universität wien

DIPLOMARBEIT

Titel der Diplomarbeit

„Differential grandparental investment“

Verfasserin

Beatrix Putz

angestrebter akademischer Grad

Magistra der Naturwissenschaften (Mag.rer.nat.)

Wien, 2013

Studienkennzahl lt. Studienblatt:	A 190 445 347
Studienrichtung lt. Studienblatt:	Lehramtsstudium UF Biologie und Umweltkunde UF Französisch
Betreuerin / Betreuer:	ao. Univ.-Prof. MMag. Dr. Sylvia Kirchengast

Acknowledgement

It is a pleasure to thank those who made this thesis possible. I would like to express my gratitude to my supervisor, Sylvia Kirchengast, for her guidance, support and encouragement.

I am grateful to my family and friends for their help and understanding throughout my studies and the thesis writing.

Many thanks are also due to those who participated in this study.

This thesis is dedicated with love to my grandparents.

Table of Contents

Acknowledgement **III**

Dedication **V**

1. Introduction **1**

1.1. Evolutionary theories 1

1.2. Life history 4

1.3. Evolution of senescence 8

1.4. Biology of the menopause 9

1.5. Evolutionary explanations for menopause 12

1.6. Evolutionary changes in human life history 19

1.7. Grandparental investment 19

2. Method **24**

2.1. Participants 24

2.2. Materials 25

2.3. Procedure 26

2.4. Statistical analysis 26

3. Results **29**

4. Discussion **53**

4.1. Proxies for grandparental investment: Solicitude, contact frequencies and feelings of closeness 54

4.2. Determinants of grandparental investment 56

4.3. Discriminative grandparental investment 59

5. Conclusion **63**

6. Abstract **66**

7. References **67**

Appendix **78**

Fragebogen 78

Zusammenfassung 90

Curriculum Vitae **91**

1. Introduction

1.1. Evolutionary theories

The publication *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life* (Darwin, 1859) laid the foundation for modern evolutionary theory. Darwin (1859) argued that natural and sexual selection are basic mechanisms for evolution. Natural selection is described as the "*preservation of favourable variations and the rejection of injurious variations*" (Darwin, 1859, p. 81). This process is based on the condition that „*more individuals are produced than can possibly survive"* (Darwin, 1859, p. 63) and on the ideas referring to Darwin of "*heritable variation (i.e., individuals in a population differ from each other and some of that difference is heritable)*" (Salmon & Crawford, 2008, p.3) and "*differential reproductive success (i.e., some individuals, because of their differences, are better able to survive and reproduce than others are)*" (Salmon & Crawford, 2008, p.3). Sexual selection may happen within one sex or between the sexes and "*depends on the success of certain individuals over others of the same sex in relation to the propagation of the species*" (Darwin, 1871, p. 398). Competition for mates between members of the same sex is referred to as intrasexual selection, whereas differential mate choice of members of the opposite sex is referred to as intersexual selection (Buss, 2006). As for example males may compete with others for sexual access to females and females may choose males as their mates. However, these two types of sexual selection, competition for mates and mate choice, are not limited to the sexes (Gwynne, 1991).

Between 1930 and 1950 evolutionary theory was refined and combined with findings from modern genetics and its related fields as for example population genetics, leading to a new approach known as synthetic theory of evolution (Reif et al. 2000; Goetz & Shackelford, 2006). In 1964, the concept of evolutionary theory was extended to the ideas of inclusive fitness theory. Inclusive fitness is defined as

> *the personal fitness which an individual actually expresses in its production of adult offspring … stripped of all components … due to the individual's social environment, leaving the fitness he would express if not exposed to any of the harms or benefits of that environment … augmented by certain fractions of the quantities of harm and benefit which the individual himself causes to the fitnesses of his neighbours. The fractions in question are simply the*

coefficients of relationship … (Hamilton, 1964a; as cited in Grafen, 1984, p. 67).

According to this definition inclusive fitness incorporates direct fitness considered as direct reproductive fitness as well as indirect fitness (Schäfer, 2008; Grupe, Christiansen, Schröder, & Wittwer- Backofen, 2005). The model, which was developed by Hamilton, could account for the evolution of social behaviour, formerly regarded as a puzzle because it could not be explained by classical fitness. Altruism involves a fitness cost to the donor and therefore it is not supposed to be maintained by natural selection (Salmon & Crawford, 2008).

The conditions under which altruism could evolve are described in Hamilton's own words in the following way: "*The social behaviour of a species evolves in such a way that in each distinct behaviour- evoking situation the individual will seem to value his neighbours' fitness against his own according to the coefficients of relationship appropriate to that situation*." (Hamilton, 1946b, p. 19). This explanation has become known as Hamilton's rule and is used as a device for calculating the conditions under which certain alleles can spread (Grafen, 1984). Hamilton's rule in the more popular form states that b/c > 1/*r*, whereas in the form of *r*b – c > 0 it is applied for statistical testing (Grafen, 1984). In the equitation b is the benefit to the recipient, c is the cost to the donor and *r* is the coefficient of relatedness, representing *„the probability that the two individuals each have an allele that is a copy of one in a common ancestor*" (Salmon & Crawford, 2008, p. 9). Referring to Dawkins' (1989) calculations for degrees of kinship, the coefficient of relatedness is calculated from r= a $(0,5)^{b}$, where a is the number of common ancestors and b is the number of generation links (Oberzaucher, 2008). It follows therefore that r= 0.5 for parent and offspring or between full siblings, r= 0.25 for grandparents and grandchildren or between half-siblings and r= 0.125 for great- grandparents and great- grandchildren or cousins.

Based on the ideas of inclusive fitness theory the "*gene's point of view*" (Hamilton, 1964a, p. 16) came into focus. It has been suggested that neither groups nor individuals are the essential units of selection but rather genes. Williams (1996) argued that natural selection acts indirectly on genes and thereby creates adapted genes. As he pointed out, the "*selection of such genes of course is mediated by the phenotype, and to be favourably selected, a gene must augment phenotypic reproductive success as the arithmetic mean effect of its activity in the population in which it is selected*." (Williams, 1996, p. 25). According to this view, natural selection

does not act directly on genes but it is mediated through the phenotype. Considering that genes occur in different forms as alternative alleles those affecting the developmental process cause phenotypic variation. Different phenotypes may vary in their fitness on average, thus leading to a change in allele frequencies: alleles that have a high arithmetic mean effect and confer high fitness will become more common in populations compared to alternatives. Taking these aspects into account, alleles are considered basic units of selection (Alcock & Crawford, 2008).

The assumption derived from inclusive fitness theory that organisms' goal is to maximize inclusive fitness or that they act "*as if*" (Grafen, 2006, p. 561) to maximize their inclusive fitness, led to a controversial debate between evolutionary psychologists and sociobiologists. As Hamilton pointed out, "*Species following the model should tend to evolve behaviour such that each organism appears to be attempting to maximize its inclusive fitness.*" (Hamilton, 1964a, p. 1). Although both evolutionary psychology and sociobiology are based on the principles of natural selection, understood in modern inclusive fitness terms, they do not share the view of fitness maximization. Sociobiologists regard organisms to behave "as if" they were maximizing their inclusive fitness and from their point of view natural selection tends to cause them to act in this way (Grafen, 2006). Referring to these ideas it has been suggested that "*natural selection is the process by which fitness is maximized*." (Grafen, 2006; as cited in West et al., 2007, p. 417). By contrast, from evolutionary psychologists' point of the view, the assumption that humans act as fitness maximizers is regarded as a sociobiological fallacy (Buss, 1991, 1995). It has been argued that factors influencing fitness vary across sexes, ages and situations, therefore, there is no domain-general psychological mechanism and "*humans thus cannot have psychological mechanisms the goal of which is to maximize reproductive success (either consciously or unconsciously)*." (Buss, 1991, p. 463).

Nevertheless, sociobiology and evolutionary psychology are part of evolutionary biology, so both are based on the adaptionist approach which states that "*natural selection produces adaptations that solve problems associated with survival and reproduction*" (Goetz & Shackelford, 2006, p. 570). In addition, the evolutionary process generates byproducts of adaptations and noise, which neither solve adaptive problems nor have functional design. Byproducts are coupled with adaptations, whereas noise is not tied to adaptations. Noise, also called random effects, can be produced by mutations and random changes in the development or changes of the

environment (Goetz & Shackelford, 2006). Moreover, there is general agreement that not every behaviour is adaptive (Alcock & Crawford, 2008). Human behavioural ecology, for instance, is based on the idea that humans adopt conditional strategies by applying selected decision rules. Therefore, it is assumed that they respond to a given set of circumstances flexibly and in a fitness-enhancing manner (Borgerhoff Mulder, 2003), but it would be misleading to conclude that "*all behaviour should be adaptive*" (Borgerhoff Mulder, 2003, p. 6).

1.2. Life history

Adaptations that solve problems associated with survival and reproduction are the focus of life history theory. Life history includes essential features like growth, mortality and fertility and offers evolutionary explanations for the rate and timing of these variables (Hill & Kaplan 1999). "*Life histories evolve so as to maximize the contribution of genetic material to the following generations*" (Voland, 1998, p. 348) and thereby efforts concerning survival and reproduction have to be made. Depending on the target of such effort, the form of effort is called somatic effort or reproductive effort. Reproductive effort unifies mating effort, parenting effort and nepotistic effort. Reproductive potential is accumulated by somatic effort, whereas existing reproductive potential is exploited by reproductive effort. "*The principal of allocation refers to the fact that energy and/ or time allocated for one function cannot be simultaneously allocated to a competing function*" (Hill & Kaplan, 1999, p. 404) and consequently allocation decisions have to be made. This causes various allocation conflicts which result in trade-offs. Firstly, there is a trade-off between somatic and reproductive effort which means between current and future reproduction. Secondly, a trade-off between quality and quantity of offspring results from the allocation of reproductive effort to increasing offspring fitness or to increasing offspring number. Thirdly, there is a conflict between mating effort and parenting effort. Lastly, there exists a trade-off between nepotistic effort (helping relatives) and direct reproduction (Hill & Kaplan, 1999; Voland, 1998).

As the existing reproductive potential of an individual is exploited by reproductive effort, it has been stated that "*to the degree that reproductive effort reduces remaining reproductive value, it is considered an investment*" (Trivers 1972; as cited in Voland, 1998, p. 349). Furthermore, parental investment has been defined as "*any investment by the parent in an individual offspring that increases the*

offspring's chance of surviving (and hence reproductive success) at the cost of the parent's ability to invest in other offspring" (Trivers, 1972, p. 139). It has been argued that relative parental investment influences the way in which the two types of sexual selection interact. According to the theory of *Parental investment and sexual selection* (Trivers, 1972) intrasexual selection operates on the sex whose relative parental investment is smaller, whereas intersexual selection operates on the sex whose parental investment is greater in relation to the other sex. In many species female investment in their offspring is greater and therefore females are supposed to exercise mate choice and males are supposed to compete for sexual access to them. Although male parental investment may equal or exceed female investment, female initial parental investment is greater. It has been proposed that this imbalance in initial parental investment results from the differentiation of gametes into mobile sperm and relatively immobile eggs (Trivers, 1972). Gametes do not only differ in mobility but also in their size that is coupled with metabolic investment. Compared to the sperm cell, the production of the ovum requires larger energetic investment. Consequently, it has been proposed that this imbalance in investment influences the parental investment pattern. Trivers (1972) suggested that "*her initial very great investment commits her to additional investment more than the male's initial slight investment commits him*" (Trivers, 1972, p. 144). However, it has been argued that initial investment in itself does not commit her to additional investment (Dawkins, 1989). In mammals additional maternal investment is required due to gestation and lactation (Buss & Schmitt, 1993). Females might terminate their investment in their offspring's development after birth, but it would not pay them in the future to abandon them and to invest in bringing up the subsequent offspring to the same level (Dawkins, 1989).

Due to the discrepancy in investment in offspring, women's potential production of offspring may not reach the same level as men's, resulting in reproductive constraints that differ between the sexes. Male reproductive success is constrained by the number of women they can gain sexual access to, whereas female reproductive success is constrained by the resources that are accessible to them. In order to solve adaptive problems that are associated with these constraints, both sexes have evolved reproductive strategies (Buss & Schmitt, 1993), which are regarded as conditional strategies (Euler & Weitzel, 1996). Depending on environmental conditions individuals make cost benefit decisions about behavioural

alternatives and engage in those that are reproductively profitable. Conditional strategies enable flexible behaviour under varying circumstances and yield reproductive success (Alexander, 1990; Voland, 1998). Reproductive strategies do not imply a conscious process (Buss & Schmitt, 1993); accordingly, humans "*strive for more proximate outcomes that themselves lead reliably to increases in reproductive success, compared to alternative actions. Examples are efforts to attain wealth, power, and status."* (Alexander, 1990, p. 255). Moreover, instead of maximizing fertility, parents may adopt strategies that maximize long-term reproductive success (Borgerhoff Mulder, 2003). Due to trade-offs in resource allocation, the maximum number of offspring is not supposed to represent the optimal number of offspring (Grainger & Beise, 2004; Penn & Smith, 2007). Evidence for adaptive fertility behaviour has been provided in two agricultural populations (Meij et al., 2009; Strassmann & Gillespie, 2002). In addition, while a correlation between reproduction and longevity in humans could be expected (Westendorp & Kirkwood, 1998), it has proved difficult to establish (Hurt, Ronsmans, & Thomas, 2006) and it is still debated whether the relationship is positive, negative or non-significant (Helle, Lummaa, & Jokela, 2005; Hurt et al., 2004; Jasienska, Nenko, & Jasienski, 2006; Lycett, Dunbar, & Voland, 2000; Penn & Smith, 2007).

Reproductive success is used as a proxy measure for an individual's fitness (Borgerhoff Mulder, 2003). In order to achieve reproductive success, efforts concerning reproduction have to be made (Euler & Weitzel, 1996). Reproductive effort is composed of mating effort, parenting effort and nepotistic effort and therefore it is not only restricted to production of offspring. Parents may support their offspring in their reproductive effort, so parents' reproductive effort includes extraparental nepotistic effort (Euler, Hoier & Rohde, 2001). Consequently, it has been proposed that "*the number of grandchildren is a better measure of reproductive success than the number of children*" (Euler & Weitzel, 1996, p. 41). Furthermore, Coall and Hertwig (2010) suggested applying a broader definition of parental investment for grandparents: Any behaviour of parents that increases the offspring's fitness at cost to the fitness of the parent, of other offspring or of other relatives is considered an investment (Clutton-Brock, 1991). "*Support of reproduction by older postreproductive individuals*" (Kaplan, Hill, Lancaster, & Hurtado, 2000, p. 156) is a characteristic feature of human life histories. The term postreproductive is used to designate womens' life phase after menopause when fertility has ceased. Some authors

differentiate between postreproductive and postgenerative life phase. They prefer the term postgenerative to be applied for the postmenopausal phase as "*personal reproductive success can be increased by parental or grandparental effort during this phase of life*" (Voland, 1998, p.358).

Both human and primate life histories have a long period of offspring dependence from birth until weaning and a long average adult lifespan. Charnov's approach (1991, 1993) of dimensionless relationships between female mammalian life history variables could account for these characteristic features. Charnov (1993) argued that the invariance in life history traits is caused by certain kinds of trade-off relations which themselves are characterised by symmetry principles. Life history variables have dimensions of time or time^{-1} or weight, so the ratio of variables within the time or size group is dimensionless. If this dimensionless ratio is a constant, the relationship between variables is termed invariant.

Within mammals the product of age at maturity and average instantaneous mortality rate of adults αM is invariant. Age at maturity α is the period of independent growth from independence to maturity, namely the age at first reproduction. *M* is inversely proportional to α. According to Charnov's (1993) model average αM value is the same for primates as for mammals (0.73). Furthermore, the product of the period of independent growth and yearly clutch size in daughters αb *is* invariant, so primates and mammals share the same αb value. For a fixed body size primates have lower values in the yearly clutch size in daughters *b* and higher values in the average adult lifespan *1/M* compared with other mammals.

Charnov and Berrigan (1993) proposed that these characteristics of primates are caused by their slow individual growth rates. From conception to independence the rate of growth depends on the energy delivery from mothers to their offspring. From independence to first reproduction the offspring's production energy is channelled into growth. As they reach maturity, the production energy is channelled into producing offspring (Charnov & Berrigan, 1993). The trade- off that underlies postweaning growth and offspring production has been described by in an allometric production function: $dW/dT = AW^{0.75}$. The height of the production function A is on average approximately 1 for mammals and approximately 0.40 for primates (Charnov, 1993). Moreover, W is body weight and dW/ dT is the production energy (Charnov & Berrigan, 1993). This production function has further implications for the values of *b* and *1/M.* The relative size at weaning δ is calculated on the ratio of

weaning weight to adult weight at age α: $W_0/ W(\alpha) = \delta$. As δ is 0.33 for mammals as well as for primates, offspring is weaned when they reach approximately one third of adult weight at maturity (Charnov, 1993). It follows from the production equitation that primates' offspring need a longer period of time to reach that weight due to the low production rate A. This implies that the yearly clutch size in daughters is smaller in primates compared with other mammals. The production energy that is channelled into producing offspring also depends on the mother's body weight (Charnov & Berrigan, 1993). The body weight at maturity is determined by the mortality rate *M (*Charnov, 1993*).* As the period of independent growth entails a mortality cost, natural selection acts on the age at maturity and thereby affects adult body weight. The inverse of the average adult instantaneous mortality rate *M* is the average adult lifespan *1/M: 1/M*= $(1.4/A).W^{0.30}$*.* For given size the average adult lifespans of primates are longer compared with other mammals due to the low production rate A (Charnov & Berrigan, 1993). However, in humans the period of offspring dependence and the average adult lifespan are exceptionally long and these features are characteristic for human life histories (Kaplan et al., 2000).

Moreover, the mortality rates change with age leading to an age-specific pattern of mortality that is U-shaped. In humans infant mortality is high and then the mortality rate declines. The mortality rate of adults remains at a low level but increases during later adulthood from about 40 years of age onwards (Gage, 2000; Kaplan & Lancaster, 2003). Mortality is caused by extrinsic factors such as environmental hazards as well as intrinsic factors. The intrinsic state of an individual declines with age leading to a decline in fertility and a decline in survival probability (Partridge, 1997). This increase in age specific mortality rates due to intrinsic deterioration is referred to as senescence (Hill, 1993). The evolved rate of senescence is related to the impact of external factors on mortality (Hill, 1993; Partridge, 1997). Additionally, the age specific decline in fertility rates is referred to as reproductive senescence (Hill & Hurtado, 1991).

1.3. Evolution of senescence

According to evolutionary theories of senescence the decline in function is either regarded from the optimality perspective or as a consequence of mutation pressure. Williams (1957) proposed pleiotropic genes as an underlying mechanism for the evolution of senescence. Due to a decline in reproductive probability, genes

that have positive effects on fitness early in life and negative effects later in life are favourably selected. Such beneficial effects early in life could be at the expense of longevity: "*natural selection will frequently maximize vigor in youth at the expense of vigor later on and thereby produce a declining vigor (senescence) during adult life*." (Williams, 1957, p. 410). But senescence is an also unfavourable character selection acts against. As a consequence, there is a balance between these two selective forces that act to increase or to decrease the rates of senescence (Williams, 1957). Kirkwood (1997) proposed that somatic maintenance and repair are limited because available resources are also allocated for reproduction. This limitation in investment would lead to an accumulation of random somatic damage which in turn causes senescence (Kirkwood, 2002). Mutational explanations are based on the idea that there is a balance between mutation and selection (Haldane, 1957). Charlesworth (1994) proposed that if mutant alleles with deleterious effects on survival late in life are sufficiently frequent, there will be a shift in this equilibrium which causes senescence. However, evidence has been found for both the mutation-accumulation and the optimality theory (Partridge & Barton, 1993).

1.4. Biology of the menopause

In women reproductive senescence occurs before somatic senescence. The age at which menopause takes place varies and has been reported to range from 40 to 60 years (de Bruin et al. 2001), from 45 to 55 years (Grupe et al., 2005) or between the ages of 40 and 55 (Kirchengast, 2006). For an overview see table 1, which shows the mean or median age of menopause in different parts of the world. In industrialised countries the average age is about 51 years (World Health Organization [WHO], 1996). This means that fertility in women ends half the maximum life span of humans which is between 100 and 120 years (Kaplan et al., 2000). In 2002, life expectancy at birth was 78 years for women in developed countries (including Australia, Japan, New Zealand, European countries and North America). In the same year, life expectancy at birth was 82.2 years (uncertainty 81.8 - 82.4) for women in Austria (WHO, 2003). Furthermore, this implies that based on average life expectancy at birth nearly one third of life span in women is postgenerative. And yet, in modern hunter-gatherer populations women's life expectancy at age 45 is between 19 and 22 years (Blurton Jones, Hawkes, & O'Connell, 2002) and similar data have also been reported for forager-horticulturalists

and acculturated hunter-gatherers (Gurven & Kaplan, 2007). Various factors have been identified that are associated with the timing of menopause, including socioeconomic status, number of live births and active smoking (Gold, 2011).

This long postmenopausal life span of women is one characteristic feature of human life history. Female nonhuman primates show similar hormone profiles, changes in body composition and changes in physiology but in most species reproductive and somatic senescence occur in tandem (Bellino & Wise, 2003, Fedigan & Pavelka, 2006). In species that cease to cycle the postcycling life span is relatively short as for example in Japanese macaques and has been documented only for some rare individuals (Fedigan & Pavelka, 2006). Evidence for a long postmenopausal life phase has only been found in female short-finned pilot whales, *Globicephala macrorhynchus* (Marsh & Kasuya, 1984, 1986).

