so much attention*

  *to me. Everyone else was so hectic and life sucked and I was stressed out all the time*

  *even as a kid, but her undivided attention really helped me get through it."*

- C5: *"I distinctly remember her trying to teach me how to walk… It took a while I didn't*

  *walk for a long time. She used this giant teddy bear to try and coax me from one place to*

  *another… She read to me. I speak Russian today just because she spent so much time*

  *reading and watching old Soviet cartoons with me.*

- G2: *"I just sit down and play with her for a while, whatever she wants to do. At this point*

  *she's playing with everything. Blocks, books, she's got the walkie toys. She has her own*

  *little room, you just sit down and you play with her and you tell her stories. She looks at*

  *you, she's repeating words…You can see the mind is awakening and it's awesome."*

- M3: *"They have fun together. It was her idea to go to the local library so they go to the*

  *library together… and she really helps me push her to the next stage so she helped her to*

  *start crawling.."*

- When C5 was younger, she had a lot of health problems. Her mom was busy working, so whenever she had a flare up or didn't feel good, her grandmother would take care of her. According to C5, *"I refused to be home with my mom when I was sick.. She would just yell at me when I wouldn't take my meds and she was tired from work. My grandma would lay in bed with me all day, she was just so caring and nurturing.. I would feel better quicker because of the time she dedicated to me."*

Guidance and Emotional Support Interview Examples:

- G2: *"(My daughter) had a lot of questions about what she was going through physically. You can read all the books you want but still not really know when it comes.. I kept telling her, don't read too much because everyone is different, So she would say, is this normal? Did you go through this? I said, you don't have to do what I did but here's what worked for me... They want advice. They want to know what is normal and what is not and what they should be doing."*

- M2: *"When I first came out of the hospital after giving birth to T., I lived with my mother in Scituate. My husband and I both did. For the first couple of months we did that.. I didn't want to go home with my first child I was scared. And, I just wanted to be around my mother."*

- G1's daughter in law was a young mother and G1 stepped in often to make sure the child is safe in their house: *"I went over their house one day and the toaster cord is hanging*

*down… I mean when he was just a baby she put him on the table and he fell off on the*

*floor and I did step in then. I said, once he starts wiggling and moving around you can't*

*do that! I don't think A., thinks I'm her mother, but I think we're pretty close and she*

*confides in me a lot, asks me a lot of questions."*

The Grandmother Identity Interview Examples

1) Continuity

● G5 lost her husband and soon after retired, was going through an emotionally difficult time. Her granddaughter gave her a new, meaningful role and responsibility.

● G2's daughter found out she was pregnant the same day her grandfather died. G2 recalls *"…it was a sad time for all of us. My daughter and my son were all very close to my father as well. We were all kind of a close family and to lose dad, that was a tough time. And so she brought a lot of happiness into the family. She was a blessing and it just shows you that life goes on."*

● G1 also discussed the change in her family with the birth of her grandson: *"I love family and I felt like our family was just a boring bunch of old people, all adults. Now you have a baby and everyone is alive again…he brought back joy to our staggering holidays and family get togethers. And now you have this little kid and he just lights up the room when he comes in and you know everybody loves him!"*

● G6 was going through a difficult divorce when her grandchild was born, and recalls an emotionally difficult time accepting growing old: *"You know, in my family, beauty and*

*youth was everything... I hated myself when I saw the wrinkles, the saggy skin.. My*

*husband didn't love me anymore. But I would look at my granddaughter and none of that*

*would matter anymore. She helped me heal.*"

2) Centrality

- G6: *"I don't remember what I was like not being a grandmother"*

- G3: *"Everyone always said... it's so special being a grandma and I always thought that*

  *they're just overreacting, I thought... I already had kids, it won't be too different. But*

  *then my grandson was born and I understood what they're talking about. It's way*

  *different... I became calling myself grandma as soon as he was born. I didn't think he*

  *would change who I was, my identity, but he did."*

3) Cultural/Social Passing

- G2*: "I feel a responsibility to my granddaughter... To teach her, to play with her, to*

  *show her right from wrong, to say no, to set her limits.. It's not just mom and dad, she*

  *has got to learn it from other sources."*

- G6: *"It was the most important thing to me to teach her to appreciate life... To see the*

  *beauty in life, to foster curiosity for life in her. I knew if she had that, she could do*

  *anything, she would be unstoppable. And that she is."*

- M3: "*I feel like thats where I really learned to identify as a cultural Jew, I didn't get it*

  *from my dad as much so what foods to eat, what things to order, arts, history, aesthetics,*

  *appreciation I got all that from my grandmother. So I would love for S. to get all that*

*from her grandmother. But she could have a combination of my appreciation for the*

*Caribbean and my mothers experience being a Caribbean person and that would be*

*great. You know S. is mixed race, I'm mixed race, it's going to be great for her to build*

*that confidence, to build what that means for her, especially when I imagine she's going*

*to grow up looking white and people will identify her as white. So, that's going to be*

*important. Culture is the transmission of value, so as much  of that she can get. To feel*

*like she belongs in multiple parts of the world and to feel like she can go anywhere in the*

*world because she belongs you know. I would like her to speak Patsoi, its not going to*

*happen for me. Anything so that we can be Carribean together through her."*

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