Table 1. Mean (or median*) age at menopause in several countries for which data are available

Country	Age at Menopause (in Years)	Reference
Australia	50.4	Walsh (1978)
Canary Islands	48.6	Sosa Henriquez et al. (1994)
Chile	50.0*	Morabia and Costanza (1998)
China	49.0*	Morabia and Costanza(1998)
Colombia	50.0*	Morabia and Costanza (1998)
Czechoslovkia	51.21	Magurský, Mesko, and Sokolík (1975)
Finland	51.0*	Luoto, Kaprio, and Uutela (1994)
France	52.0	Salat-Baroux (1980)
Ghana	48.05	Kwawukume, Ghosh, and Wilson (1993)
India (Punjab)	44.6	Singh and Ahuja (1980)
Indonesia	50.5	Samil and Wishnuwardhani (1994)
Japan	49.33	Kono et al. (1990)
Malaysia	50.7	Ismael (1994)
Mexico	46.5	Garrido-Latorre et al. (1996)
Nepal (high altitude)	46.8*	Beall (1983)
Nigeria	48.4	Okonofua, Lawal, and Bamgbose (1990)
Philippines	48.0	Ramoso-Jalbuena (1994)
Russia	49.0	Balan (1995)
South Africa (black women)	49.5	Walker et al. (1984)
Sweden	50.9*	Hagstad (1988)
Switzerland	50.0	Morabia et al. (1996)
Taiwan	49.5	Chow, Huang, and Lee (1997)
Thailand	50.3	Tungphaisal et al. (1991)
Turkey	47.8	Neslihan Carda et al. (1998)
United Arab Emirates	47.3	Rizk et al. (1998)
USA	51.3*	Kato et al. (1998)

Women undergo a transition from reproductive to postgenerative life which is commonly referred to as menopause. In fact, the transition is divided into three stages: (a) premenopause, (b) perimenopause, and (c) postmenopause. At the beginning the fertility declines during a period which is called premenopause (Pavelka & Fedigan, 1991). At perimenopause women go through menopausal transition during which menstrual cycles become irregular and finally cease. Perimenopause also includes a period of time that lasts 12 months after final menstrual period (Burger, Dudley, Robertson, & Dennerstein, 2002). Menopause is a specific event and ”*refers to the permanent cessation of menstruation and menstrual cycles*” (Pavelka & Fedigan, 1991, p. 14). The clinical definition of menopause also refers to the fact that the final cessation is ascertained retrospectively. As per this definition, menopause is the cessation of spontaneous menstruation for at least 12 months (Wu, Zelinski, Ingram, & Ottinger, 2005). The postmenopause is the final stage of the transition from reproductive to postgenerative life and begins 12 months after the final menstrual period. Proximate explanations for menopause refer to the depletion of ovarian follicular reserve and to the disruption in the hypothalamic-pituitary-gonadal axis (Pavelka & Fedigan, 1991). The follicular reserve is established during the prenatal development as primordial follicles (primary oocytes and follicular epithelium) that are arrested in the cell cycle between the first and the second stage of meiosis (Sadler, 2003). A small number of follicles resume meiosis during menstrual cycles and are being ovulated. During aging the number of follicles declines as they become atretic: as for example at the time of birth there are still up to 2 million primary oocytes, at puberty about 40.000 of them are left and only up to 500 primary oocytes are being ovulated (Sadler, 2003).

The hypothalamic-pituitary-gonadal axis has an important role in the regulation of hormonal secretion that underlies menstrual cycling. During the first phase of a menstrual cycle, the follicular phase, gonadotropin releasing hormone (GnRH) from the hypothalamus stimulates an increasing release of two types of gonadotropins from the anterior part of the pituitary gland: follicle-stimulating hormone (FSH) which stimulates follicular maturation and luteinising hormone (LH). FSH and LH stimulate the secretion of estradiol, a type of estrogen, and due to a positive feedback loop high levels of estradiol increase the release of LH (Pavelka & Fedigan, 1991). By contrast, the release of FSH is reduced to some degree by high levels of estradiol and inhibin (Santoro, 2005). After LH levels reached their maximum, ovulation takes

place. At ovulation, the oocyte leaves the follicle and during the second phase of a cycle, the luteal phase, the remaining part of the follicle becomes a temporary gland, the corpus luteum which produces progesterone. In a negative feedback loop progesterone and estradiol inhibit GnRH release and as a consequence FSH and LH levels are reduced. The corpus luteum degenerates if fertilisation does not occur, so estradiol and progesterone levels decline. As a result, a new menstrual cycle starts with menstruation and GnRH stimulates the release of FSH and LH. The negative and positive feedback loops are essential for the regulation of hormonal secretion. Without ovulation no corpus luteum develops and as a consequence FSH and LH levels increase (Pavelka & Fedigan, 1991). And the disruption of these feedback loops in the hypothalamic-pituitary-gonadal axis also plays a role in the cessation of reproductive function. Whether this reproductive decline is ovary-driven or brain-driven is debatable (Wu et al., 2005); however, it has been stated that there is a marked increase in FSH levels and a decline in estradiol levels (Burger et al., 2002; Santoro, 2005).

Reproductive senescence in men is not characterised by a complete cessation of reproductive function. In men, production of gametes continues throughout life and is relatively invariant with age. Even though changes in sperm quality have been suggested, age-related changes in spermatogenesis are modest and they are not supposed to affect fertility. Nevertheless, fertility in men changes with age. Reproductive senescence seems to reflect a change in the allocation of energetic resources between somatic and reproductive effort. It is an open question whether changes in somatic tissue investment and consequent somatic deterioration that underlie this shift are adaptative or caused by overall senescence of both reproductive and somatic systems. Testosterone acts as a proximate mechanism that regulates energetic allocation between somatic tissues that reflect both somatic and reproductive efforts. Nevertheless, age-related declines in testosterone levels show considerable population differences. By contrast, age-related increases in FSH and LH levels are invariant across populations and seem to be an ubiquitous trait of reproductive senescence in men (Bribiescas, 2006).

1.5. Evolutionary explanations for menopause

Ultimate explanations for menopause refer to hypotheses that view menopause either as an adaptation or as a byproduct. The main hypotheses that

attempt to explain the evolution of menopause are summarised in table 2.

Table 2. Hyptheses and theories for the evolution of menopause

Hypothesis or theory	Description	Reference
Old grandmother hypothesis	Cessation of fertility is regarded as an adaptation that favours investment in existing offspring when the costs of reproducing late are outweighed by benefits of helping offspring to survive and reproduce.	Williams (1957) Alexander (1974)
New grandmother hypothesis	The long postmenopausal lifespan is due to intergenerational transfers among women which enhance their female kin's fertility and the survivorship of their offspring.	Hawkes, O'Connell, Blurton Jones, Alvarez, and Charnov (1998)
Mother hypothesis	Premature reproductive senescence is both a byproduct of selection for efficient early reproduction and an adaptation for prolonged maternal investment in still-dependent offspring, thus ensuring their survival.	Peccei (2001a)
Difficult-to-acquire-food hypothesis	Lengthy juvenile learning period and long lifespan are supposed to have co-evolved due to a dietary shift.	Kaplan et al. (2000)
Reproductive senescence hypothesis	Reproductive senescence is caused by general senescence, but somatic functions are maintained for the period of infant dependence.	Packer, Tatar, and Collins (1998)

The ideas about menopause which were developed by Williams (1957) later became known as the old grandmother hypothesis. Menopause is regarded as an adaptation and although the care of grandoffspring has not been considered originally, this hypothesis is referred to be about inclusive fitness:

> *At some time during human evolution it may have become advantageous for a woman of forty-five or fifty to stop dividing her declining faculties between the care of extant offspring and the production of new ones. A termination of increasingly hazardous pregnancies would enable her to devote her whole remaining energy to the care of her living children, and would remove childbirth mortality as a possible cause for failure to raise these children. Menopause, although apparently a cessation of reproduction, may have arisen as a reproductive adaptation to a life-cycle already characterized by senescence, unusual hazards in pregnancy and childbirth, and a long period of juvenile dependence. If so, it is improper to regard menopause as a part of the aging syndrome.* (Williams, 1957, p. 407)

A long period during which the weaned offspring is still dependent on older individuals for care is a feature of human life history. In the primate pattern of growth and development juvenility is the stage between infancy and adulthood, precisely the time from weaning to reproductive maturity. Juveniles are nutritionally independent after weaning. By contrast human life history is characterised by two additional stages between infancy and adulthood: childhood preceding juvenility and adolescence following juvenility (Bogin & Smith, 2000). In humans, weaned children are still dependent on older individuals for feeding until juvenility (Bogin, 1997). However, as a life history feature childhood is commonly referred to as a period of juvenile dependence (Kaplan et al., 2000).

When children are still dependent prolonged maternal care is required resulting in changes in the optimal allocation of reproductive effort to increasing offspring fitness or to increasing offspring number. As Williams (1957) pointed out, aging women do better allocate reproductive efforts to increasing offspring fitness because of mortality risks associated with reproduction. Because this hypothesis is about early termination of fertility relative to maximum lifespan it is also referred to as "'*stopping early' hypothesis*" (Hawkes et al., 1998, p. 1336). Alexander (1974) also raised the topic of allocation of reproductive effort in older women and argued that in addition to increasing offspring fitness grandchildren's fitness may also be increased either qualitatively or quantitatively. Accordingly, menopause is regarded as an adaptation that makes assistance of grandmothers possible (Peccei, 2001a).

Moreover, the dependency of human offspring and the increase in risk of childbirth-associated mortality with age could provide an explanation for the evolution of menopause only when combined with a decrease in grandchild mortality by 10% and an increase in adult daughter's fertility by 10% due to assistance from a post-generative grandmother (Shanley & Kirkwood, 2001). When applying this model to another population, findings also pointed to the importance of considering the role of grandmothers in the evolution of menopause (Shanley, Sear, Mace, & Kirkwood, 2007).

The new grandmother hypothesis is about inclusive fitness, but instead of the early termination of fertility the long postmenopausal life span is proposed to be the human life history trait that needs explanation. Accordingly, it has been argued that the reproductive span of humans is not short in relation to average lifespan as it was proposed by Hill and Hurtado (1991), it is rather as long as those of other primate

species. Central to this hypothesis is the assumption that postmenopausal women increase the reproductive success of their daughters and nieces by provisioning their children. As a consequence, somatic senescence is slowed down by increasing the selection against mutations with unfavourable effects later in life or compensating for early negative effects such as lower reproductive effort (Hawkes et al., 1998). In contrast to the old grandmother hypothesis menopause is not regarded as an adaptation, it is rather a byproduct of increased longevity. Instead, grandmothering is considered an adaptation that might explain the long postmenopausal life span (Peccei, 2001a). Indeed, Grainger and Beise (2004) showed that the existence of menopause could neither be explained by the positive effects of grandmothers on the survival of grandoffspring nor by the impact of mothers on late-born offspring's survival chances; none of these benefits did outweigh the cost of ceasing reproduction. However, the long-term reproductive benefits of grandmaternal care could account for the evolution of post-generative longevity, thus providing support for the new grandmother hypothesis.

The new grandmother hypothesis is based on Charnov's approach (1991, 1993) of dimensionless relationships between female mammalian life history variables that were compared for orangutans, gorillas, chimpanzees and humans (Hawkes et al., 1998). Several variables were examined: average adult lifespan *1/M*, age at maturity, age at weaning, period of independent growth α, daughters per year *b,* the product of the period of independent growth and instantaneous mortality rate αM, the ratio of weaning weight to adult weight δ, and the product of the period of independent growth and daughters per year αb. It has been stated that combined with Charnov's (1991, 1993) model „*the grandmother hypothesis can account for long lifespans after menopause, late age at maturity, early weaning, and high fertility*" (Hawkes et al., 1998, p. 1338) in humans. It has been proposed that food provisioning by postmenopausal women allows early age at weaning and short interbirth intervals and thereby grandmothers increase the reproductive success of their daughters (Hawkes et al., 1998). Due to inclusive fitness benefits of grandmothering, selection favours increased longevity leading either to decreases in adult mortality rates or increases in age at maturity (O' Connell, Hawkes, and Blurton Jones, 1999). Alvarez (2000) provided further support for the new grandmother hypothesis by examining these life history variables on a set of 16 primate species. It has been found that age at maturity is adjusted to life span. Compared with other

primates humans have shorter birth spacing and therefore higher birth rates as expected from age at maturity. In addition it has been found that the age of weaning is early in humans. As these variables are linked, provisioning grandmothers who help their daughters and nieces to wean their children earlier may increase their own inclusive fitness (Alvarez, 2000).

However, several aspects of the assumption that Hawkes et al. (1998) made have been criticised. Firstly, it has been noted that only the instantaneous mortality rate *M* and in the average adult lifespan *1/M* were considered, whereas the maximum lifespan was left out. Secondly, it has been argued that it would be more appropriate to use age at maturity AM instead of the period of independent growth α to compare humans with other primate species (Peccei, 2001a). The human life cycle is characterised by childhood, a period of growth between infancy and the juvenile stage, were children are still dependent (Bogin, 1997). Strictly speaking, as α is the „*period of independent growth from weaning to age at maturity*“ (Peccei, 2001a, p.442), α should not be used to compare humans and other primate species. Thirdly, as α is high, the product of the period of independent growth and annual fecundity (annual birth rate) αb also reaches a high value. It has been stated that the high value of αb in humans reflects the fact that the period of independent growth incorporates childhood (Peccei, 2001a).

The mother hypothesis is not about inclusive fitness, but menopause is regarded as an early termination of fertility. “*With prolonged fertility negatively affecting maternal well-being and maternal mortality negatively affecting juvenile survivorship, it is reasonable to posit that premature reproductive senescence and the postreproductive lifespan in human females evolved to ensure prolonged investment in offspring who were already born*.” (Peccei, 2001a, p. 447). Accordingly, it has been argued that menopause is an adaptation for prolonged maternal investment, but it is also a byproduct of selection for efficient early reproduction (Peccei, 2001b). Peccei (1995) has argued that menopause evolved in response to the increasing dependence of offspring. In the origin of menopause encephalisation and infant altriciality acted as selective pressures. The development of larger brains in hominids required postnatal brain growth thereby leading to a prolonged period of dependence. It has been assumed that postmenopausal women gain relatively greater reproductive success by investing in the survival and fertility of existing offspring: through providing prolonged maternal care women may enhance the

survival of their offspring to adulthood and even their offspring's fertility before they reach sexual maturity. According to this view, an increase in cranial capacities permitted by a prolonged period of offspring dependence led to further increases in the maximum potential lifespan. In addition, average life expectancies increased due to prolonged maternal care. These changes in the maximum potential lifespan and in average life expectancies also affected the age of onset of menopause. It has been proposed that in the origin of menopause when maximum potential lifespan levels were lower the age of onset might have been earlier (Peccei, 1995).

Packer et al. (1998) proposed that menopause may be the result of general senescence. In a study sample of female olive baboons and female lions which show kin-directed cooperative behaviour postgenerative females neither increased the fertility of their daughters nor the survival of their daughters' offspring. It has been argued that reproductive senescence is expected at later ages when only little additional fitness can be gained from continued reproduction as in this case reproductive senescence is not opposed by natural selection. In contrast to the reproductive function the somatic function is maintained by selection as long as offspring survival is dependent on maternal survival. In addition to the mother's age specific life expectancy the duration of offspring dependency also plays a role in the timing of reproductive cessation. Species with prolonged offspring dependency are supposed to have longer postgenerative lifespans. Therefore, it has been suggested that prolonged offspring dependency may account for a long postgenerative lifespan in women (Packer et al., 1998). Based on these assumptions it has been proposed that the postgenerative lifespan is the result of mothering. After their reproductive function has already ceased mothers benefit from rearing still dependent offspring (Peccei, 2001a). Nevertheless, Hill and Hurtado (1999) criticised that the model which was developed by Packer et al. (1998) could account for the evolution of human menopause. Based on data on Ache from Paraguay it has been argued that at the age of menopause selection is still strong due to low adult mortality rates and humans' age specific life expectancy is high compared to other species. Moreover, maternal survival is crucial to offspring survival only until five years of age in humans, so the postmenopausal lifespan is longer than the period of offspring dependency. And the reproductive function in men does not cease although mortality rates of offspring are also influenced by paternal survival (Hill & Hurtado, 1999).

The difficult-to-acquire-food hypothesis also attempts to explain the long postmenopausal life span but considers both male and female foraging strategies, whereas the new grandmother hypothesis focuses on female foraging strategies. According to this view distinctive features of humans such as an exceptionally long average adult lifespan, an extended period of offspring dependence, support of reproduction by older postgenerative individuals and a very large brain are co-evolved responses to a dietary shift (Kaplan et al., 2000). It has been suggested that the dietary transition occurred about 2 mya ago with the evolution of the genus *Homo* entering a skill-intensive feeding niche (Kaplan, Lancester, & Robson, 2003). The dietary specialisation on high-quality resources may have two important effects that result in the co-evolution of investment in development and in mortality reduction as well as greater longevity. Firstly, in order to acquire the skill to exploit high-quality and difficult-to-acquire food resources investment in time and in development are required. If an extended period of learning results in high adult energy capture rates, later productivity in middle and late adulthood compensates for time investment in skill acquisition. As a consequence, lowered mortality rates and increased longevity would be favourably selected to reap the benefits of investment in development and therefore lengthy juvenile learning period and long lifespan are supposed to have co-evolved. Secondly, specialising on large food packages may promote food sharing and cooperation between males and females, and thereby favours longer juvenile periods and reduces juvenile and early adult mortality rates. Thus, increased brain size and slow life histories are supposed to result from a dietary shift toward high-quality food resources (Kaplan et al., 2000).

If one considers menopause as the given and long postmenopausal lifespan as the feature of human life history that needs explanation, the question remains about the ultimate causes of long lifespan in men. It has been hypothesised that male lifespan may be explained by selection for long lifespan in women, as both male and female offspring inherit genes for longevity (Hawkes et al., 1998; Peccei, 2001a), or by fitness benefits of continued reproduction with age (Lahdenperä, 2010; Williams, 1957). A two-sex demographic model has shown that late-age male reproduction can be a driving force for evolution of extended lifespan in both sexes (Tuljapurkar, Puleston, & Gurven, 2007), although the effect on female lifespan has not been supported by evidence (Lahdenperä, Lummaa, & Russell, 2011).

1.6. Evolutionary changes in human life history

Three possible dates during human evolution have been suggested for the occurrence of increases in age at maturity and in postmenopausal lifespan (Hawkes et al., 1998). These relevant life history changes are supposed to be associated with the appearance of *H. erectus* (1.8 mya), archaic *H. sapiens* (600 kya) or modern *H. sapiens (*50 kya) (Peccei, 2001a). The life history of early *H. erectus* was already characterised by an expansion of the childhood period, but the adolescent stage first appeared during the time of late *H. erectus.* Both stages further increased during the time of archaic *H. sapiens* and reached their current dimensions with the appearance of modern *H. sapiens* (Bogin & Smith, 1996). Based on estimates on brain and body weight the maximum lifespan is supposed to have exceeded 50 years since early *H. erectus* (Bogin & Smith, 1996; O' Connell et al., 1999). Accordingly, it has been argued that long life spans are not a recent phenomenon (O'Connell et al., 1999). Longevity is supposed to have increased in *H. erectus* relative to australopithecines, and consequently postmenopausal survival may be an ancient trait in the genus *Homo*. With the appearance of modern *H. sapiens* the maximum lifespan reached its current dimensions and it is assumed that there has been essentially no change since then (Pavelka & Fedigan, 1991). By contrast, average life expectancies at birth increase steadily in many recent populations as the rates of mortality of infants and juveniles decline (Hawkes, 2003). But high mortality levels in the past do not imply that only few adults survived to old age. By using model life tables as well as findings from anthropological demography and paleodemography it has been argued that despite short life expectancies age structures of human populations are characterised by a large fraction of elders (Hawkes & Blurton Jones, 2005).

1.7. Grandparental investment

The four grandparents invest varying amounts of time and resources in their grandchildren (Laham, Gonsalkorale, & von Hippel, 2005). Proxies for grandparental investment include various behaviours ranging from ratings of grandparental solicitude to feelings of closeness. Assistance in sex-specific reproductive strategy and certainty of genetic relationship are basic determinants of grandparental investment, but they do not account solely for the total variance. The investment is also moderated by socioecological conditions, such as type of descent and type of residence (Euler & Michalski, 2007; Huber & Breedlove, 2007) or rules of wealth

inheritance (Holden, Sear, & Mace, 2003). Moderating variables include residential distance, marital status of grandparent, number of living grandchildren, age of grandparent and sex of grandchild (Euler & Michalski, 2007; Euler & Weitzel, 1996). As moderating variables have been further identified birth order of parents (Salmon, 1999), type of investment activity (Euler & Michalski, 2007) and age of grandchild (Pashos, 2000). Michalski (2010) pointed out that parents may play an important role in moderating or encouraging grandparental investment. This view is supported by the findings that the relationship between grandparents and parents affects the grandparents' investment in their grandchildren (Pashos & McBurney, 2008) and that closer parent-grandparent ties are linked to closer grandchild-grandparent relations (Chan & Elder, 2000). Furthermore, it has already been shown that grandparent-parent relationships themselves may be explained by consanguinity, sex-specific reproductive strategy and relational certainty (Euler et al., 2001)

Parental investment theory accounts for sex differences in parental investment and in parental certainty and is applied to interpret sex differences in reproductive strategies and in certainty of genetic relationship. In mammals fertilisation and gestation occur internally within females. Consequently, this form of reproduction causes an asymmetry between the sexes in parental investment. The asymmetry between the sexes already exists at the time of fertilisation as females' initial parental investment is greater than males' (Trivers, 1972). This asymmetry further increases due to gestation, leading to an imbalance in minimum obligatory investment. In order to produce offspring females' minimum amount of parental investment is higher than males' whose parental investment can end with copulation. As a consequence of this discrepancy in minimum obligatory investment, men and women pursue different reproductive strategies to achieve successful reproduction (Goetz & Shackelford, 2009). Men and women have a complex repertoire of mating strategies consisting of both short-term and long-term mating and these strategies may also be combined. When pursuing a long-term strategy both sexes invest substantially in their children's care (Buss, 1998; Buss, 2006). In order to ensure their offspring's survival to adulthood, maternal investment is essential in humans, whereas paternal investment is not (Bjorklund & Shackelford, 1999). The presence of a mother has an exceedingly positive effect on the survival of their children especially under the age of two. When compared to the effect of mothers, fathers' influence on child survival is much smaller (Mace & Sear, 2005). Women may increase their direct reproductive output by

investing in their children‘s care. By contrast, in order to increase their production of offspring men may also opt for mating with additional women (Buss, 2002). Given the large parental obligatory investment, it has been argued that women would obtain relatively higher reproductive benefits from long-term strategies associated with high investment, whereas in relation to women men would on average receive higher reproductive benefits from short-term strategies associated with low investment (Goetz & Shackelford, 2009).

The discrepancy in minimum obligatory investment is supposed to cause a benefit structure that differs between the sexes and consequently affects the reproductive strategies an individual chooses (Buss, 1998). Furthermore, it is in the grandparents' inclusive fitness interest to support their children in their reproductive strategy (Euler & Weitzel, 1996). But when grandparents support their offspring in their reproductive effort, it makes a difference to them whether they assist their son or their daughter. Grandparents are assumed to be more inclined to support their daughters by providing child care. In order to improve the reproductive chances of their sons, grandparents may also support them by creating additional mating opportunities (Euler & Michalski, 2007). Consequently, maternal grandparents are expected to provide more care for their grandchildren than paternal grandparents (Euler & Weitzel, 1996).

As fertilisation occurs internally within female mammals, males can not be certain that their offspring are their own. In mammalian species with male parental care they run the risk of being cuckolded and wasting their investment on another male's offspring (Trivers, 1972). Because of maternity certainty and paternity uncertainty men and women have faced recurrently different problems over human evolutionary history, so specific psychological mechanisms as adaptive solutions are hypothesised to have evolved (Buss, 1998). The discrepancy between putative and actual paternity has been reported to be about 1-3% in modern human populations (Anderson, 2006; Bellis, Hughes, Hughes, & Ashton, 2005; Euler, 2004). Nevertheless, nonpaternity rates in ancestral populations have been estimated to be about 10% (Euler & Michalski, 2007). As an evolved response to the problem of uncertainty of parenthood that men have faced, men's jealousy, more than women's, is activated by cues of sexual infidelity (Buss, 2006). By contrast, women can be certain of their parenthood because of internal fertilisation and gestation. In addition, they become

attached to their offspring at birth, so their risk of misdirection of parental investment is low (Daly & Wilson, 1980).

The gender difference in parental certainty has also further consequences regarding the inclination of an individual to invest resources in kin. Cuckoldry may server the genetic relationship between two putatively related individuals of common male descent in each generation link. Beside psychological mechanisms designed to recognise putative kin both sexes have evolved psychological processes designed to estimate relational certainty. Relational certainty is the probability of two individuals being related given the probability that cuckoldry may occur in each generation link that separates them (DeKay & Shackelford, 2000).

There are two generation links between grandparents and their grandchildren, so there are two possibilities in the line of descent to be severed by cuckoldry. Maternal grandmothers are certain of their maternity and of their daughters' relationship with their children, so their genetic relatedness to their grandchildren is completely certain. Maternal grandfathers are not certain of their paternity, but of their daughters' relationship with their children. As there is one uncertain link, their level of genetic relatedness to their grandchildren is intermediate. Paternal grandmothers are certain about their maternity, but uncertain of their sons' relationship with their children. Accordingly, their level of genetic relatedness to their grandchildren is also intermediate. Paternal grandfathers are neither certain of their paternity nor of their sons' relationship with their children. Therefore, their level of genetic relatedness to their grandchildren is doubly uncertain. Varying levels of grandparental genetic relatedness resulting from differences in grandparental certainty correspond to differences that have been found in the general pattern of grandparental investment: grandmothers invest more in their grandchildren than grandfathers (DeKay & Shackelford, 2000; Euler & Weitzel, 1996; Laham et al., 2005). In fact, certainty of genetic relatedness has been identified as a predictor of direct care in birth (Huber & Breedlove, 2007) and sex-specific reproductive strategies have been found to account for the female kin bias in birth-related investment (Huber, Linhartova, Cope, & Lacy, 2004).

According to the preferential investment hypothesis the availability of more certain investment outlets moderates the differential investment between the maternal grandfather and the paternal grandmother. Laham et al. (2005) have hypothesised that if paternal grandmothers have also grandchildren via their

daughters, they have genetically more certain outlets available. Grandmothers have one link of uncertainty in the genetic relationship to their sons' children, whereas their genetic relatedness is completely certain to their daughters' children. Therefore, they may invest in grandchildren via their daughters at the expense of grandchildren via their sons. Maternal grandfathers have one link of uncertainty in the genetic relationship to their daughters' children and two links of uncertainty to their sons' children, so they do not have more certain investment outlets available if they have other grandchildren via their daughters. Accordingly, it has been assumed that if paternal grandmothers have grandchildren via daughters, the investment of maternal grandfathers will be relatively greater. Moreover, paternal grandfathers have one uncertain genetic link to their daughters' children, but two to their sons' children. So if they have more certain outlets available, they may also invest in grandchildren via their daughters at the expense of grandchildren via their sons. Furthermore, it has been hypothesised that grandparents diffuse their resources as a function of the total number of their grandchildren. Equally certain kin should only suffer diffusion effects, whereas less certain kin should suffer additional differential investment effects from the presence of more certain kin (Laham et al., 2005).

In order to examine grandparental care one approach is to use anthropomorphic data which is obtained either from historical records or from current populations. Statistics on survivorship of grandchildren provide objective measures, but the measured effect of a grandparent is indirect. Another approach to get information on living populations is to use questionnaires which provide more subjective measures and reveal more subtle differences in grandparental care (Chrastil, Getz, Euler, & Starks, 2006). Ratings by adult grandchildren about grandparental care received during childhood are used for detecting these differences. As ratings by grandparents may be influenced by equity norms, questioning grandchildren may be more valid to detect differences in the levels of grandparental care (Euler & Weitzel, 1996; Euler & Michalski, 2007).

In this study three predictions that have been adapted from Euler & Weitzel (1996) were tested using data from questionnaires asking adult grandchildren about the grandparental care they received during childhood.

> *Hypothesis 1*: The four grandparents (maternal grandmother, maternal grandfather, paternal grandmother and paternal grandfather) do not provide equal amounts of care for the grandchild.

Women devote a larger proportion of their reproductive effort to parenting than do men, so supporting grandparents are expected to provide more care for their daughters' children than for their sons' children (Euler & Weitzel, 1996). As grandparents help their offspring in their reproductive strategy, a second prediction can be made:

> *Hypothesis 2*: Maternal grandparents provide more care for the grandchild than paternal grandparents.

Grandmothers can be certain of their genetic relationship to their daughters and to their daughters' children and therefore they are expected to provide more care for their grandchildren than grandfathers (DeKay & Shackelford, 2000). A third prediction can be made because of differing levels of relational certainty:

> *Hypothesis 3*: Within each grandparent couple (maternal or paternal), grandmothers provide more care for the grandchild than grandfathers.

An ordered pattern of grandparental solicitude can be predicted by combining these hypotheses: the maternal grandmother (MGM) should be the most caring. The maternal grandfather (MGF) is supposed to care less, followed by the paternal grandmother (PGM). The paternal grandfather (PGF) should provide the smallest amount of care.

2. Method

2.1. Participants

276 persons of both sexes (78 male and 198 female) of ages 18 to 44 years participated in this study (M= 23.73, SD= 4.01). Male participants had a median age of 24.00 years and a mean age of 24.69 years (SD= 3.81). Female participants had a median age of 23.00 years and a mean age of 23.35 years (SD= 4.02). The participants were predominately students at the University of Vienna (90.6%). Students at other universities were registered at the Vienna University of Technology (1.1%), at the Vienna University of Economics and Business (0.7%), at the Medical University of Vienna (0.4%) or had already finished their studies (4.0%). Some participants did not mention any degree programme (3.3%). The duration of study ranged from the 1st to the 28th semester, the mean duration of study was 7.03 semester (SD= 4.69, N= 258).

The study is based on a sample of 270 respondents as 6 of the returned questionnaires had to be excluded from further analysis, five of them were not

completed and in one case all grandparents died early.

2.2. Materials

Adult grandchildren were asked about their memories of received grandparental care in childhood. It has been assumed that the ratings by grandchildren may better indicate differential grandparental care because the ratings by grandparents may be influenced by equity norms (Euler & Weitzel, 1996; Euler & Michalski, 2007). The questionnaire based on Euler and Weitzel (1996) included questions about the participants, their siblings, their biological parents and their maternal and paternal biological grandparents. Participants were asked about the number, sex and age of their biological siblings. Referring to their biological parents participants were asked to indicate age, vital status, educational level, main economic activity, occupation (adapted from Hoffmann & Scott, 1993) and marital status. In industrial societies, occupation has been identified as the best single indicator of socioeconomic status (Kleining & Moore 1968). Furthermore, the participants were asked to report how many aunts and uncles they have on the paternal and maternal side of the family. In addition data was collected on the number and sex of their children. The questionnaire also sought information about their maternal and paternal grandparents' age and vital status. The main economic activity and the marital status of their grandparents referred only up to the participant's age of seven years. This particular period is characterised by infancy followed by childhood stage (Bogin, 1997). It has been proposed that about seven years of age the transition from childhood to juvenile stage takes place (Bogin, 1997). The participants were asked to report all grandparents that were alive during childhood and they were asked about their living conditions and experiences they made during this time, in relation to each grandparent type (maternal grandmother, maternal grandfather, paternal grandmother and paternal grandfather). Residential distance of each grandparent was estimated on a scale of 1 to 10, which had been slightly adapted from Euler and Weitzel (1996): in the house, in the neighbourhood, a short distance away (e.g. in the same village or in the same quarter of a city), in the city or neighbouring village, in the surrounding area, in the region, daytrip, a day's journey, long distance travel, flight. Furthermore, participants were asked to rate the frequency of contact with each grandparent on a scale of 1 to 10 (1= every day; 10= lost contact). Additionally they have been asked to report who initiated contact with

both grandparent couples (mother, father, grandmother or grandfather). Moreover, they were asked how much each grandparent had cared[1] for them. The intensity was rated on a scale of 1 to 5 (1= not at all; 5= extraordinary) which had been slightly adapted from Euler and Weitzel (1996). The quality of relationship with each grandparent was rated on a scale of 1 to 5 (1= very bad relationship; 5= very good relationship). In addition the participants were asked to whom of their grandparents they feel close to and to give the reasons for their decision. Furthermore, they were asked to report if they felt disadvantaged or preferred to siblings or cousins.

2.3. Procedure

Data were collected from 23rd June 2008 until 17th December 2008 at the Biocenter, University of Vienna, Althanstraße 14, 1090 Vienna. The students were asked to fill out a questionnaire (created with Microsoft® Word 2002) which was handed over to them or sent to them per email. They were told that this study is about the relationship between grandparents and their grandchildren. The participants were informed that their answers would be treated confidentially and anonymously. The analysis was limited to the biological relatives, so additional information about half-siblings and stepsiblings was excluded. Before the analysis could be conducted, control procedures were done in order to detect logical inconsistencies in collected information. Information about the biological parents' age, year of death, main economic activity up to the participant's age of seven years and marital status was compared with each other. Moreover, the overall number of cousins was compared with the proportion of females to males. Information about the biological grandparents' age, year of death, main economic activity and marital status was also compared with each other. In order to find out whether grandparents lived up to the participant's age of seven years, the vital status and the year of death were compared with a control question where participants were asked to report all grandparents that were alive during childhood.

2.4. Statistical analysis

SPSS® 15.0.1.1 was used for data analysis, which only referred to grandparents who lived up to the participant's age of seven years. Data analyses

[1] Euler & Weitzel (1996) have argued that the German word *kümmern* covers *care(giving)* and *solicitude,* so both expressions may be applied interchangeably in this sense.

involved descriptive analyses (descriptive analysis, frequency analysis, cross tabulation with chi-square analysis), regression analyses (linear regression, binary logistic regression analysis) and correlation analyses (bivariate correlation).

The variables that were examined for the purpose of finding out relationships between them are presented in chronological order: The sex of participants was either male (1) or female (2). The main economic activity of parents had seven levels that were labelled employed (1), unemployed, looking for a job (2), student (3), homemaker (4), retired (5), permanently disabled (6), I do not know (15). The marital status of parents also had seven levels: living together (1), separated (2), married (3), divorced (4), widowed (5), I do not know (15), both parents are dead (0). Existence of cousins through uncles or aunts on the maternal and on the paternal side of the family had three levels that were labelled yes (1), no (0), I do not know (15). Moreover, the age of each grandparent was attributed to six groups: <50 years (0), 50-59 years (1), 60-69 years (2), 70-79 years (3), 80-89 years (5), >90 years (6). The levels of marital status of each grandparent couple were nearly identical to that of parents namely living together (1), separated (2), married (3), divorced (4), widowed (5), I do not know (15), both grandparents are dead (0). Based on reported living grandparents (either no (0) or yes (1)) the number of living grandparents was calculated and attributed to three groups: one other grandparent alive (1), two other grandparents alive (2), three other grandparents alive (3). The residential distance of each grandparent was estimated on a scale of 1 to 10: in the house (1), in the neighbourhood (2), a short distance away (e.g. in the same village or in the same quarter of a city) (3), in the city or neighbouring village (4), in the surrounding area (5), in the region (6), daytrip (7), a day‘s journey (8), long distance travel (9), flight (10). Additionally, the frequency of contact of each grandparent was rated on a scale of 1 to 10: every day (1), several times a week (2), once a week (3), several times a month (4), at least once a month (5), less than once a month (6), several times a year (7), once a year (8), less frequently (9), lost contact (10). The intensity of care of each grandparent was rated on a 5-point scale: not at all (1), almost not (2), average (3), considerable (4) extraordinary (5). The quality of relationship was also rated on a 5-point scale: very bad relationship (1), rather bad (2), neither good nor bad (3), rather good (4), very good relationship (5). Furthermore, the feeling of closeness to each grandparent was either existent or not existent (either yes (1) or no (0)).

In the first place descriptive analyses were done. Descriptive analyses were used for examining participants' duration of study and their parents' age range. Frequency analyses were used for analysing demographic details about the participants (age range, gender composition and variety of course of studies), their biological siblings (number of siblings), their parents (vital status, educational level, main economic activity, occupation, marital status, number of their biological siblings and number of their children and gender composition) and their grandparents (age group, vital status, main economic activity and marital status). Considering childhood memories frequency analyses were also carried out on residential distance, frequency of contact, initiation of contact, intensity of care, quality of relationship, feeling of closeness and feelings of being disadvantaged or preferred. In order to calculate means and standard deviations of residential distance, frequency of contact, initiation of contact, intensity of care and quality of relationship, a subsample of cases of participants whose four grandparents were alive during childhood was selected.

Secondly, cross tabulations were used to analyse relationships between two variables. Chi-square tests were made in order to find out whether the two variables are independent or not. Relationships between the following variables were analysed for each grandparent type: intensity of care × frequency of contact, intensity of care × residential distance, intensity of care × quality of relationship. Furthermore, the relationships between intensity of care × number of living grandparents, quality of relationship × number of living grandparents, frequency of contact × number of living grandparents and feeling of closeness × number of living grandparents were analysed. Moreover, the relationships between marital status of parents × quality of relationship and marital status of grandparents × intensity of care were examined.

Thirdly, regression analyses were conducted in order to get detailed information about the relationship between independent and dependent variables. Linear regression analyses were done for quality of relationship and intensity of care of each grandparent type. The relationships between quality of relationship (dependent variable) and sex of participant, existence of cousins, age group of grandparent, residential distance and intensity of care (independent variables) were analysed. Intensity of care (dependent variable) and sex of participant, main economic activity of mother, existence of cousins, age group of grandparent and residential distance (independent variables) were also analysed. Binary logistic

regression analyses were used to examine the relationship between feeling of closeness (dependent variable) of each grandparent type and intensity of care, frequency of contact, residential distance and quality of relationship (independent variables).

Fourthly, bivariate correlations were used to analyse intra- and inter-couple correlations concerning frequency of contact, intensity of care and quality of relationship.

Lastly, independent samples t-tests were used for comparing the means of grandparental care between grandparents living together and those living separately and also between non-widowed and widowed grandparents.

3. Results

Results are collated in the following way: frequency analyses, cross tabulations with chi-square analyses, linear regression analyses, binary logistic regression analyses, bivariate correlations and independent samples t-tests.

Sociodemographic description of participants

More than three out of four (87.8%) reported to have a brother or sister (N= 270). They mentioned to have one sibling (54.9%), two siblings (31.6%), three siblings (8.4%), four siblings (3.4%), five siblings (1.7%) (valid percent; N= 237). Their father's age ranged from 37 to 71 years (M= 51.17, SD= 5.83, N= 269). Their mother's age ranged from 30 to 72 years (M= 54.06, SD= 6.79, N= 264). Concerning their parents' vital status the participants reported that both parents were alive (90.0%), their mother was dead (1.5%), their father was dead (7.8%), or both parents were dead (0.7%) (N= 270). Their mother's highest educational level was compulsory schooling (10.4%), apprenticeship training (19.7%), medium-level technical and vocational school (15.2%), an academic secondary school or higher-level technical and vocational school (23.8%), universities and universities of applied sciences (30.1%) or unknown (0.7%) (valid percent; N= 269). Their mother's main economic activity up to the participant's age of seven years was indicated as employed (61.8%), student (1.1%), homemaker (35.1%), unknown (1.9%) (valid percent; N=262). Of those reported as employed 57.8% had a full-time employment, 42.2% had a part-time employment (N= 154). Their mother's occupation was assigned to legislators, senior officials and managers (5.1%), professionals (26.9%), technicians

and associate professionals (5.8%), clerks (29.5%), service workers and shop and market sales workers (18.6%), skilled agricultural and fishery workers (5.8%), craft and related workers (2.6%), elementary occupations (2.6%), unknown (3.2%) (valid percent; N= 156). Their father's highest educational level was compulsory schooling (4.8%), apprenticeship training (25.9%), medium-level technical and vocational school (16.7%), an academic secondary school or higher-level technical and vocational school (16.7%), universities and universities of applied sciences (34.1%) or unknown (1.9%) (valid percent; N= 270). Their father's main economic activity up to the participant's age of seven years was indicated as employed (97.0%), unemployed, looking for a job (0.4%), student (1.1%), homemaker (0.7%), unknown (0.7%) (valid percent; N=270). Of those reported as employed 98.8% had a full-time employment, 1.2% had a part-time employment (N= 243). Their father's occupation was assigned to legislators, senior officials and managers (15.6%), professionals (22.1%), technicians and associate professionals (19.3%), clerks (9.0%), service workers and shop and market sales workers (8.6%), skilled agricultural and fishery workers (4.5%), craft and related workers (11.1%), plant and machine operators and assemblers (4.5%), elementary occupations (0.8%), armed forces (0.4%), unknown (4.1%) (valid percent; N= 244). Concerning their parents' marital status participants reported that they were living together (9.7%), separated (4.1%), married (82.4%), divorced (3.4%), or widowed (0.4%) (valid percent; N= 267).

Vital status of grandparents

Participants reported that during childhood their maternal grandmother (91.9%), their maternal grandfather (70.4%), their paternal grandmother (85.9%) and their paternal grandfather (65.4%) were alive (valid percent).

Residential distance

As can be seen from table 3, the nearest residences were reported for the paternal grandmother (14.0%) and the paternal grandfather (14.0%), followed by the maternal grandmother (9.3%) and the maternal grandfather (4.3%) (valid percent). The greatest distances were rated for the MGF (5.9%), followed by the PGF (4.7%), the MGM (3.7%) and the PGM (3.1%).

Table 3. Residential distance according to each grandparent type

Residential distance	Grandparent type (valid percent)			
	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
In the house	9.3%	4.3%	14.0%	14.0%
In the neighbourhood	8.5%	8.1%	8.3%	6.4%
Short distance (village, quarter of a city)	13.0%	12.9%	19.3%	21.6%
City, neighbouring village	22.4%	22.6%	17.5%	16.4%
Surrounding area	11.0%	12.4%	9.2%	9.4%
Region	7.7%	9.1%	9.2%	8.8%
Daytrip	13.0%	12.9%	8.8%	8.8%
Day‘s journey	8.9%	9.7%	6.1%	4.7%
Long distance travel	2.4%	2.2%	4.4%	5.3%
Flight	3.7%	5.9%	3.1%	4.7%

In a subsample restricted to cases of participants whose four grandparents were alive during childhood, paternal grandparents lived on average in closer proximity to their grandchildren than maternal grandparents: PGM (M= 4.53, SD= 2.56), PGF (M= 4.62, SD= 2.62), MGM (M= 4.82, SD= 2.26), MGF (M= 5.05, SD= 2.28) (valid N (listwise)= 104).

Frequency of contact

As can be seen from table 4, the most frequent contact with a grandparent was reported for the maternal grandmother (18.6%), followed by the paternal grandmother (17.8%), the paternal grandfather (15.1%) and the maternal grandfather (12.5%) (valid percent). By contrast, they lost contact to their PGF (8.1%), followed by their PGM (4.8%), their MGF (4.3%) and their MGM (0.8%).

Table 4. Frequency of contact according to each grandparent type

Frequency of contact	Grandparent type (valid percent)			
	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
Every day	18.6%	12.5%	17.8%	15.1%
Several times a week	24.0%	24.5%	13.9%	13.4%
Once a week	13.6%	12.5%	15.7%	14.0%
Several times a month	9.1%	10.3%	9.6%	10.5%
At least once a month	7.0%	6.5%	9.1%	8.7%
Less than once a month	6.2%	4.3%	4.8%	4.1%
Several times a year	14.9%	16.8%	17.0%	15.7%
Once a year	3.7%	5.4%	4.3%	6.4%
Less frequently	2.1%	2.7%	3.0%	4.1%
Lost contact	0.8%	4.3%	4.8%	8.1%

In a subsample restricted to cases of participants whose four grandparents were alive during childhood, grandchildren had on average more frequent contact with their maternal grandparents than with their paternal grandparents: MGM (M= 3.63, SD= 0.23), MGF (M= 4.04, SD= 0.25), PGM (M= 4.45, SD= 0.27), PGF (M= 4.81, SD= 0.28) (valid N (listwise)= 103).

Initiation of contact

Participants mentioned that contact with their maternal grandparents was initiated by their mother (85.3%), their maternal grandmother (35.9%), their maternal grandfather (16.8%) and their father (7.5%). Furthermore, they mentioned that contact with their paternal grandparents was initiated by their father (59.3%), their mother (41.4%), their paternal grandmother (34.9%) and their paternal grandfather (17.5%) (valid percent).

Intensity of care

As can be seen from table 5, the most intense care was provided by the maternal grandmother (37.3%), followed by the maternal grandfather (21.2%), the paternal grandmother (17.7%) and the paternal grandfather (9.8%) (valid percent). By contrast, no care was provided by the PGF (17.3%), followed by the MGF (11.6%), the PGM (8.7%) and the MGM (2.4%).

Table 5. Intensity of care according to each grandparent type

Intensity of care	Grandparent type (valid percent)			
	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
Not at all	2.4%	11.6%	8.7%	17.3%
Almost not	10.1%	18.0%	13.9%	19.7%
Average	21.1%	27.0%	31.2%	26.0%
Considerable	29.1%	22.2%	28.6%	27.2%
Extraordinary	37.2%	21.2%	17.7%	9.8%

In a subsample restricted to cases of participants whose four grandparents were alive during childhood, grandchildren received on average more intense care from their grandmothers than from their grandfathers: MGM (M= 3.93, SD= 0.10), PGM (M= 3.22, SD= 0.11), MGF (M= 3.19, SD= 0.13), PGF (M= 2.80, SD= 0.12) (valid N (listwise)= 107).

Quality of relationship

As can bee seen from table 6, the quality of relationship was rated highest for the maternal grandmother (60.6%), followed by the maternal grandfather (43.5%), the paternal grandmother (36.1%) and the paternal grandfather (27.7%) (valid percent). The lowest ratings of quality of relationship were given for the PGF (12.7%), followed by the MGF (8.6%), the PGM (7.9%) and the MGM (1.2%).

Table 6. Quality of relationship according to each grandparent type

Quality of relationship	Grandparent type (valid percent)			
	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
Very bad	1.2%	8.6%	7.9%	12.7%
Rather bad	6.5%	7.0%	9.7%	10.2%
Neither good nor bad	11.8%	17.7%	24.7%	25.9%
Rather good	19.9%	23.1%	21.6%	23.5%
Very good	60.6%	43.5%	36.1%	27.7%

In a subsample restricted to cases of participants whose four grandparents were alive during childhood, grandchildren reported to have better relationships with their maternal grandparents: MGM (M= 4.39, SD= 9.10E-02), MGF (M= 3.87, SD= 0.13), PGM (M= 3.65, SD= 0.13), PGF (M= 3.42, SD= 0.13) (valid N (listwise)= 103).

Feelings of closeness

Participants answered that they feel very close to their maternal grandmother (59.6%), their paternal grandmother (25.2%), their maternal grandfather (16.3%), and their paternal grandfather (9.3%) (valid percent).

The most frequently cited reason for feelings of closeness was contact during childhood (58.1%). Other reported reasons were emotional closeness (50.6%), current contact (37.0%), abscence of other grandparents (10.9%), coresidence (9.8%), others (8.3%), monetary gifts (5.3%) and gifts received (4.9%) (valid percent).

In a subsample restricted to cases of participants whose four grandparents were alive during childhood participants reported to feel close to their maternal grandmother (63.0%), their paternal grandmother (23.1%), their maternal grandfather (20.4%), and their paternal grandfather (5.6%) (valid percent).

Feelings of being preferred or disadvantaged

Participants cited that they felt preferred by their maternal grandmother (14%), by their maternal grandfather (11.4%), by their paternal grandmother (12.0%) and by their paternal grandfather (10.8%) (valid percent). As can be seen from table 7, they most reported to be preferred by their maternal grandmother to cousins through maternal aunts (47.1%). They most stated to be preferred by their maternal grandfather to their sister (38.1%) and at equal frequency to cousins through maternal aunts (38.1%). Moreover, they most felt preferred by their paternal grandmother to cousins through paternal uncles (40.7%) and by their paternal grandfather to their sister (33.3%) and at equal frequency to cousins through paternal uncles (33.3%) as well as to cousins through paternal aunts (33.3%) (valid percent).

Table 7. Feelings of being preferred by each grandparent type

Feelings of being preferred to	**Grandparent type (valid percent)**			
	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
Brother	20.6%	23.8%	22.2%	27.8%
Sister	17.6%	38.1%	33.3%	33.3%
Cousins through maternal uncles	32.4%	23.8%	11.1%	11.1%
Cousins through maternal aunts	47.1%	38.1%	14.8%	5.6%
Cousins through paternal uncles	2.9%	4.8%	40.7%	33.3%
Cousins through paternal aunts	5.9%	9.5%	37.0%	33.3%

Participants cited that they felt disadvantaged by their maternal grandmother (7.4%), by their maternal grandfather (7.0%), by their paternal grandmother (14.2%) and by their paternal grandfather (13.2%) (valid percent). As can be seen from table 8, they most reported to be disadvantaged by their maternal grandmother to cousins through maternal uncles (33.3%) and at equal frequency to cousins through maternal aunts (33.3%). They most stated to be disadvantaged by their maternal grandfather to their brother (38.5%) and at equal frequency to cousins through maternal aunts (38.5%). Moreover, they most felt disadvantaged by their paternal grandmother to cousins through paternal uncles (40.6%) and by their paternal grandfather to cousins through paternal uncles as well (50.0%) (valid percent).

Table 8. Feelings of being disadvantaged by each grandparent type

Feelings of being disadvantaged to	Grandparent type (valid percent)			
	Maternal grandmother	Maternal grandfather	Paternal grandmother	Paternal grandfather
Brother	16.7%	38.5%	18.8%	22.7%
Sister	16.7%	23.1%	25.0%	13.6%
Cousins through maternal uncles	33.3%	38.5%	3.1%	4.5%
Cousins through maternal aunts	33.3%	30.8%	0%	0%
Cousins through paternal uncles	0%	0%	40.6%	50.0%
Cousins through paternal aunts	0%	0%	37.5%	36.4%

Number of siblings

Cross tabulations with chi-square analysis found a statistically significant relationship between intensity of care and number of siblings for the MGF (Chi-square value: 28.4, df= 16, p= 0.028). No statistically significant relationship was found between intensity of care and number of siblings for the MGM (Chi-square value: 7.4, df= 16, p= 0.964), the PGM (Chi-square value: 20.8, df= 16, p= 0.188) and the PGF(Chi-square value: 19.0, df= 16, p= 0.268).

Number of cousins

Cross tabulations with chi-square analysis did not find any statistically significant relationship between intensity of care and number of cousins through uncles for the maternal grandmother (Chi-square value: 49.3, df= 48, p= 0.419), the maternal grandfather (Chi-square value: 41.6, df= 44, p= 0.575), the paternal

grandmother (Chi-square value: 53.8, df= 48, p= 0.260) and the paternal grandfather (Chi-square value: 55.4, df= 48, p= 0.215).

Furthermore, cross tabulations with chi-square analysis did not find any statistically significant relationship between intensity of care and number of cousins through aunts for the maternal grandmother (Chi-square value: 65.6, df= 52, p= 0.097), the maternal grandfather (Chi-square value: 73.4, df= 56, p= 0.059), the paternal grandmother (Chi-square value: 55.1, df= 48, p= 0.223) and the paternal grandfather (Chi-square value: 38.7, df= 48, p= 0.828).

Main economic activity of grandparents

Cross tabulations with chi-square analysis found a statistically significant relationship between intensity of care and main economic activity for the MGF (Chi-square value: 75.2, df= 16, p= 0.000). No statistically significant relationship was found for the MGM (Chi-square value: 26.1, df= 20, p= 0.163), the PGM (Chi-square value: 20.5, df= 24, p= 0.666) and the PGF (Chi-square value: 19.2, df= 20, p= 0.507).

Marital status of grandparents

Cross tabulations with chi-square analysis found a statistically significant relationship between intensity of care and marital status of grandparents for the maternal grandmother (Chi-square value: 34.8, df= 20, p= 0.021), the maternal grandfather (Chi-square value: 85.3 df= 16 p= 0.000), the paternal grandmother (Chi-square value: 36.8 df= 20 p= 0.012) and the paternal grandfather (Chi-square value: 26.5 df= 16 p= 0.047).

Frequency of contact

Cross tabulations with chi-square analysis found a statistically significant relationship between intensity of care and frequency of contact for the maternal grandmother (Chi-square value: 208.7, df= 36, p= 0.000), the maternal grandfather (Chi-square value: 155.9, df= 36, p= 0.000), the paternal grandmother (Chi-square value: 184.3, df= 36, p= 0.000) and the paternal grandfather (Chi-square value: 126.7, df= 36, p= 0.000) (See table 9 (MGM), table 10 (MGF), table 11 (PGM) and table 12 (PGF)).

Table 9. Intensity of care (MGM)× Frequency of contact (MGM)

Frequency of contact	Intensity of care (maternal grandmother)				
	Not at all	Almost not	Average	Considerable	Extraordinary
Every day	0%	0%	3.9%	9.9%	40.4%
Several times a week	0%	4.2%	19.6%	28.2%	30.3%
Once a week	0%	12.5%	13.7%	12.7%	15.7%
Several times a month	0%	4.2%	15.7%	8.5%	7.9%
At least once a month	0%	8.3%	7.8%	14.1%	1.1%
Less than once a month	16.7%	16.7%	13.7%	4.2%	0%
Several times a year	0%	45.8%	21.6%	14.1%	4.5%
Once a year	33.3%	4.2%	2.0%	7.0%	0%
Less frequently	16.7%	4.2%	2.0%	1.4%	0%
Lost contact	33.3%	0%	0%	0%	0%

Chi-square value: 208.7 df= 36 p= 0.000

64% expected count < 5.

Table 10. Intensity of care (MGF) × Frequency of contact (MGF)

Frequency of contact	Intensity of care (maternal grandfather)				
	Not at all	Almost not	Average	Considerable	Extraordinary
Every day	0%	0%	3.9%	19.0%	34.2%
Several times a week	0%	6.3%	29.4%	42.9%	26.3%
Once a week	5.0%	12.5%	13.7%	7.1%	21.1%
Several times a month	5.0%	9.4%	15.7%	4.8%	13.2%
At least once a month	5.0%	6.3%	5.9%	14.3%	0%
Less than once a month	10.0%	9.4%	5.9%	0%	0%
Several times a year	20.0%	37.5%	17.6%	9.5%	5.3%
Once a year	5.0%	15.6%	5.9%	2.4%	0%
Less frequently	10.0%	3.1%	2.0%	0%	0%
Lost contact	40.0%	0%	0%	0%	0%

Chi-square value: 155.9 df= 36 p= 0.000

74% expected count < 5.

Table 11. Intensity of care (PGM) × Frequency of contact (PGM)

Frequency of contact	Intensity of care (paternal grandmother)				
	Not at all	Almost not	Average	Considerable	Extraordinary
Every day	5.0%	3.1%	11.3%	26.2%	34.1%
Several times a week	0%	3.1%	7.0%	20.0%	31.7%
Once a week	0%	0%	21.1%	21.5%	17.1%
Several times a month	0%	9.4%	12.7%	15.4%	0%
At least once a month	5.0%	25.0%	11.3%	6.2%	0%
Less than once a month	10.0%	3.1%	8.5%	3.1%	0%
Several times a year	10.0%	37.5%	22.5%	6.2%	12.2%
Once a year	10.0%	9.4%	2.8%	1.5%	4.9%
Less frequently	15.0%	3.1%	2.8%	0%	0%
Lost contact	45.0%	6.3%	0%	0%	0%

Chi-square value: 184.3 df= 36 p= 0.000

62% expected count < 5.

Table 12. Intensity of care (PGF) × Frequency of contact (PGF)

Frequency of contact	Intensity of care (paternal grandfather)				
	Not at all	Almost not	Average	Considerable	Extraordinary
Every day	3.3%	11.8%	11.6%	21.3%	35.3%
Several times a week	3.3%	0%	9.3%	27.7%	29.4%
Once a week	3.3%	8.8%	27.9%	14.9%	5.9%
Several times a month	3.3%	20.6%	9.3%	12.8%	0%
At least once a month	13.3%	14.7%	7.0%	6.4%	0%
Less than once a month	0%	2.9%	11.6%	2.1%	0%
Several times a year	3.3%	20.6%	18.6%	14.9%	23.5%
Once a year	23.3%	8.8%	0%	0%	5.9%
Less frequently	10.0%	5.9%	4.7%	0%	0%
Lost contact	36.7%	5.9%	0%	0%	0%

Chi-square value: 126.7 df= 36 p= 0.000

80% expected count < 5.

Residential distance

Cross tabulations with chi-square analysis found a statistically significant relationship between intensity of care and residential distance for the maternal grandmother (Chi-square value: 88,6 df= 36 p= 0.000), the maternal grandfather (Chi-square value: 51.6, df= 36, p= 0.044), the paternal grandmother (Chi-square

value: 54.0, df= 36, p= 0.027) and the paternal grandfather (Chi-square value: 57.1, df= 36, p= 0.014) (See table 13 (MGM), table 14 (MGF), table 15 (PGM) and table 16 (PGF)).

Table 13. Intensity of care (MGM) × Residential distance (MGM)

Residential distance	Intensity of care (maternal grandmother)				
	Not at all	Almost not	Average	Considerable	Extraordinary
In the house	0%	0%	1.9%	5.6%	19.8%
In the neighbourhood	0%	0%	5.8%	5.6%	15.4%
Short distance (village, quarter of a city)	0%	8.0%	11.5%	12.7%	16.5%
City, neighbouring village	0%	20.0%	19.2%	23.9%	25.3%
Surrounding area	0%	16.0%	15.4%	11.3%	7.7%
Region	0%	4.0%	15.4%	8.5%	4.4%
Daytrip	33.3%	28.0%	17.3%	11.3%	6.6%
Day‘s journey	33.3%	12.0%	7.7%	12.7%	3.3%
Long distance travel	33.3%	4.0%	1.9%	2.8%	0%
Flight	0%	8.0%	3.8%	5.6%	1.1%

Chi-square value: 88.6 df= 36 p= 0.000

58% expected count < 5.

Table 14. Intensity of care (MGF) × Residential distance (MGF)

Residential distance	Intensity of care (maternal grandfather)				
	Not at all	Almost not	Average	Considerable	Extraordinary
In the house	0%	0%	0%	7.3%	12.8%
In the neighbourhood	4.8%	0%	5.9%	12.2%	15.4%
Short distance (village, quarter of a city)	9.5%	6.1%	13.7%	14.6%	17.9%
City, neighbouring village	9.5%	24.2%	23.5%	26.8%	23.1%
Surrounding area	4.8%	12.1%	13.7%	17.1%	10.3%
Region	9.5%	12.1%	13.7%	2.4%	7.7%
Daytrip	14.3%	21.2%	13.7%	9.8%	7.7%
Day‘s journey	19.0%	15.2%	7.8%	7.3%	2.6%
Long distance travel	9.5%	3.0%	2.0%	0%	0%
Flight	19.0%	6.1%	5.9%	2.4%	2.6%

Chi-square value: 51.6 df= 36 p= 0.044

76% expected count < 5.

Table 15. Intensity of care (PGM) × Residential distance (PGM)

Residential distance	Intensity of care (paternal grandmother)				
	Not at all	Almost not	Average	Considerable	Extraordinary
In the house	5.0%	6.3%	10.0%	23.1%	17.5%
In the neighbourhood	5.0%	0%	8.6%	12.3%	10.0%
Short distance (village, quarter of a city)	10.0%	15.6%	15.7%	23.1%	27.5%
City, neighbouring village	15.0%	28.1%	17.1%	13.8%	17.5%
Surrounding area	5.0%	3.1%	14.3%	10.8%	5.0%
Region	15.0%	12.5%	11.4%	7.7%	2.5%
Daytrip	20.0%	12.5%	8.6%	4.6%	7.5%
Day‘s journey	0%	15.6%	7.1%	1.5%	7.5%
Long distance travel	20.0%	3.1%	2.9%	3.1%	2.5%
Flight	5.0%	3.1%	4.3%	0%	2.5%

Chi-square value: 54.0 df= 36 p= 0.027

62% expected count < 5.

Table 16. Intensity of care (PGF) × Residential distance (PGF)

Residential distance	Intensity of care (paternal grandfather)				
	Not at all	Almost not	Average	Considerable	Extraordinary
In the house	3.4%	8.8%	11.4%	23.9%	23.5%
In the neighbourhood	10.3%	2.9%	2.3%	10.9%	5.9%
Short distance (village, quarter of a city)	6.9%	29.4%	20.5%	28.3%	17.6%
City, neighbouring village	6.9%	23.5%	22.7%	10.9%	17.6%
Surrounding area	6.9%	5.9%	13.6%	10.9%	5.9%
Region	24.1%	2.9%	15.9%	0%	0%
Daytrip	13.8%	8.8%	6.8%	8.7%	5.9%
Day‘s journey	6.9%	2.9%	2.3%	2.2%	17.6%
Long distance travel	10.3%	5.9%	2.3%	2.2%	5.9%
Flight	10.3%	8.8%	2.3%	2.2%	0%

Chi-square value: 57.1 df= 36 p= 0.014

82% expected count < 5.

Quality of relationship

Firstly, cross tabulations with chi-square analysis found a statistically significant relationship between intensity of care (MGM) and quality of relationship (MGM) (Chi-square value: 253.3, df= 16, p= 0.000) and between intensity of care (MGM) and quality of relationship (MGF) (Chi-square value: 48.4, df= 16, p= 0.000) (See table 17 and table 18). No statistically significant relationship was found between intensity of care (MGM) and quality of relationship (PGM) (Chi-square value: 22.1, df= 16, p= 0.141) and between intensity of care (MGM) and quality of relationship (PGF) (Chi-square value: 10.1, df= 16, p= 0.861) (See table 19 and table 20).

Table 17. Intensity of care (MGM) × Quality of relationship (MGM)

Intensity of care (MGM)	**Quality of relationship (maternal grandmother)**				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	100%	12.5%	0%	0%	0%
Almost not	0%	50.0%	27.6%	8.3%	3.4%
Average	0%	31.3%	44.8%	37.5%	10.7%
Considerable	0%	6.3%	20.7%	35.4%	31.5%
Extraordinary	0%	0%	6.9%	18.8%	54.4%

Chi-square value: 253.3 df= 16 p= 0.000

56% expected count < 5.

Table 18. Intensity of care (MGM) × Quality of relationship (MGF)

Intensity of care (MGM)	**Quality of relationship (maternal grandfather)**				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	13.3%	0%	3.4%	0%	1.3%
Almost not	26.7%	30.8%	17.2%	0%	6.4%
Average	13.3%	15.4%	20.7%	30%	15.4%
Considerable	33.3%	38.5%	44.8%	35%	21.8%
Extraordinary	13.3%	15.4%	13.8%	35%	55.1%

Chi-square value: 48.4 df= 16 p= 0.000

56% expected count < 5.

Table 19. Intensity of care (MGM) × Quality of relationship (PGM)

Intensity of care (MGM)	Quality of relationship paternal grandmother)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	0%	4.8%	7.8%	2.2%	0%
Almost not	5.6%	4.8%	11.8%	6.5%	12.7%
Average	11.1%	42.9%	13.7%	17.4%	18.3%
Considerable	27.8%	23.8%	25.5%	37.0%	35.2%
Extraordinary	55.6%	23.8%	41.2%	37.0%	33.8%

Chi-square value: 22.1 df= 16 p= 0.141

44% expected count < 5.

Table 20. Intensity of care (MGM) × Quality of relationship (PGF)

Intensity of care (MGM)	Quality of relationship (paternal grandfather)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	4.8%	6.3%	2.6%	0%	4.9%
Almost not	9.5%	6.3%	5.1%	17.6%	7.3%
Average	9.5%	18.8%	17.9%	17.6%	19.5%
Considerable	38.1%	18.8%	28.2%	32.4%	36.6%
Extraordinary	38.1%	50.0%	46.2%	32.4%	31.7%

Chi-square value: 10.1 df= 16 p= 0.861

48% expected count < 5.

Secondly, a statistically significant relationship was found between intensity of care (MGF) and quality of relationship (MGM) (Chi-square value: 37.4, df= 16, p= 0.002) and between intensity of care (MGF) and quality of relationship (MGF) (Chi-square value: 169.7, df= 16, p= 0.000) (See table 21 and table 22). No statistically significant relationship was found between intensity of care (MGF) and quality of relationship (PGM) (Chi-square value: 21.4, df= 16, p= 0.165) and between intensity of care (MGF) and quality of relationship (PGF) (Chi-square value: 11.4, df= 16, p= 0.784) (See table 23 and table 24).

Table 21. Intensity of care (MGF) × Quality of relationship (MGM)

Intensity of care (MGF)	Quality of relationship (maternal grandmother)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	33.3%	14.3%	13.0%	5.0%	11.4%
Almost not	33.3%	71.4%	34.8%	17.5%	9.5%
Average	33.3%	0%	30.4%	35.0%	24.8%
Considerable	0%	14.3%	8.7%	30.0%	24.8%
Extraordinary	0%	0%	13.0%	12.5%	29.5%

Chi-square value: 37.4 df= 16 p= 0.002

52% expected count < 5.

Table 22. Intensity of care (MGF) × Quality of relationship (MGF)

Intensity of care (MGF)	Quality of relationship (maternal grandfather)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	81.3%	23.1%	12.1%	2.4%	1.2%
Almost not	18.8%	61.5%	39.4%	7.1%	8.6%
Average	0%	7.7%	39.4%	47.6%	19.8%
Considerable	0%	7.7%	9.1%	35.7%	27.2%
Extraordinary	0%	0%	0%	7.1%	43.2%

Chi-square value: 169.7 df= 16 p= 0.000

48% expected count < 5.

Table 23. Intensity of care (MGF) × Quality of relationship (PGM)

Intensity of care (MGF)	Quality of relationship (paternal grandmother)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	8.3%	13.3%	11.1%	11.4%	14.1%
Almost not	16.7%	6.7%	22.2%	11.4%	20,3%
Average	16.7%	53.3%	19.4%	17.1%	31.3%
Considerable	16.7%	13.3%	25.0%	42.9%	15.6%
Extraordinary	41.7%	13.3%	22.2%	17.1%	18.8%

Chi-square value: 21.4 df= 16 p= 0.165

48% expected count < 5.

Table 24. Intensity of care (MGF) × Quality of relationship (PGF)

Intensity of care (MGF)	Quality of relationship (paternal grandfather)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	14.3%	14.3%	12.9%	13.3%	9.7%
Almost not	28.6%	7.1%	16.1%	23.3%	12.9%
Average	14.3%	50.0%	22.6%	16.7%	32.3%
Considerable	21.4%	14.3%	19.4%	30.0%	22.6%
Extraordinary	21.4%	14.3%	29.0%	16.7%	22.6%

Chi-square value: 11.4 df= 16 p= 0.784

52% expected count < 5.

Thirdly, a statistically significant relationship was found between intensity of care (PGM) and quality of relationship (PGM) (Chi-square value: 125.8, df= 16, p= 0.000) and between intensity of care (PGM) and quality of relationship (PGF) (Chi-square value: 57.8, df= 16, p= 0.000) (See table 27 and table 28). No statistically significant relationship was found between intensity of care (PGM) and quality of relationship (MGM) (Chi-square value: 10.4, df= 16, p= 0.846) and between intensity of care (PGM) and quality of relationship (MGF) (Chi-square value: 10.4, df= 16, p= 0.846) (See table 25 and table 26).

Table 25. Intensity of care (PGM) × Quality of relationship (MGM)

Intensity of care (PGM)	Quality of relationship (maternal grandmother)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	33.3%	12.5%	0%	11.9%	8.5%
Almost not	33.3%	6.3%	15.8%	14.3%	14.6%
Average	0%	37.5%	26.3%	26.2%	32.3%
Considerable	33.3%	18.8%	36.8%	28.6%	30.0%
Extraordinary	0%	25.0%	21.1%	19.0%	14.6%

Chi-square value: 10.4 df= 16 p= 0.846

56% expected count < 5.

Table 26. Intensity of care (PGM) × Quality of relationship (MGF)

Intensity of care (PGM)	Quality of relationship (maternal grandfather)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	13.3%	8.3%	7.4%	16.7%	6.8%
Almost not	6.7%	16.7%	18.5%	16.7%	10.8%
Average	20.0%	25.0%	22.2%	25.0%	39.2%
Considerable	33.3%	33.3%	29.6%	30.6%	27.0%
Extraordinary	26.7%	16.7%	22.2%	11.1%	16.2%

Chi-square value: 10.4 df= 16 p= 0.846

60% expected count < 5.

Table 27. Intensity of care (PGM) × Quality of relationship (PGM)

Intensity of care (PGM)	Quality of relationship (paternal grandmother)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	44.4%	18.2%	8.9%	0%	1.2%
Almost not	33.3%	18.2%	26.8%	6.3%	2.4%
Average	16.7%	50.0%	41.1%	39.6%	19.5%
Considerable	0%	13.6%	16.1%	47.9%	37.8%
Extraordinary	5.6%	0%	7.1%	6.3%	39.0%

Chi-square value: 125.8 df= 16 p= 0.000

32% expected count < 5.

Table 28. Intensity of care (PGM) × Quality of relationship (PGF)

Intensity of care (PGM)	Quality of relationship (paternal grandfather)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	29.4%	25.0%	10.8%	0%	0%
Almost not	35.3%	25.0%	16.2%	5.6%	5.0%
Average	11.8%	43.8%	40.5%	22.2%	20.0%
Considerable	17.6%	6.3%	16.2%	47.2%	47.5%
Extraordinary	5.9%	0%	16.2%	25.0%	27.5%

Chi-square value: 57.8 df= 16 p= 0.000

48% expected count < 5.

Fourthly, a statistically significant relationship was found between intensity of care (PGF) and quality of relationship (MGM) (Chi-square value: 30.9, df= 16, p= 0.014) (See table 29), between intensity of care (PGF) and quality of relationship (PGM) (Chi-square value: 51.8, df= 16, p= 0.000) and between intensity of care (PGF) and quality of relationship (PGF) (Chi-square value: 111.3, df= 16, p= 0.000) (See table 31 and table 32). No statistically significant relationship was found between intensity of care (PGF) and quality of relationship (MGF) (Chi-square value: 20.7, df= 16, p= 0.189) (See table 30).

Table 29. Intensity of care (PGF) × Quality of relationship (MGM)

Intensity of care (PGF)	**Quality of relationship (maternal grandmother)**				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	100.0%	30.0%	25.0%	9.1%	18.8%
Almost not	0%	10.0%	33.3%	18.2%	19.8%
Average	0%	10.0%	8.3%	24.2%	32.7%
Considerable	0%	10.0%	25.0%	36.4%	22.8%
Extraordinary	0%	40.0%	8.3%	12.1%	5.9%

Chi-square value: 30.9 df= 16 p= 0.014

64% expected count < 5.

Table 30. Intensity of care (PGF) × Quality of relationship (MGF)

Intensity of care (PGF)	**Quality of relationship (maternal grandfather)**				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	30.8%	20.0%	28.6%	16.7%	16.4%
Almost not	15.4%	20.0%	28.6%	16.7%	16.4%
Average	15.4%	60.0%	19.0%	16.7%	38.2%
Considerable	15.4%	0%	19.0%	43.3%	20.0%
Extraordinary	23.1%	0%	4.8%	6.7%	9.1%

Chi-square value: 20.7 df= 16 p= 0.189

60% expected count < 5.

Table 31. Intensity of care (PGF) × Quality of relationship (PGM)

Intensity of care (PGF)	Quality of relationship (paternal grandmother)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	53.3%	31.3%	22.2%	3.0%	3.9%
Almost not	26.7%	25.0%	25.0%	18.2%	5.9%
Average	20.0%	37.5%	25.0%	30.3%	29.4%
Considerable	0%	6.3%	22.2%	39.4%	43.1%
Extraordinary	0%	0%	5.6%	9.1%	17.6%

Chi-square value: 51.8 df= 16 p= 0.000

52% expected count < 5.

Table 32. Intensity of care (PGF) × Quality of relationship (PGF)

Intensity of care (PGF)	Quality of relationship (paternal grandfather)				
	Very bad	Rather bad	Neither good nor bad	Rather good	Very good
Not at all	71.4%	47.1%	11.6%	0%	0%
Almost not	14.3%	35.3%	34.9%	15.4%	4.3%
Average	9.5%	17.6%	32.6%	28.2%	26.1%
Considerable	4.8%	0%	14.0%	46.2%	47.8%
Extraordinary	0%	0%	7.0%	10.3%	21.7%

Chi-square value: 111.3 df= 16 p= 0.000

44% expected count < 5.

Marital status of parents

Cross tabulations with chi-square analysis found a statistically significant relationship between quality of relationship and marital status of parents for the PGM (Chi-square value: 55.8, df= 16, p= 0.000). No statistically significant relationship between quality of relationship and marital status of parents was found for the MGM (Chi-square value: 8.3, df= 16, p= 0.941), the MGF (Chi-square value: 11.3, df= 12, p= 0.503) and the PGF (Chi-square value: 16.9, df= 16, p= 0.391).

Number of living grandparents

Cross tabulations with chi-square analysis did not find any statistically significant relationship between intensity of care and number of living grandparents for the maternal grandmother (Chi-square value: 10.1, df= 8, p= 0.261), the maternal grandfather (Chi-square value: 10.8, df= 8, p= 0.216), the paternal grandmother (Chi-

square value: 6.7, df= 8, p= 0.565) and the paternal grandfather (Chi-square value: 13.3, df= 8, p= 0.103).

A statistically significant relationship between quality of relationship and number of living grandparents was found for the MGF (Chi-square value: 16.0, df= 8, p= 0.042). No statistically significant relationship between quality of relationship and number of living grandparents was found for the MGM (Chi-square value: 11.9, df= 8, p= 0.154), the PGM (Chi-square value: 2.4, df= 8, p= 0.966) and the PGF (Chi-square value: 6.1, df= 8, p= 0.634).

Moreover, a statistically significant relationship between frequency of contact and number of living grandparents was found for the MGF (Chi-square value: 29.4, df= 18, p= 0.044). No statistically significant relationship between frequency of contact and number of living grandparents was found for the the MGM (Chi-square value: 16.2, df= 18, p= 0.575), the PGM (Chi-square value: 17.7, df= 18, p= 0.477) and the PGF (Chi-square value: 17.3, df= 18, p= 0.499).

Cross tabulations with chi-square analysis did not find any statistically significant relationship between feeling of closeness and number of living grandparents for the maternal grandmother (Chi-square value: 1.8, df= 2, p= 0.415), the maternal grandfather (Chi-square value: 2.1, df= 2, p= 0.354), the paternal grandmother (Chi-square value: 0.8, df= 2, p= 0.681) and the paternal grandfather (Chi-square value: 4.2, df= 2, p= 0.125).

Intensity of care

Grandchildren who have cousins through their uncles receive less intense care from the MGM than grandchildren whose uncles are childless (B= -0.15, p= 0.029).
Grandchildren who have cousins through their aunts receive less intense care from the PGF than grandchildren whose aunts are childless (B= -0.16, p= 0.028).
As residential distance increases by one unit, the intensity of care provided by the MGM, the MGF and the PGF decreases (MGM (B= -0.19, (p= 0.000), MGF (B= -0.21, p= 0.000), PGF (B= -0.13, p= 0.017)).
Grandchildren whose mothers are not employed receive less intense care from their grandparents than grandchildren whose mothers are employed (MGM (B= -0.17, p= 0.012), MGF (B= -0.17, p= 0.047), PGM (B= -0.16, p= 0.010) and PGF (B= -0.13, p= 0.034).

The proportions of variance in intensity of care which could be explained by sex, existence of cousins through uncles or aunts on the maternal and on the paternal side of the family, age of grandparent, residential distance and mother's main economic activity were 35% for the MGM, 29% for the MGF, 15% for the PGM and 26% for the PGF (see table 33).

Table 33. Intensity of care according to each grandparent type

	R^2	Regression coefficient	Significance (p- value)	95% confidence interval
Intensity of care (MGM)				
Sex	0.35	-0.02	n.s.	-0,44 – 0.41
Cousins through uncles		-0.15	0.029	-0.29 - -0.02
Cousins through aunts		-0.03	n.s.	-0.21 – 0.16
Age (MGM)		-0.17	n.s.	-0.40 – 0.06
Residential distance		-0.19	0.000	-0.28 - -0.12
Main economic activity of mother		-0.17	0.012	-0.29 - -0.04
Intensity of care (MGF)				
Sex	0.29	0.23	n.s.	-0.27 – 0.72
Cousins through uncles		-0.16	n.s.	-0.71 – 0.39
Cousins through aunts		0.04	n.s.	-0.51 – 0.59
Age (MGF)		-0.10	n.s.	-0.30 – 0.10
Residential distance		-0.21	0.000	-0.31 - -0.11
Main economic activity of mother		-0.17	0.047	-0.34 – 0.00
Intensity of care (PGM)				
Sex	0.15	-0.02	n.s.	-0.56 – 0.52
Cousins through uncles		0.22	n.s.	-0.66 – 1.09
Cousins through aunts		-0.12	n.s.	-0.27 – 0.03
Age (PGM)		0.03	n.s.	-0.18 – 0.24
Residential distance		-0.07	n.s.	-0.18 – 0.03
Main economic activity of mother		-0.16	0.010	-0.28 - -0.04
Intensity of care (PGF)				
Sex	0.26	-0.28	n.s.	-0.89 – 0.34
Cousins through uncles		0.55	n.s.	-0.19 – 1.29
Cousins through aunts		-0.16	0.028	-0.29 - -0.02
Age (PGF)		-0.00	n.s.	-0.22 – 0.21
Residential distance		-0.13	0.017	-0.23 - -0.02
Main economic activity of mother		-0.13	0.034	-0.25 - -0.01

Quality of relationship

Grandchildren who have cousins trough their uncles have lower quality relationships with the MGM than grandchildren whose uncles are childless (B= -0.36, p= 0.042).

For each additional decade of life of the PGF, the quality of relationship with the PGF decreases (B= -0.24, p= 0.010).

As intensity of care for the grandchild increases by one unit, the quality of relationship to the grandparent increases (MGM (B= 0.53, p= 0.000), MGF (B= 0.67, p= 0.000), PGM (B= 0.64, p= 0.000) and PGF (B= 0.57, p= 0.000).

The proportions of variance in quality of relationship which could be explained by sex, existence of cousins through uncles or aunts on the maternal and on the paternal side of the family, age of grandparent, residential distance and intensity of care were 49 % for the MGM, 53% for the MGF, 40% for the PGM and 57% for the PGF (see table 34).

Table 34. Quality of relationship according to each grandparent type

	R^2	Regression coefficient	Significance (p- value)	95% confidence interval
Quality of relationship (MGM)				
Sex	0.49	0.01	n.s.	-0.33 – 0.34
Cousins through uncles		-0.36	0.042	-0.70 - -0.01
Cousins through aunts		0.24	n.s.	-0.10 – 0.59
Age (MGM)		0.01	n.s.	-0.18 – 0.19
Residential distance		-0.03	n.s.	-0.09 – 0.04
Intensity of care (MGM)		0.53	0.000	0.38 – 0.68
Quality of relationship (MGF)				
Sex	0.53	-0.13	n.s.	-0.52 – 0.26
Cousins through uncles		0.04	n.s.	-0.40 – 0.47
Cousins through aunts		-0.12	n.s.	-0.55 – 0.32
Age (MGF)		0.07	n.s.	-0.09 – 0.24
Residential distance		-0.02	n.s.	-0.11 – 0.06
Intensity of care (MGF)		0.67	0.000	0.49 – 0.84
Quality of relationship (PGM)				
Sex	0.40	-0.24	n.s.	-0.72 – 0.24
Cousins through uncles		0.09	n.s.	-0.69 – 0.88
Cousins through aunts		-0.08	n.s.	-0.22 – 0.05
Age (PGM)		0.01	n.s.	-0.18 – 0.19
Residential distance		-0.01	n.s.	-0.09 – 0.09
Intensity of care (PGM)		0.64	0.000	0.44 – 0.84
Quality of relationship (PGF)				
Sex	0.57	-0.35	n.s.	-0.85 – 0.15
Cousins through uncles		0.55	n.s.	-0.05 – 1.15
Cousins through aunts		-0.04	n.s.	-0.16 – 0.07
Age (PGF)		-0.24	0.010	-0.42 - -0.06
Residential distance		-0.04	n.s.	-0.13 – 0.04
Intensity of care (PGF)		0.57	0.000	0.38 – 0.77

Feeling of closeness

As can be seen from table 35, a one unit increase in residential distance is associated with a 0.33 increase in the log odds of feeling of closeness of the MGF

(B= 0.33, p= 0.048). The odds of feeling of closeness increase by a factor of 1.39 for each unit increase in residential distance (MGF (Exp(B)= 1.39)).

Furthermore, a one unit increase in intensity of care is associated with an increase in the log odds of feeling of closeness of the MGF (B= 0.84, p= 0.002), of the PGM (B= 0.92, p=0.000) and of the PGF (B= 1.18, p =0.002). The odds of feeling of closeness increase by a factor of 2.33, 2.51 and 3.26 for each unit increase in intensity of care (MGF (Exp(B)= 2.33), PGM (Exp(B)= 2.51), PGF (Exp(B)= 3.26)).

A one unit increase in quality of relationship is associated with an increase in the log odds of feeling of closeness of the MGM (B= 0.88, p= 0.000), of the MGF (B= 0.83, p=0.020), of the PGM (B= 0.49, p= 0.011) and of the PGF (B= 1.15, p= 0.005). The odds of feeling of closeness increase by a factor of 2.42, 2.29, 1.64 and 3.17 for each unit increase in quality of relationship (MGM (Exp(B)= 2.42), MGF (Exp(B)= 2.29), PGM (Exp(B)= 1.64), PGF (Exp(B)= 3.17)).

Table 35. Binary logistic regression

		Regression coefficient B	Significance (p- value)	95% confidence interval EXP (B)
Feeling of closeness (MGM)				
Residential distance		0. 04	n.s.	0.85 – 1.28
Frequency of contact		-0.07	n.s.	0.74 – 1.17
Intensity of care		0.13	n.s.	0.77 – 1.69
Quality of relationship		0.88	0.000	1.63 – 3.60
Feeling of closeness (MGF)				
Residential distance		0.33	0.048	1.00 – 1.94
Frequency of contact		-0.13	n.s.	0.62 – 1.23
Intensity of care		0.84	0.002	1.38 – 3.93
Quality of relationship		0.83	0.020	1.14 – 4.64
Feeling of closeness (PGM)				
Residential distance		-0.19	n.s.	0.65 – 1.04
Frequency of contact		0.09	n.s.	0.84 – 1.41
Intensity of care		0.92	0.000	1.57 – 4.03
Quality of relationship		0.49	0.011	1.12 – 2.39
Feeling of closeness (PGF)				
Residential distance		-0.13	n.s.	0.36 – 1.22
Frequency of contact		0.12	n.s.	0.80 – 1.59
Intensity of care		1.18	0.002	1.55 – 6.86
Quality of relationship		1.15	0.005	1.42 – 7.08

Frequency of contact

The intra-couple correlations of frequency of contact had high correlation coefficients, thus indicating strong positive linear relationships that were also statistically significant (maternal grandparents (r= 0.76, p= 0.000), paternal

grandparents (r= 0.84, p= 0.000)), in contrast to the four inter-couple correlations (MGM and PGM (r= 0.11, p= 0.115)), MGF and PGF (r= 0.12, p= 0.188), MGM and PGF (r= 0.01p= 0.903) and PGM and MGF (r= 0.12, p= 0.132)).

Intensity of care

The intra-couple correlations of intensity of care provided by the grandparents had high positive correlation coefficients, thus indicating strong positive linear relationships that were also statistically significant (maternal grandparents (r= 0.62, p= 0.000), paternal grandparents (r=0.78, p= 0.000)). In contrast the four inter-couple correlations did not have any statistically significant relationship (MGM and PGM (r= 0.06, p= 0.351)), MGF and PGF (r= 0.14, p= 0.122), MGM and PGF (r=0.08, p= 0.274) and PGM and MGF (r= 0.06, p= 0.438)).

Quality of relationship

The intra-couple correlations of quality of relationship indicated positive linear relationships that were also statistically significant (maternal grandparents (r= 0.44, p= 0.000), paternal grandparents (r= 0.68, p= 0.000)). Inter-couple correlations revealed only a weak positive linear relationship that was statistically significant between the two grandfathers (MGF and PGF (r= 0.19, p= 0.031). Other inter-couple correlations did not have any statistically significant relationship (MGM and PGM (r= 0.13, p= 0.058), MGM and PGF (r= 0.05, p= 0. 534) and PGM and MGF (r= 0.08, p= 0.264).

Marital status of grandparent

As can be seen from table 36, a statistically significant difference in means of grandparental care has only been found between maternal grandfathers who lived with their partner and those who lived separately.

Table 36. Intensity of care of each grandparent type according to marital status

Grandparent	Marital status									
	Living together / married		Separated/ divorced			Non-widowed		Widowed		
	Mean	N	Mean	N	p	Mean	N	Mean	N	p
Maternal grandmother	3,95	171	3,42	24	ns	3,95	171	3,87	47	ns
Maternal grandfather	3,47	159	1,52	21	0.000	3,47	159	2,71	7	ns
Paternal grandmother	3,30	154	3,04	23	ns	3,30	154	3,45	44	ns
Paternal grandfather	2,86	118	2,63	16	ns	2,86	118	3,09	32	ns

4. Discussion

This study investigated three predictions using retrospective ratings by adult grandchildren about received grandparental care during childhood.

Hypothesis 1: The four grandparents (maternal grandmother, maternal grandfather, paternal grandmother and paternal grandfather) do not provide equal amounts of care for the grandchild.

Hypothesis 2: Maternal grandparents provide more care for the grandchild than paternal grandparents.

Hypothesis 3: Within each grandparent couple (maternal or paternal), grandmothers provide more care for the grandchild than grandfathers.

Results from a subsample of grandchildren who reported four living grandparents during childhood indicate that the four grandparents provide varying amounts of care. It has been found that the maternal grandmother and the paternal grandfather represent opposite ends of the continuum, with the maternal grandmother caring most and the paternal grandfather caring least. The maternal grandfather and the paternal grandmother provided intermediate levels of care. Thus, results provided support for hypothesis 1.

In addition, maternal grandparents have been expected to be more inclined to support their offspring by providing child care than paternal grandparents. Hypothesis 2 was not supported as it has also been found in this subsample that both the maternal and the paternal grandmother provided more care for their grandchildren than both grandfathers. This finding was unanticipated and suggests that the ordered pattern of grandparental care may be moderated by social roles. Social roles may determine care giving differences between parents and consequently between grandparents. If so and the childcare role is mainly ascribed to women, then women may provide more care for their children and grandchildren than men (Euler & Weitzel, 1996; Euler & Michalski, 2007).

Moreover, grandparents have been expected to be more inclined to invest their resources, the more they can be certain of the genetic relationship with their grandchildren. Hypothesis 3 was supported, indicating that grandmothers invest more in their grandchildren than grandfathers due to higher levels of genetic relatedness. Maternal grandparents have higher levels of genetic relatedness than paternal grandparents and within each grandparental couple grandmothers have higher levels of genetic relatedness than grandfathers: The maternal grandmother’s genetic

relatedness with her grandchildren is completely certain, whereas the maternal grandfather's level of genetic relatedness with his grandchildren is intermediate. The paternal grandmother's level of genetic relatedness with her grandchildren is also intermediate but higher than the paternal grandfather's level of genetic relatedness with his grandchildren which is doubly uncertain.

4.1. Proxies for grandparental investment: Solicitude, contact frequencies and feelings of closeness

Although the ordered pattern of grandparental solicitude could not be replicated exactly, results are broadly consistent with those of other studies and suggest that grandparents do not provide care for their grandchildren indiscriminately. To assess the amount of grandparental care, Euler and Weitzel (1996), asked adults to report how much each grandparent had cared for them during childhood. The maternal grandmother was rated as the most caring grandparent, followed by the maternal grandfather, the paternal grandmother, and the paternal grandfather. The same pattern of grandparental caregiving has been found in a sample of urban Germans and in a sample of urban Greeks, who were asked to rate grandparental care retrospectively (Pashos, 2000). By contrast, a different pattern has been found in a sample of rural Greeks. Grandmothers also received higher ratings than grandfathers within each grandparent couple, but higher ratings of grandparental care were reported for paternal grandparents than for maternal grandparents. Furthermore, male participants rated grandparental care higher than females. It has been suggested that this patrilateral caregiving bias, the higher caregiving of paternal grandparents as compared to maternal grandparents, may be explained by patrilateral cultural traditions in rural Greece (Pashos, 2000).

Beside grandparental care, frequency of contact and feelings of closeness are used as proxy measures of investment. Therefore, frequency of contact and closeness ratings are expected to resemble the predicted ordered pattern of grandparental care. Firstly, it has been found that frequency of contact conforms to this ranking pattern in a subsample of grandchildren with four living grandparents. Maternal grandmothers see their grandchildren the most, followed by maternal grandfathers, paternal grandmothers and then paternal grandfathers. Secondly, however, reported closeness showed the same pattern as grandparental care in this subsample. Grandchildren perceived themselves as emotionally closest to the

maternal grandmother, followed by the paternal grandmother, the maternal grandfather and the paternal grandfather.

Similar patterns of contact frequency and closeness ratings have been found in a study by Laham et al. (2005) who analysed retrospective ratings by adult grandchildren. The highest feeling thermometer and exposure ratings were reported for the maternal grandmother, followed by the maternal grandfather, the paternal grandmother and the paternal grandfather. Moreover, contemporaneous reports of investment behaviour are consistent with these findings from retrospective reports from childhood. Bishop, Meyer, Schmidt, and Gray (2009) had adults with four living grandparents rate the frequency of behaviours received from and directed to grandparents. The highest level of contact, including visits, and the highest rated emotional closeness were reported with the maternal grandmother. Intermediate levels of contact and of rated closeness were reported with the maternal grandfather and the paternal grandmother. Level of contact and closeness with the paternal grandfather were rated lowest by adult grandchildren.

Furthermore, no statistically significant relationship has been found between frequency of contact and feelings of closeness, but results indicate that grandchildren feel closer to their grandparents the higher they rate the quality of their relationship. And grandchildren feel closer to their maternal grandfather, their paternal grandmother and their paternal grandfather, the more intense these grandparents care for them. Thus, data provide support for the differentiation between quality and quantity of contact between grandparents and grandchildren. As Laham et al. (2005) have argued, frequency may not accurately reflect quality of exposure, so feelings of closeness have been considered to serve as a clearer proxy for grandparental investment than contact frequencies.

In addition, it has been found that ratings of frequency of contact were more similar within grandparental pairs than between grandparental pairs. The same finding has been observed in a study by Pollet, Nettle, and Nelissen (2006), who analysed contact frequency ratings by grandparents. No strong differences have been found in contact frequencies within grandparental couples, whereas consistent differences have been found between grandparental pairs. Furthermore, the findings from the current study appear to provide support for the incidental exposure hypothesis. Incidental exposure may account for differences in exposure between the maternal grandfather and the paternal grandmother, assuming that their partners

encourage or discourage frequent contact with their grandchildren (Laham et al., 2005). That the contact frequency of grandparents with their grandchildren is affected by their partner‘s wishes for contact is suggested from the finding that more frequent contact has been reported with the maternal grandfather than with the paternal grandmother, but there has been no large difference in frequency of contact within grandparental pairs.

4.2. Determinants of grandparental investment

Beside sex-specific reproductive strategy and certainty of genetic relatedness, previous studies have identified a set of variables which may moderate the pattern of discriminative grandparental investment, including sex of grandchild, residential distance, grandparent age, marital status of grandparent, number of living grandparents and number of living grandchildren (Euler & Michalski, 2007; Euler & Weitzel, 1996).

First of all, results indicate that sex of grandchild has neither an effect on grandparental care nor on quality of relationship with grandparents. Similarly, in a study by Eisenberg (1998) it has been found that other aspects of grandparental investment such as closeness to grandparents, liking and activities grandparents participated in with their grandchildren were not affected by sex of grandchildren. Moreover, any sex difference has neither been found in closeness and exposure ratings (Laham et al., 2005) nor in solicitude ratings among urban Germans and urban Greeks (Pashos, 2000). By contrast, female grandchildren reported more frequent contact with their grandparents than male grandchildren in a study by Salmon (1999), who asked undergraduate students to report the frequency of visiting and phoning with their grandparents. In addition, higher solicitude ratings by female grandoffspring have also been observed by Euler & Weitzel (1996). It has been assumed that this positive rating bias is caused by the female grandchildren themselves (Euler & Weitzel, 1996; Salmon, 1999). But further studies revealed that the difference between male and female solicitude ratings does not apply to all four grandparents equally, providing support for grandparental preference for female grandoffspring (Euler & Michalski, 2007) as well as for male grandoffspring among rural Greeks (Pashos, 2000).

Assuming a possible relationship between sex of grandchild and differential grandparental care, the sex chromosome hypothesis has been proposed as an

alternative to the paternity assurance hypothesis. With respect to sex chromosome a male grandchild is directly related to his paternal grandfather through the Y chromosome, whereas the X chromosome may come from his maternal grandfather or his maternal grandmother. A female grandchild is directly related to her paternal grandmother through one X chromosome and the second one may come from her maternal grandfather or her maternal grandmother. Thus, it has been hypothesised that paternal grandfathers may prefer grandsons and paternal grandmothers may prefer granddaughters. Nevertheless, data on which both hypotheses for differential grandparental care have been tested suggested that paternity assurance investment dominates over sex chromosome investment favouring either X or Y. Furthermore, it has been found that, paternity assurance dominated these investment strategies in the model, given relatively high values of grandparental investment and relatively high rates of extra-pair paternity (Chrastil et al., 2006). Examining the effects of sex chromosomal relatedness and those predicted by paternity uncertainty on grandparental investment, a recent study by Tanskanen, Rotkirch & Danielsbacka (2011) provided additional support for the paternal uncertainty theory.

Secondly, results indicate no correlation between residential distance and reported quality of relationship, but a negative correlation between residential distance and ratings of grandparental care has been found in line with previous studies (Euler & Weitzel, 1996; Pashos, 2000). Systematic gradations according to grandparent type from the paternal grandfather to the maternal grandmother were not present in the correlations between residential distance and intensity of care, as opposed to findings by Euler and Weitzel (1996). The numerical values of the correlation coefficients in the present study were highest for the maternal grandfather, followed by the maternal grandmother and the paternal grandfather.

In the current study, paternal grandparents lived closer to their grandchildren than maternal grandparents, a finding that has also been observed by Salmon (1999). Closer residential proximity to paternal grandparents has also been found in a sample of rural Greeks, whereas residential distance did not differ between the grandparent types in the samples of urban Germans and urban Greeks (Pashos, 2000). By contrast, closer proximity to daughters‘ children has been suggested to account for the higher investment in grandchildren through daughters than grandchildren through sons in a retirement sample (Michalski & Shackelford, 2005). However, in this study, as in previous ones (Euler & Weitzel, 1996), differences in

residential distance did not correspond to the pattern of grandparental care. Moreover, different patterns have been found for frequency of contact, quality of relationship and feelings of closeness, so it can be concluded that residential distance did not serve as a predictor of grandparental investment.

Thirdly, as in previous research (Euler & Weitzel, 1996; Pashos, 2000) grandparent age did not correlate with the ratings of grandparental care. And a negative correlation between grandparent age and quality of relationship has only been found for the paternal grandfather, but not for any other grandparents. Moreover, a relationship between intensity of care and main economic activity has only been found for the maternal grandfather. Similarly, in a study by Pashos (2000) analyses revealed that employment did not affect grandparental caregiving.

Fourthly, intra-couple correlations of intensity of care ratings suggest that grandparents participate in caregiving as a couple, as it has been suggested by Euler and Weitzel (1996). Furthermore, results showed a relationship between marital status of grandparents and intensity of grandparental care. Further analysis revealed that non-widowed and widowed grandparents did not differ in terms of their mean intensity of care, which is consistent with past research (Euler & Weitzel, 1996). Contrary to expectations, however, separated paternal grandmothers and paternal grandfathers did not provide on average less care for their grandchildren, only separated maternal grandfathers differed from those who lived with their partner. Therefore, findings are inconclusive as to whether martial separation affects grandparental caregiving.

Fifthly, Euler and Weitzel (1996) have hypothesised that the availability of other grandparents may influence the grandparent‘s inclination to care for their grandchildren. It has been supposed that the more grandparents were available the diffusion of grandparental care may increase, but data did not support this hypothesis (Euler & Weitzel, 1996). Similarly, in the current study the number of grandparents did neither affect intensity of grandparental care nor reported feelings of closeness. A relationship between number of grandparents and quality of relationship as well as between number of grandparents and frequency of contact has only been found for the maternal grandfather.

Finally, a relationship between the number of siblings and intensity of grandparental care has only been found for the maternal grandfather, but not for the other three grandparent types. Moreover, results show that neither the number of

cousins through aunts and nor the number of cousins through uncles had an effect on the care provided by grandparents. Thus, results do not indicate a diffusion of grandparental resources as a function of the number of grandchildren as it has been supposed by Laham et al. (2005). According to the preferential investment hypothesis grandchildren who have cousins through their mothers‘ sisters are expected to suffer diffusion effects. Grandchildren who have cousins through their fathers‘ brothers are also expected to suffer from diffusion effects and those who have cousins through their fathers‘ sisters may additionally suffer differential investment effects (Laham et al., 2005). In the current study paternal grandfathers have been reported to be less caring, when grandchildren had cousins through paternal aunts, thus, more certain investment outlets have been available for paternal grandfathers. By contrast, paternal grandmothers did not care less even if more viable investment options were present. Contrary to the preferential investment hypothesis it has been found that maternal grandmothers cared less for their grandchildren through their daughters, when they also had grandchildren through their sons, thereby investing in less certain outlets at the expense of more certain investment outlets. If grandchildren had cousins through uncles, they also rated the quality of relationship with their maternal grandmother lower. Therefore, data do not provide consistent support for the preferential investment hypothesis. The findings of Bishop et al. (2009) did not show preferences for more certain kin either, as any differences in closeness to paternal grandmothers have been discovered, when grandchildren had cousins through their fathers‘ sisters and therefore alternate investment outlets were available.

4.3. Discriminative grandparental investment

In this study, contact frequencies, care giving and closeness have been used as proxies to estimate the amount of grandparental investment. The present findings suggest, on the one hand, that care giving and closeness may serve as useful proxies for grandparental investment. On the other hand, is seems that frequency of contact may not be a good proxy measure for several reasons, including (a) the differentiation between quality and quantity of contact, (b) the variance in investment due to incidental exposure, and (c) the initiation of contact attributable to both parents and grandparents.

The findings further support the idea of discriminative grandparental investment. Results indicate a gradation from the maternal grandmother to the paternal grandfather: The maternal grandmother invested most in her grandoffspring; both the maternal grandfather and the paternal grandmother invested an intermediate amount; and the lowest levels of investment were provided by the paternal grandfather. These results are consistent with those of other studies (Euler & Weitzel, 1996; Laham et al., 2005) and suggest that grandparental investment varies as a function of certainty of genetic relatedness.

In contrast to previous studies (Euler & Weitzel, 1996; Laham et al., 2005; Pashos, 2000), however, maternal grandfathers did not invest more than paternal grandmothers. A possible explanation for this might be that social roles moderate the pattern of grandparental investment. Assistance in sex-specific reproductive strategy and certainty of genetic relatedness have been considered as basic factors of grandparental investment, but they only account for a part of the total variance, albeit a considerable one. It seems reasonable to suppose that future research would benefit from the consideration of proximate mechanisms. Proximate explanations may help interpret ultimate causes and generate a more complete understanding of investment asymmetries.

In line with previous studies (Euler & Michalski, 2007; Euler & Weitzel, 1996) results of the current study indicate that differences in grandparental care giving may not be explained by residential distance, grandparent age, number of grandparents or number of grandchildren. In addition, the present findings suggest that care giving by grandparents remains uninfluenced by grandchild sex as the data of urban Germans and urban Greeks also showed (Pashos, 2000). In general, therefore, it seems that the grandparental investment patterns are robust to the influence of those potentially relevant factors.

Previous studies have reported beneficial effects of grandparental investment for grandchildren in historical and contemporary traditional societies. Grandparents have been found to exert an influence on fitness components including survival (Beise, 2004; Kemkes-Grottenthaler, 2005; Voland & Beise, 2002) and nutritional status of grandchildren (Gibson & Mace, 2005; Sear, Mace, & McGregor, 2000). A discriminative effect of investment has also been found in patterns of grandparental support: The effects of grandparents differ in terms of their impact, which may be beneficial, detrimental or neutral, and in their timing as well.

Findings from a 17th to 19th centuries population in Japan suggested that the presence of a maternal grandmother decreases the likelihood of a child‘s death, whereas the presence of a grandfather increased the likelihood of a child‘s death. Results also indicated that the presence of a paternal grandmother had an negative effect on the likelihood of a girl‘s death. Even though these results were not statistically significant, they were suggestive. A statistically significant and positive effect on the likelihood of a boy‘s death has been found when a paternal grandmother was present (C. Jamison, Cornell, P. Jamison, & Nakazato, 2002).

Moreover, analyses of entries in the church registers of a region in Germany of the 18th and 19th centuries revealed that the maternal grandmother and the paternal grandmother have different impacts on the survival of their grandchildren. It has been found that the presence of a maternal grandmother reduced the children‘s risk to die in the age period of 6 to 12 months. An opposite effect has been found for the paternal grandmother as her presence increased the child‘s death risk in the first month (Voland and Beise, 2002). It has been argued that maternal grandmothers beneficially influenced the survival of their grandchildren in the weaning process. By contrast, the observed effect of the paternal grandmother may be attributed to impacts of the conflict-prone relationship between the mother-in-law and daughter-in-law during pregnancy (Beise and Voland, 2002).

Specific socio-ecological conditions that have been prevalent for a 17th and 18th century French Canadian population may explain different findings concerning the paternal grandmother (Beise, 2004). Data from a historical population in Quebec, characterised by high fertility and growth rates, showed that the presence of a maternal grandmother had a survival effect on grandchildren of one and two years of age. In addition, a moderate effect on the mortality risk of grandchildren has been found for the paternal grandmother during the first month of life. With respect to these period specific effects, it has been proposed that the paternal grandmother may have provided support for the daughter-in-law during pregnancy, whereas the maternal grandmother may have directly helped her daughter with childcare. Both grandfathers did not affect their grandchildren‘s survival chances in the first three years of age; nevertheless, a survival increasing effect has been found concerning the maternal grandfather from three to five years of age.

Beside child survival, grandparents also appear to have different effects on the nutritional status of their grandchildren. The benefits of provisioning grandmothers on

children's nutritional welfare have been highlighted first in a contemporary population in rural Tanzania (Hawkes, O'Connell, & Blurton Jones, 1997). By using demographic and anthropomorphic data from a community in rural Ethiopia, Gibson and Mace (2005) found that both grandmothers had a positive influence on child height when they were alive, but the paternal grandmother only had a positive effect on male child's height. Matrilocal residence was associated with lower average child height, but improved child survival chances in this patrilineal community. Contrary to the findings by Pashos (2000), a patrilateral bias in grandparental investment due to patrilineality has not been reported. Beneficial effects of maternal grandmothers on child nutritional status and on child survival have also been reported for a rural Gambian population (Sear et al., 2000).

Sear and Mace (2008) reviewed the evidence for influences of grandparenting on child survival and showed that the effect of the maternal grandmother tends to be beneficial. It has also been shown that the paternal grandmother's effect is more equivocal, whereas maternal and paternal grandfathers have been found to have little or no effect on child survival. In general, it has been reported that the presence of a maternal grandmother increases her grandchildren's survival chances and this effect is most pronounced at average weaning age as well (Beise, 2004; Voland & Beise, 2002). Nevertheless, in a matrilineal society in Malawi maternal grandmothers seemed to have a negative effect on female child survival; moreover, maternal aunts appeared to increase child mortality rates when family resources were owned by women (Sear, 2008). Thus, it has been hypothesised that these detrimental impacts may be due to competition between matrilineal kin for resource ownership.

Overall, findings from studies using demographic data on historical and current populations suggest that grandmothers may increase their inclusive fitness by providing grandparental support (Beise, 2004). Whether these fitness benefits account for the evolution of a postmenopausal lifespan is still matter of debate (Peccei, 2001a). Analyses of multigenerational records from a Finnish and a Canadian population during the 18th and 19th century, however, showed a relationship between prolonged postmenopausal longevity and offspring fitness, hence inclusive fitness benefits by helping offspring. In both populations, the number of grandchildren has been positively affected by the length of the postmenopausal lifespan. Furthermore, Finnish data revealed that a living postmenopausal grandmother has a positive effect on both her offspring's lifetime fecundity and

lifetime reproductive success. It has been demonstrated that the presence of a postmenopausal mother is associated in both sexes with reduced ages at first reproduction, reduced first three inter-birth intervals and increased reproductive tenures. And it has also been found that a living grandmother has a positive effect on her grandchildren's survival probability between two and fifteen years of age. These overall findings support the hypothesis that inclusive fitness benefits account for the evolution of prolonged postmenopausal longevity (Lahdenperä, Lummaa, Helle, Tremblay, & Russell, 2004). A further analysis of the same data set revealed that a living grandfather has a positive influence only on his first-born offspring's lifetime fecundity if it was a male. Grandfather presence was also associated with benefits on offspring's key life history traits, such as increased reproductive tenures of first-born male offspring, reduced ages at first reproduction and reduced inter-birth intervals. But grandfathers have been found to neither increase their offspring's lifetime reproductive success, nor the survival probability of their grandoffspring. Due to this lack of fitness enhancing grandfather effects, it has been argued that grandfathering cannot account for the long lifespan in men (Lahdenperä, Russell, & Lummaa, 2007).

Recent findings suggest that selective pressures continue operating on modern human populations. By examining Finnish population data from the 18th and 19th century, Courtiol, Pettay, Jokela, Rotkirch & Lummaa (2012) assessed the variance in relative reproductive success and the variance in relative mating success. While the former was used to calculate the opportunity for total selection, the later was used to measure the opportunity for sexual selection. Evidence has been provided that demonstrates the opportunity for natural and sexual selection to occur. Thus, it can be concluded that human populations still have the potential for evolutionary changes in response to selection.

Future research investigating the proximate and ultimate causes that differentiate grandparental investment may provide further understanding of the role that grandparents have played in human evolution and may continue to do so in modern humans.

5. Conclusion

This study investigated three predictions derived from the hypothesis of discriminative grandparental solicitude (Euler & Weitzel, 1996), which considers assistance in sex-specific reproductive strategy and certainty of genetic relatedness

as basic factors associated with grandparental investment. The purpose of the current study was to reevaluate the role of these variables. Data revealed that grandparents do not support their relatives indiscriminately. The relevance of grandparental genetic relatedness for investment in grandchildren is supported by the findings. It was also shown that the differences in grandparental care and feelings of closeness between the maternal grandfather and the paternal grandmother could not be attributed to the effects of sex-specific reproductive strategy. The results of this study indicate that the pattern of grandparental investment may be moderated by social roles.

The current findings add to a growing body of literature on grandparental investment. Although all four grandparents may play an important role in the lives of their grandchildren, the maternal grandmother seems to have a prominent position. The maternal grandmother has been reported to be the most caring grandparent as well as having the best relationships with her grandchildren and also represents the most frequently named grandparent with regard to perceived emotional closeness. Sex of grandchild, residential distance, grandparent age, number of grandparents or number of grandchildren did not have any influence on differential grandparental care, but grandparental investment may be moderated by other variables that have not been examined in the present study, such as quality of grandparent-parent relationships (Euler et. al, 2001; Euler & Michalski, 2007), birth order of parents (Salmon, 1999), or type of investment activity (Euler & Michalski, 2007).

There are some limitations of this study that need to be acknowledged. First, the sample size is considerably smaller than that of Euler and Weitzel's (1996) original research. However, as the findings corroborated the results of Euler and Weitzel's study in general, the lower amount of data does not seem to have influenced the overall results. Secondly, an issue that was not addressed in this study was whether sex-specific reproductive strategy or certainty of genetic relatedness act as a stronger determinant on grandparental care. As suggested by Euler and Weitzel (1996), both factors were considered to be of equal weight. Thirdly, the current study was unable to analyse the family's socioeconomic status. The method to estimate the socioeconomic status has been used without success.

Further research might investigate the inclusive fitness benefits of grandparental investment and might offer new insights into the evolution of menopause. Nevertheless, the effects of grandparental investment on children's

fertility or on grandchildren's survival might not be observed in contemporary industrial societies, which are characterised by low fertility and infant mortality rates. In industrial societies, there might be beneficial effects in terms of children's and grandchildren's mental health and wellbeing in low-risk family contexts and in terms of teenage pregnancy and maternal depression under high risk conditions (Coall & Hertwig, 2010). More work will need to be done to evaluate these potential benefits.

While this study has focused on the ultimate causes for grandparental investment, the findings point the need to consider proximate mechanisms such as values and norms. Sociological and evolutionary accounts may complement each other for a better understanding of the evolution of grandparental investment (Coall & Hertwig, 2010). Future studies employing this combined approach might explore the correlation between grandparent-parent relationships and grandparental investment and examine whether they depend on each other. Such research might also assess the parents' role in moderating or encouraging grandparental investment.

6. Abstract

Assistance in sex-specific reproductive strategy and certainty of genetic relatedness have been used to explain differential investment in grandchildren. In a study in Austria, 276 subjects were asked to rate the grandparental care they had received during childhood, which served as a proxy for grandparental investment. The data gained from the questionnaire were analysed using descriptive analyses, regression analysis and correlation analysis. The findings that maternal grandmothers are rated as most intense caregivers to whom grandchildren perceive themselves as emotionally closest, followed by paternal grandmothers, maternal grandfathers and paternal grandfathers indicate that the pattern of grandparental care reflects differential degrees of genetic relatedness and is also moderated by social roles. Discriminative grandparental care appears to be a robust phenomenon, which is not influenced by sex of grandchild, residential distance, grandparent age, number of grandparents or number of grandchildren.

7. References

Alcock, J., & Crawford, C. (2008). Evolutionary questions for evolutionary psychologists. In C. Crawford, & D. Krebs (Eds.). *Foundations of Evolutionary Psychology* (pp. 25-45). New York: Lawrence Erlbaum.

Alexander, R. D. (1974). The evolution of social behavior. *Annu. Rev. Ecol. Syst., 5*, 325-383.

Alexander, R. D. (1990). Epigenetic rules and Darwinian algorithms. *Ethology and Sociobiology, 11*, 241-303.

Alvarez, H. P. (2000). Grandmother hypothesis and primate life histories. *American Journal of Physical Anthropology, 113*, 435-450.

Anderson, K. G. (2006). How well does paternity confidence match actual paternity? Evidence from worldwide nonpaternity rates. *Current Anthropology, 47*(3), 513-520.

Balan, V. E. (1995). [Epidemiology of the climacteric period in a large city]. *Akush. Ginekol. (Mosk.), 3*, 25-28. Abstract retrieved from PubMed database.

Beall, C. M. (1983). Ages at menopause and menarche in a high-altitude Himalayan population. *Ann. Hum. Biol., 10*(4), 365-370. Abstract retrieved from PubMed database.

Beise, J. (2004). The helping and the helpful grandmother- The role of maternal and paternal grandmothers in child mortality in the 17th and 18th century population of French Settlers in Quebec, Canada. MPIDR Working Paper WP 2004-004.

Beise, J., & Voland, E. (2002). A multilevel event history analysis of the effects of grandmothers on child mortality in a historical German population (Krummhörn, Ostfriesland, 1720-1874). *Demographic Research, 7*(13), 469-497.

Bellino, F. L., & Wise, P. M. (2003). Nonhuman primate models of menopause workshop. *Biology of Reproduction, 68*, 10-18.

Bellis, M. A., Hughes, K., Hughes, S. & Ashton, J. R. (2005). Measuring paternal discrepancy and its public health consequences. *Journal of Epidemiology and Community Health*, 59, 749–54.

Bishop, D. I., Meyer, B. C., Schmidt, T. M., & Gray, B. R. (2009). Differential investment behavior between grandparents and grandchildren: The role of paternity uncertainty. *Evolutionary Psychology, 7*(1), 66-77.

Bjorklund, D. F., & Shackelford, T. K. (1999). Differences in parental investment contribute to important differences between men and women. *Current Directions in Psychological Science, 8*(3), 86-89.

Blurton Jones, N. G., Hawkes, K., & O'Connell, J. F. (2002). Antiquity of postreproductive life: Are there modern impacts on hunter-gatherer postreproductive life spans? *American Journal of Human Biology, 14*, 184–205.

Bogin, B. (1997). Evolutionary hypotheses for human childhood. *Yearbook of Physical Anthropology, 40,* 63-89.

Bogin, B., & Smith, B. H. (1996). Evolution of the human life cycle. *American Journal of Human Biology, 8,* 703-716.

Bogin, B., & Smith, B. H. (2000). Evolution of the human life cycle. In S. Stinson, B. Bogin, R. Huss-Ashmore, & D. O'Rourke (Eds.), *Human Biology: An Evolutionary and Biocultural Perspective* (pp. 377-424). New York: Wiley-Liss.

Borgerhoff Mulder, M. (2003). Human behavioural ecology. *Nature Encyclopedia of Life Sciences,* 1-12.

Bribiescas, R. G. (2006). On the evolution, life history, and proximate mechanisms of human male reproductive senescence. *Evolutionary Anthropology, 15,* 132-141.

Buss, D. M. (1991). Evolutionary personality psychology. *Annu. Rev. Psychol., 42,* 459-491.

Buss, D. M. (1995). Evolutionary psychology: A new paradigm for psychological science. *Psychological Inquiry, 6*(1), 1-30.

Buss, D. M. (1998). Sexual strategies theory: Historical origins and current status. *The Journal of Sex Research, 35*(1), 19-31.

Buss, D. M. (2002). Human mating strategies. *Samfundsokonomen, 4,* 47-58.

Buss, D. M. (2006). Strategies of human mating. *Psychological Topics, 15*(2), 239-260.

Buss, D. M., & Schmitt, D. P. (1993). Sexual strategies theory: An evolutionary perspective on human mating. *Psychological Review, 100*(2), 204-232.

Burger, H. G., Dudley, E. C., Robertson, D. M., & Dennerstein L. (2002). Hormonal changes in the menopause transition. *Recent Progress in Hormone Research, 57,* 257-275.

Chan, C. G., & Elder Jr., G. H. (2000). Matrilineal advantage in grandchild-grandparent relations. *The Gerontologist, 40*(2), 179-190.

Charlesworth, B. (1994). *Evolution in age- structured populations* (2nd ed.). Cambridge: Cambridge University Press.

Charnov, E. L. (1991). Evolution of life history variation among female mammals. *Proc. Natl. Acad. Sci. USA, 88,* 1134-1137.

Charnov, E. L. (1993). *Life history invariants: Some explorations of symmetry in evolutionary ecology.* Oxford: Oxford University Press.

Charnov, E. L., & Berrigan, D. (1993). Why do female primates have such long lifespans and so few babies? Or life in the slow lane. *Evolutionary Anthropology, 1,* 191-194.

Chow, S. N., Huang, C. C., & Lee, Y. T. (1997). Demographic characteristics and medical

aspects of menopausal women in Taiwan. *J. Formos. Med. Assoc.*, *96*(10), 806-811. Abstract retrieved from PubMed database.

Chrastil, E. R., Getz, W. M., Euler, H. A., & Starks, P. T. (2006). Paternity uncertainty overrides sex chromosome selection for preferential grandparenting. *Evolution and Human Behavior*, *27*, 206-223.

Clutton-Brock, T. H. (1991). *The evolution of parental care.* Princeton, NJ: Princeton University Press.

Coall, D. A., & Hertwig, R. (2010). Grandparental investment: past, present, and future. *Behavioral and Brain Sciences*, *33*, 1-59.

Courtiol, A., Pettay, J. E., Jokela, M., Rotkirch, A., & Lummaa, V. (2012). Natural and sexual selection in a monogamous historical human population. *Proc. Natl. Acad. Sci. USA, 109*(21), 8044-8049.

Daly, M., & Wilson, M. (1980). Discriminative parental solicitude: A biological perspective. *Journal of Marriage and the Family*, *42*(2), 277-288.

Darwin, C. (1859). *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life* (1st ed.). London: John Murray.

Darwin, C. (1871). *The descent of man, and selection in relation to sex*: *Vol. 2.* (1st ed.). London: John Murray.

Dawkins, R. (1989). *The selfish gene*. (2nd ed.). Oxford: Oxford University Press.

de Bruin, J. P., Bovenhuis, H., van Noord, P. A. H., Pearson, P. L., van Arendonk, J. A. M., te Velde, E. R., Kuurman, W. W., & Dorland, M. (2001). The role of genetic factors in age at natural menopause. *Human Reproduction*, *16*(9), 2014-2018.

DeKay, W. T., & Shackelford, T. K. (2000). Toward an evolutionary approach to social cognition. *Evolution and Cognition*, *6*(2), 185-195.

Eisenberg, A. R. (1988). Grandchildren's perspectives on relationships with grandparents: The influence of gender across generations. *Sex Roles*, *19*(3-4), 205-217.

Euler, H. A. (2004). Genspur aus der Steinzeit. Psychologie der Vaterschaftsungewissheit. In H. Haas, & C. Waldenmaier, *Der Kuckucksfaktor. Raffinierte Frauen? Verheimlichte Kinder? Zweifelnde Väter?* (pp. 34-82 and 323-330). Prien: Gennethos e. K. Verlag.

Euler, H. A., Hoier, S., & Rohde, P. A. (2001). Relationship-specific closeness of intergenerational family ties: Findings from evolutionary psychology and implications for models of cultural transmission. *Journal of Cross-Cultural Psychology*, *32*(2), 147-158.

Euler, H. A., & Michalski, R. L. (2007). Grandparental and extended kin relationships. In C. Salmon, & T. K. Shackelford (Eds.), *Family relationships: an evolutionary perspective* (pp.185-204). Oxford: Oxford University Press.

Euler, H. A., & Weitzel, B. (1996). Discriminative grandparental solicitude as reproductive strategy. *Human Nature, 7*, 39-59.

Fedigan, L. M., & Pavelka, M. S. M. (2006). Reproductive cessation in female primates: Comparisons of Japanese macaques and humans. In C. Campbell, A. Fuentes, K. C. MacKinnon, M. Panger, & S. Bearder (Eds.), *Primates in Perspective* (pp.437-447). Oxford: Oxford University Press.

Gage, T. B. (2000). Demography. In S. Stinson, B. Bogin, R. Huss-Ashmore, D. O'Rourke (Eds.), *Human Biology: An Evolutionary and Biocultural Perspective* (pp.507-551). New York: Wiley-Liss.

Garrido-Latorre, F., Lazcano-Ponce, E. C., López-Carrillo, L., & Hernández-Avila, M. (1996). Age of natural menopause among women in Mexico City. *Int. J. Gynaecol. Obstet., 53*(2), 159-166. Abstract retrieved from PubMed database.

Gibson, M. A., & Mace, R. (2005). Helpful grandmothers in rural Ethiopia: A study of the effect of kin on child survival and growth. *Evolution and human behaviour, 26*, 469-482.

Goetz, A. T., & Shackelford, T. K. (2006). Modern application of evolutionary theory to psychology: Key concepts and clarifications. *American Journal of Psychology, 119*(4), 567-584.

Goetz, A. T., & Shackelford, T. K. (2009). Sexual conflict in humans: evolutionary consequences of asymmetric parental investment and paternity uncertainty. *Animal Biology, 59*, 449-456.

Gold, E. B. (2011). The timing of the age at which natural menopause occurs. *Obstetrics and Gynecology Clinics of North America, 38*(3), 425-440.

Grafen, A. (1984). Natural selection, kin selection and group selection. In J. Krebs, & N. Davies (Eds.), *Behavioural Ecology: An evolutionary approach* (2nd ed., pp. 62-84). Oxford: Blackwell Scientific Publications.

Grafen, A. (2006). Optimization of inclusive fitness. *Journal of Theoretical Biology, 238*, 541-563.

Grainger, S., & Beise, J. (2004). Menopause and post-generative longevity: Testing the 'stopping-early' and 'grandmother' hypotheses. MPIDR Working Paper WP 2004-003.

Grupe, G.., Christiansen, K., Schröder, I., & Wittwer- Backofen, U. (2005). *Anthropologie-Ein einführendes Lehrbuch*. Berlin, Heidelberg, New York: Springer.

Gurven, M., & Kaplan, H. (2007). Longevity among hunter-gatherers: A cross-cultural examination. *Population and Development Review 33*(2), 321-365.

Gwynne, D. T. (1991). Sexual competition among females: What causes courtship-role reversal? *TREE, 6*(4), 118-121.

Hagstad, A. (1988). Gynecology and sexuality in middle-aged women. *Women & Health, 13*(3-4), 57-80. Abstract retrieved from PubMed database.

Haldane, J. B. S. (1957). The cost of natural selection. *Journal of Genetics, 55*(3), 511-524.

Hamilton, W. D. (1964a). The genetical evolution of social behaviour. I. *J. Theoret. Biol., 7*(1), 1-16.

Hamilton, W. D. (1964b). The genetical evolution of social behaviour. II. *J. Theoret. Biol., 7*(1), 17-52.

Hawkes, K. (2003). Grandmothers and the evolution of human longevity. *Amercian Journal of Human Biology, 15*, 380-400.

Hawkes, K., & Blurton Jones, N. (2005). Human age structures, paleodemography, and the grandmother hypothesis. In E. Voland, A. Chasiotis, & W. Schiefenhovel (Eds.), *Grandmotherhood: The evolutionary significance of the second half of female life* (pp.118-140). New Brunswick, NJ: Rutgers University Press.

Hawkes, K., O'Connell, J. F., & Blurton Jones, N. G. (1997). Hadza women's time allocation, offspring provisioning and the evolution of long postmenopausal life spans. *Current Anthropology*, *38*, 551–577.

Hawkes, K., O'Connell, J. F., Blurton Jones, N. G., Alvarez, H., & Charnov, E. L. (1998). Grandmothering, menopause, and the evolution of human life histories. *Proc. Natl. Acad. Sci. USA*, *95*, 1336-1339.

Helle, S., Lummaa, V., & Jokela, J. (2005). Are reproductive and somatic senescence coupled in humans? Late, but not early, reproduction correlated with longevity in historical Sami women. *Proc. R. Soc. B, 272*, 29-37.

Hill, K. (1993). Life history theory and evolutionary anthropology. *Evolutionary Anthropology*, *2*(3), 78-88.

Hill, K., & Kaplan, H. (1999). Life history traits in humans: theory and empirical studies. *Annu. Rev. Anthropol., 28*, 397-430.

Hill, K., & Hurtado, A. M. (1991). The evolution of reproductive senescence and menopause in human females: An evaluation of the grandmother hypothesis. *Human Nature*, *2*(4), 313-350.

Hill, K., & Hurtado, A. M. (1999). Packer and Colleagues' Model of Menopause for Humans. *Human Nature*, *10*(1), 199-204.

Hoffmann, E., & Scott, M. (1993). The revised International Standard Classification of Occupation (ISCO-88): A short presentation. Geneva: Bureau of Statistics-International Labour Office. Retrieved December 13, 2009 http://www.ilo.org/public/english/bureau/stat/download/papers/short.pdf

Holden, C. J., Sear, R., & Mace, R. (2003). Matriliny as daughter-biased investment. *Evolution and Human Behavior*, *24*, 99-112.

Huber, B. R., Linhartova, V., Cope, D., & Lacy, M. (2004). Evolutionary theory and birth-related investments by kin in cross-cultural perspective. *World Cultures*, *15*(1), 60–79.

Huber, B. R., & Breedlove, W. L. (2007). Evolutionary theory, kinship, and childbirth in cross-cultural perspective. *Cross-Cultural Research*, *41*, 196–219.

Hurt, L. S., Ronsmans, C., Campbell, O. M. R., Saha, S., Kenward, M., & Quigley, M. (2004). Long-term effects of reproductive history on all-cause mortality among adults in rural Bangladesh. *Studies in Family Planning*, *35*(3), 189–196.

Hurt, L. S., Ronsmans, C., & Thomas, S. L. (2006). The effect of number of births on women's mortality: Systematic review of the evidence for women who have completed their childbearing. *Population Studies*, *60*(1), 55-71.

Ismael, N. N. (1994). A study on the menopause in Malaysia. *Maturitas*, *19*(3), 205-209. Abstract retrieved from PubMed database.

Jasienska, G., Nenko, I., & Jasienski, M. (2006). Daughters increase longevity of fathers, but daughters and sons equally reduce longevity of mothers. *American Journal of Human Biology*, *18*, 422–425.

Jamison, C. S., Cornell, L. L., Jamison, P. L., & Nakazato, H. (2002). Are all grandmothers equal? A review and a preliminary test of the “grandmother hypothesis” in Tokugawa Japan. American Journal of Physical Anthropology, 119, 67-76.

Kaplan, H., Hill, K., Lancaster, J., & Hurtado, A. M. (2000). A theory of human life history evolution: Diet, intelligence, and longevity. *Evolutionary Anthropology*, *9*, 156-185.

Kaplan, H., & Lancaster, J. B. (2003). An evolutionary and ecological analysis of human fertility, mating patterns, and parental investment. In K. W. Wachter, & R. A. Bulatao (Eds.), *Offspring: Human Fertility Behavior in Biodemographic Perspective* (pp.170-223). Washington: National Academy Press.

Kaplan, H., Lancaster, J., & Robson, A. (2003). Embodied capital and the evolutionary economics of the human life span. In J. R. Carey, & S. Tuljapurkar (Eds.), *Life Span: Evolutionary, Ecological, and Demographic Perspectives*. Supplement to *Population and Development Review*, *29*, 152-182. New York: Population Council.

Kato, I., Toniolo, P., Akhmedkhanov, A., Koenig, K. L., Shore, R., & Zeleniuch-Jacquotte, A. (1998). Prospective study of factors influencing the onset of natural menopause. *J. Clin. Epidemiol.*, *51*(12), 1271-1276. Abstract retrieved from PubMed database.

Kemkes-Grottenthaler, A. (2005). Of grandmothers, grandfathers and wicked step-grandparents. Differential impact of paternal grandparents on grandoffspring survival. *Historical Social Research*, *30*(3), 219-239.

Kirchengast, S. (2006). Spezielle Fragen der Reproduktionsbiologie- proximate und ultimate Determinanten der Reproduktion. Vorlesung an der Universität Wien.

Kirkwood, T. B. L. (1997). The origins of human ageing. *Phil. Trans. R. Soc. Lond., B 352*(1363), 1765-1772.

Kirkwood, T. B. L. (2002). Evolution of ageing. *Mechanisms of Ageing and Development, 123*, 737-745.

Kleining, G., & Moore, H. (1968). Soziale Selbsteinstufung (SSE): Ein Instrument zur Messung sozialer Schichten. *Kölner Zeitschrift für Soziologie und Sozialpsychologie, 20*(3), 502-552.

Kono, S., Sunagawa, Y., Higa, H., & Sunagawa, H. (1990). Age of menopause in Japanese women: trends and recent changes. *Maturitas*, *12*(1), 43-49. Abstract retrieved from PubMed database.

Kwawukume, E. Y., Ghosh, T. S., & Wilson, J. B. (1993). Menopausal age of Ghanaian women. *Int. J. Gynaecol. Obstet., 40*(2), 151-155. Abstract retrieved from PubMed database.

Laham, S. M., Gonsalkorale, K., & von Hippel, W. (2005). Darwinian grandparenting: Preferential investment in more certain kin. *PSPB*, *31*(1), 63-72.

Lahdenperä, M. (2010). *Evolution of prolonged longevity in humans*. Doctoral dissertation, University of Turku. Retrieved May 29, 2012 https://www.doria.fi/bitstream/handle/10024/52526/AnnalesAII246Lahdenpera.pdf

Lahdenperä, M, Lummaa, V., Helle, S., Tremblay, M, & Russell, A. F. (2004). Fitness benefits of prolonged post-reproductive lifespan in women. *Nature, 428*, 178-181.

Lahdenperä, M., Lummaa, V., & Russell, A. F. (2011). Selection on male longevity in a monogamous human population: Late-life survival brings no additional grandchildren. *Journal of Evolutionary Biology*, *24*, 1053–1063.

Lahdenperä, M., Russell, A. F., & Lummaa, V. (2007). Selection for long lifespan in men: Benefits of grandfathering? *Proc. R. Soc. B, 274*, 2437–2444.

Luoto, R., Kaprio, J., Uutela, A. (1994). Age at natural menopause and sociodemographic status in Finland. *Am. J. Epidemiol., 139*(1), 64-76. Abstract retrieved from PubMed database.

Lycett, J. E., Dunbar, R. I. M., & Voland, E. (2000). Longevity and the costs of reproduction in a historical human population. *Proc. R. Soc. Lond. B, 267*, 31-35.

Mace, R., & Sear, R. (2005). Are humans cooperative breeders? In E. Voland, A. Chasiotis, & W. Schiefenhoevel (Eds.), *Grandmotherhood: the Evolutionary Significance of the Second Half of Female Life* (pp.143-159). New Brunswick, NJ: Rutgers University Press.

Magurský, V., Mesko, M., Sokolík, L.(1975). Age at the menopause and onset of the climacteric in women of Martin District, Czechoslovkia. Statistical survey and some biological and social correlations. *Int. J. Fertil., 20*(1), 17-23. Abstract retrieved from PubMed database.

Marsh, H., & Kasuya, T. (1984). Changes in the ovaries of the short-finned pilot whale, *Globicephala macrorhynchus*, with age and reproductive activity. *Rep. Int. Whal. Commn*., *6*, 311–335.

Marsh, H., & Kasuya, T. (1986). Evidence for reproductive senescence in female cetaceans. *Rep. Int. Whal. Commn*., *8*, 57–74.

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., & Westendorp R. G. J. (2009). Quality–quantity trade-off of human offspring under adverse environmental conditions. *Journal of Evolutionary Biology*, *22*, 1014–1023.

Michalski, R. L. (2010). Measures of grandparental investment as a limiting factor in theoretical and empirical advancement. *Behavioral and Brain Sciences*, *33*, 32-33.

Michalski, R. L., & Shackelford, T. K. (2005). Grandparental investment as a function of relational uncertainty and emotional closeness with parents. *Human Nature*, *16*(3), 292-304.

Morabia, A., Costanza, M. C., & World Health Organization Collaborative Study of Neoplasia and Steroid Contraceptives (1998). International variability in ages at menarche, first livebirth, and menopause. *Am. J. Epidemiol*., *148*(12), 1195-1205.

Morabia, A., Khatchatrian, N., Bernstein, M., Walker, D. M., & Campana, A. (1996). Reproductive characteristics of a population of urban Swiss women. *Acta Obstet. Gynecol, Scand.*, *75*(9), 838-842. Abstract retrieved from PubMed database.

Neslihan Carda, S., Bilge, S. A., Oztürk, T. N., Oya, G., Ece, O., & Hamiyet, B. (1998). The menopausal age, related factors and climacteric symptoms in Turkish women. *Maturitas*, *30*(1), 37-40. Abstract retrieved from PubMed database.

Oberzaucher, E. (2008). Urbane Ethologie. Vorlesung an der Universität Wien.

O'Connell, J. F., Hawkes, K., & Blurton Jones, N. G. (1999). Grandmothering and the evolution of *Homo erectus. Journal of Human Evolution*, *36*, 461-485.

Okonofua, F. E., Lawal, A., & Bamgbose, J. K. (1990). Features of menopause and menopausal age in Nigerian women. *Int. J. Gynaecol. Obstet.*, *31*(4), 341-345. Abstract retrieved from PubMed database.

Packer, C., Tatar, M., & Collins, A. (1998). Reproductive cessation in female mammals. *Nature*, *392*, 807-811.

Pashos, A. (2000). Does paternal uncertainty explain discriminative grandparental solicitude? A cross-cultural study in Greece and Germany. *Evolution and Human Behavior*, *21*, 97-100.

Pashos, A., & McBurney, D. H. (2008). Kin relationships and the caregiving biases of grandparents, aunts, and uncles: A two-generational questionnaire study. *Human Nature*, *19*(3), 311-330.

Partridge, L. (1997). Evolutionary biology and age-related mortality. In K. W. Wachter, & C. E. Finch (Eds.), *Between Zeus and the Salmon: The Biodemography of Longevity* (pp.78-95). Washington: National Academy Press.

Partridge, L., & Barton, N. H. (1993). Optimality, mutation and the evolution of ageing. *Nature, 362*, 305-311.

Pavelka, M. S. M., & Fedigan, L. M. (1991). Menopause: A comparative life history perspective. *Yearbook of Physical Anthropology*, *34*, 13-38.

Peccei, J. S. (1995). The origin and the evolution of menopause: The altriciality-lifespan hypothesis. *Ethology and Sociobiology*, *16*, 425-449.

Peccei, J. S. (2001a). A critique of the grandmother hypotheses: Old and new. *American Journal of Human Biology*, *13*, 434-452.

Peccei, J. S. (2001b). Menopause: Adaptation or epiphenomenon? *Evolutionary Anthropology*, *10*, 43-57.

Penn, D. J., & Smith, K. R. (2007). Differential fitness costs of reproduction between the sexes. *Proc. Natl. Acad. Sci. USA, 104*(2), 553-558.

Pollet, T. V., Nettle, D., & Nelissen, M. (2006). Contact frequencies between grandparents and grandchildren in a modern society: Estimates of the impact of paternity uncertainty. *Journal of Cultural and Evolutionary Psychology*, *4*(3-4), 203–214.

Ramoso-Jalbuena, J. (1994). Climacteric Filipino women: a preliminary survey in the Philippines. *Maturitas*, *19*(3), 183-190. Abstract retrieved from PubMed database.

Reif, W.-E., Junker, T., & Hossfeld, U. (2000). The synthetic theory of evolution: general problems and the German contribution to the synthesis. *Theory Biosci.*, *119*, 41-91.

Rizk, D. E., Bener, A., Ezimokhai, M., Hassan, M. Y., & Micallef, R. (1998). The age and symptomatology of natural menopause among United Arab Emirates women. *Maturitas*, *29*(3), 197-202. Abstract retrieved from PubMed database.

Sadler, T. W. (2003). *Medizinische Embryologie: die normale menschliche Entwicklung und ihre Fehlbildungen* (10. Aufl.). Stuttgart: Georg Thieme Verlag.

Salat-Baroux, J. 1980. [The menopause and its problems (author's transl)]. *Sem. Hop.*, *56*(33-36), 1343-1345. Abstract retrieved from PubMed database.

Salmon, C. A. (1999). On the impact of sex and birth order on contact with kin. *Human Nature, 10*(2), 183-197.

Salmon, C. A., & Crawford, C. (2008). Evolutionary psychology: The historical context. In C. Crawford, & D. Krebs (Eds.). *Foundations of Evolutionary Psychology* (pp. 1-21). New York: Lawrence Erlbaum.

Samil, R. S., & Wishnuwardhani, S. D. (1994). Health of Indonesian women city-dwellers of perimenopausal age. *Maturitas, 19*(3), 191-197. Abstract retrieved from PubMed database.

Santoro, N. (2005). The menopausal transition. *The American Journal of Medicine*, *118*(12B), 8S-13S.

Schäfer, K. (2008). Verhaltensökologie des Menschen. Vorlesung an der Universität Wien.

Sear, R. (2008). Kin and child survival in rural Malawi. *Human Nature*, *19*(3), 277-293.

Sear, R., & 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.

Sear, R., Mace, R., & McGregor, I. A. (2000). Maternal grandmothers improve nutritional status and survival of children in rural Gambia. *Proc. R. Soc. Lond. B*, *267*, 1641-1647.

Shanley, D. P., & Kirkwood, T. B. L. (2001). Evolution of the human menopause. *Bioessays*, *23*, 282-287.

Shanley, D. P., Sear, R., Mace, R., & Kirkwood, T. B. L. (2007). Testing evolutionary theories of menopause. *Proc. R. Soc. B*, *274*, 2943-2949.

Singh, L., & Ahuja, S. (1980). An estimation of reproductive performance in the women of Punjab. *Anthropol. Anz*., *37*(4), 266-270. Abstract retrieved from PubMed database.

Sosa Henríquez, M., Navarro Rodríguez, M. C., Limiñana Cañal, J. M., Wagner Fahlin, A., Guerra Ramos, J. M., Nicholas, A. R., López Prado, P., & Hernández Hernández, D. (1994). Age of menopause onset in Canary Islands women. *Rev. Sanid. Hig. Publica*, *68*(3), 385–391. Abstract retrieved from PubMed database.

Strassmann, B. I., & Gillespie, B. (2002). Life-history theory, fertility and reproductive success in humans. *Proc. R. Soc. Lond. B*, *269*, 553-562.

Tanskanen, A., O., Rotkirch, A., & Danielsbacka, M. (2011). Do grandparents favor granddaughters? Biased grandparental investment in UK. *Evolution and Human Behavior*, *32*(6), 407-415.

Tuljapurkar, S. D., Puleston, C. O., & Gurven, M. D. (2007). Why men matter: Mating patterns drive evolution of human lifespan. *PLoS ONE*, *2*(8), e785.

Tungphaisal, S., Chandeying, V., Sutthijumroon, S., Krisanapan, O., & Udomratn, P. (1991). Postmenopausal sexuality in Thai women. *Asia Oceania J. Obstet. Gynaecol.*, *17*(2), 143-146. Abstract retrieved from PubMed database.

Trivers, R. L. (1972). Parental investment and sexual selection. In B. Campbell (Ed.), *Sexual Selection and the Descent of Man 1871- 1971* (pp. 136-179). Chicago: Aldine.

Voland, E. (1998). Evolutionary ecology of human reproduction. *Annu. Rev. Anthropol.*, *27*, 347-374.

Voland, E., & Beise, J. (2002). Opposite effects of maternal and paternal grandmothers on infant survival in historical Krummhörn. MPIDR Working Paper WP 2001-026.

Walker, A. R., Walker, B. F., Ncongwane, J., & Tshabalala, E. N. (1984). Age of menopause in black women in South Africa. *Br. J. Obstet. Gynaecol., 91*(8), 797-801. Abstract retrieved from PubMed database.

Walsh, R.J. (1978). The age of the menopause of Australian women. *Med. J. Aust., 2*(5), 181-182, 215. Abstract retrieved from PubMed database.

West, S. A., Griffin, A. S., & Gardner A. (2007). Social semantics: altruism, cooperation, mutualism, strong reciprocity and group selection. *Journal of Evolutionary Biology, 20*, 415-432.

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

Williams, G. C. (1957). Pleiotropy, natural selection, and the evolution of senescence. *Evolution, 11*, 398-411.

Williams, G. C. (1996). *Adaptation and natural selection: A critique of some current evolutionary thought* (8th ed.) Princeton, N.J.: Princeton University Press.

Wu, J. M., Zelinksi, M. B., Ingram, D. K., & Ottinger, M. A. (2005). Ovarian aging and menopause: Current theories, hypotheses, and research models. *Experimental Biology and Medicine, 230*, 818–828.

World Health Organization. (1996). Research on the menopause. *Progress in Human Reproduction Research, 40*, 1-8. Retrieved April 2, 2008 http://www.who.int/reproductive-health/hrp/progress/40/prog40.pdf

World Health Organization. (2003). *The world health report: 2003: shaping the future* [Electronic version]. Retrieved April 14, 2008 http://www.who.int/whr/2003/en/whr03_en.pdf

Im Rahmen meiner Diplomarbeit beschäftige ich mich mit der Beziehung zwischen Großeltern und ihren Enkelkindern.

Die von Ihnen gegebenen Antworten werden streng vertraulich und anonym behandelt! Auch können aufgrund der Fragen keine Rückschlüsse auf Ihre Identität gezogen werden!

Ich bedanke mich, dass Sie sich die Zeit und Geduld für die Beantwortung des Ihnen vorliegenden Fragenkatalogs nehmen!

Fragen zu Ihrer Person

1) Wie alt sind Sie?

_____ Jahre

2) Geschlecht:

☐ männlich
☐ weiblich

3) Studienrichtung:

_____

4) Im wievielten Semester sind Sie? _____ Semester

Fragen zu Ihren Geschwistern

5) Haben Sie Geschwister?

☐ ja, _____ *(Bitte Anzahl angeben)*
☐ nein

Falls Sie Frage 5 mit „Nein" beantwortet haben, gehen Sie bitte weiter zu Frage 7.

6) Geben Sie bitte für jedes Ihrer **Geschwister** Alter und Geschlecht an. Beginnen Sie bitte jeweils mit dem/ der Ältesten.

	Alter:	Geschlecht:	Lebt Ihr Bruder/ Ihre Schwester noch?	*Falls nein*: Todesjahr
1	_____ Jahre	☐ männlich ☐ weiblich	☐ ja ☐ nein	
2	_____ Jahre	☐ männlich ☐ weiblich	☐ ja ☐ nein	
3	_____ Jahre	☐ männlich ☐ weiblich	☐ ja ☐ nein	
4	_____ Jahre	☐ männlich ☐ weiblich	☐ ja ☐ nein	
5	_____ Jahre	☐ männlich ☐ weiblich	☐ ja ☐ nein	

Fragen zu Ihren leiblichen Eltern

7) Wie alt sind Ihre leiblichen Eltern?
Ggf. wie alt waren Ihre leiblichen Eltern als sie verstarben?

Mutter: _____ Jahre Vater: _____ Jahre

8) Von meinen leiblichen Eltern

☐ leben beide Elternteile noch
☐ ist meine Mutter verstorben, Todesjahr _____
☐ ist mein Vater verstorben, Todesjahr _____
☐ sind beide Elternteile verstorben
Todesjahr der Mutter _____ Todesjahr des Vaters _____

9) Welche höchste Ausbildung hat Ihre **Mutter**?

☐ Pflichtschule
☐ Lehre
☐ Fachschule
☐ Allgemein bildende und berufsbildende höhere Schulen
☐ Hochschule, Universität
☐ weiß ich nicht

10) Denken Sie nun bitte an Ihre Kindheit zurück. Bis zu Ihrem 7. Lebensjahr war Ihre **Mutter** überwiegend

☐ erwerbstätig ☐ vollzeitbeschäftigt
☐ teilzeitbeschäftigt
☐ nicht erwerbstätig, aber auf Arbeitssuche
☐ in Ausbildung
☐ ausschließlich haushaltsführend
☐ in Pension
☐ arbeitsunfähig
☐ weiß ich nicht

Falls Ihre Mutter nicht erwerbstätig war, gehen Sie bitte weiter zu Frage 12.

11) Falls Ihre **Mutter** erwerbstätig war:
Beziehen Sie sich auf die Zeit Ihrer Kindheit und tragen Sie bitte den Beruf Ihrer **Mutter** in dasjenige Kästchen ein, in das er ihrer Meinung nach am Besten passt:

☐ Angehörige gesetzgebender Körperschaften, leitende Verwaltungsbedienstete
und Führungskräfte in der Privatwirtschaft
☐ Akademische Berufe
☐ Techniker und gleichrangige nichttechnische Berufe
☐ Bürokräfte, kaufmännische Angestellte
☐ Dienstleistungsberufe, Verkäufer in Geschäften und auf Märkten
☐ Fachkräfte in der Land- und Forstwirtschaft sowie Fischerei
☐ Handwerks- und verwandte Berufe
☐ Anlagen- und Maschinenbediener sowie Montierer
☐ Hilfsarbeitskräfte
☐ Soldaten
☐ weiß ich nicht

12) Welche höchste Ausbildung hat Ihr **Vater**?

☐ Pflichtschule
☐ Lehre
☐ Fachschule
☐ Allgemein bildende und berufsbildende höhere Schulen
☐ Hochschule, Universität
☐ weiß ich nicht

13) Denken Sie nun bitte an Ihre Kindheit zurück. Bis zu Ihrem 7. Lebensjahr war Ihr **Vater** überwiegend

☐ erwerbstätig ☐ vollzeitbeschäftigt
☐ teilzeitbeschäftigt
☐ nicht erwerbstätig, aber auf Arbeitssuche
☐ in Ausbildung
☐ ausschließlich haushaltsführend
☐ in Pension
☐ arbeitsunfähig
☐ weiß ich nicht

Falls Ihr Vater nicht erwerbstätig war, gehen Sie bitte weiter zu Frage 15.

14) Falls ihr **Vater** erwerbstätig war:
Beziehen Sie sich auf die Zeit Ihrer Kindheit und tragen Sie bitte den Beruf Ihres **Vaters** in dasjenige Kästchen ein, in das er ihrer Meinung nach am Besten passt:

☐ Angehörige gesetzgebender Körperschaften, leitende Verwaltungsbedienstete
und Führungskräfte in der Privatwirtschaft
☐ Akademische Berufe
☐ Techniker und gleichrangige nichttechnische Berufe
☐ Bürokräfte, kaufmännische Angestellte
☐ Dienstleistungsberufe, Verkäufer in Geschäften und auf Märkten
☐ Fachkräfte in der Land- und Forstwirtschaft sowie Fischerei
☐ Handwerks- und verwandte Berufe
☐ Anlagen- und Maschinenbediener sowie Montierer
☐ Hilfsarbeitskräfte
☐ Soldaten
☐ weiß ich nicht

15) Meine leiblichen Eltern waren in meiner Kindheit, bis zu meinem 7. Lebensjahr,

☐ in einer Lebensgemeinschaft
☐ getrennt lebend
☐ verheiratet
☐ geschieden
☐ verwitwet
☐ weiß ich nicht
☐ keine Angabe, da beide verstorben sind

Fragen zu den Geschwistern Ihrer leiblichen Eltern

16) Hat Ihre **Mutter** Geschwister?

☐ ja, _____ *(Bitte Anzahl angeben)*
☐ nein
☐ weiß ich nicht

Falls Sie Frage mit „Nein“ beantwortet haben, gehen Sie bitte weiter zu Frage 18.

17) Falls Ihre Mutter Geschwister hat, bitte ich Sie folgende Fragen zu beantworten:

Wenn ja, wie viele **Onkel** haben Sie mütterlicherseits? _____ *(Bitte Anzahl angeben)*

Haben Ihre Onkel mütterlicherseits Kinder?

☐ ja, _____ *(Bitte Anzahl angeben)*
☐ nein
☐ weiß ich nicht

Wenn ja, wie viele sind weiblich und wie viele männlich?
weiblich _____ männlich _____ *(Bitte Anzahl angeben)*

Wenn ja, wie viele **Tanten** haben Sie mütterlicherseits? _____ *(Bitte Anzahl angeben)*

Haben Ihre Tanten mütterlicherseits Kinder?

☐ ja, _____ *(Bitte Anzahl angeben)*
☐ nein
☐ weiß ich nicht

Wenn ja, wie viele sind weiblich und wie viele männlich?
weiblich _____ männlich _____ *(Bitte Anzahl angeben)*

18) Hat Ihr **Vater** Geschwister?

☐ ja, _____
☐ nein
☐ weiß ich nicht

Falls Sie Frage mit „Nein“ beantwortet haben, gehen Sie bitte weiter zu Frage 20.

19) Falls Ihre Vater Geschwister hat, bitte ich Sie folgende Fragen zu beantworten:

Wenn ja, wie viele **Onkel** haben Sie väterlicherseits? _____ *(Bitte Anzahl angeben)*

Haben Ihre Onkel väterlicherseits Kinder?

☐ ja, _____ *(Bitte Anzahl angeben)*
☐ nein
☐ weiß ich nicht

Wenn ja, wie viele sind weiblich und wie viele männlich?
weiblich _____ männlich _____ *(Bitte Anzahl angeben)*

Wenn ja, wie viele **Tanten** haben Sie väterlicherseits? _____ *(Bitte Anzahl angeben)*

Haben Ihre Tanten väterlicherseits Kinder?

☐ ja, _____ *(Bitte Anzahl angeben)*
☐ nein
☐ weiß ich nicht

Wenn ja, wie viele sind weiblich und wie viele männlich?
weiblich _____ männlich _____ *(Bitte Anzahl angeben)*

Fragen zu Ihren leiblichen Großeltern mütterlicherseits

20) Wie alt sind Ihre leiblichen Großeltern mütterlicherseits?
Ggf. wie alt waren Ihre leiblichen Großeltern mütterlicherseits als sie verstarben?
Falls Sie das genaue Alter nicht wissen, wählen Sie bitte die am ehesten zutreffende Altersgruppe aus.

Großmutter: _____ Jahre

☐ <50 Jahre
☐ 50-59 Jahre
☐ 60-69 Jahre
☐ 70-79 Jahre
☐ 80-89 Jahre
☐ >90 Jahre

Großvater: _____ Jahre

☐ <50 Jahre
☐ 50-59 Jahre
☐ 60-69 Jahre
☐ 70-79 Jahre
☐ 80-89 Jahre
☐ >90 Jahre

21) Von meinen Großeltern mütterlicherseits

☐ leben beide Großelternteile noch
☐ ist meine Großmutter verstorben, Todesjahr _____
☐ ist mein Großvater verstorben, Todesjahr _____
☐ sind beide Großelternteile verstorben
Todesjahr der Großmutter _____ Todesjahr des Großvaters _____

22) Denken Sie nun bitte an Ihre Kindheit zurück. Bis zu Ihrem 7. Lebensjahr war Ihre **Großmutter** überwiegend

☐ erwerbstätig ☐ vollzeitbeschäftigt
☐ teilzeitbeschäftigt
☐ nicht erwerbstätig, aber auf Arbeitssuche
☐ in Ausbildung
☐ ausschließlich haushaltsführend
☐ in Pension
☐ arbeitsunfähig
☐ weiß ich nicht
☐ keine Angabe, da schon vor meiner Geburt verstorben

23) Denken Sie nun bitte an Ihre Kindheit zurück. Bis zu Ihrem 7. Lebensjahr war Ihr **Großvater** überwiegend

☐ erwerbstätig ☐ vollzeitbeschäftigt
☐ teilzeitbeschäftigt
☐ nicht erwerbstätig, aber auf Arbeitssuche
☐ in Ausbildung
☐ ausschließlich haushaltsführend
☐ in Pension
☐ arbeitsunfähig
☐ weiß ich nicht
☐ keine Angabe, da schon vor meiner Geburt verstorben

24) Meine leiblichen Großeltern mütterlicherseits waren in meiner Kindheit, bis zu meinem 7. Lebensjahr,

☐ in einer Lebensgemeinschaft
☐ getrennt lebend
☐ verheiratet
☐ geschieden
☐ verwitwet
☐ weiß ich nicht
☐ keine Angabe, da beide verstorben sind

Fragen zu Ihren leiblichen Großeltern väterlicherseits

25) Wie alt sind Ihre leiblichen Großeltern väterlicherseits?
Ggf. wie alt waren Ihre leiblichen Großeltern väterlicherseits als sie verstarben?
Falls Sie das genaue Alter nicht wissen, wählen Sie bitte die am ehesten zutreffende Altersgruppe aus.

Großmutter: _____ Jahre

☐ <50 Jahre
☐ 50-59 Jahre
☐ 60-69 Jahre
☐ 70-79 Jahre
☐ 80-89 Jahre
☐ >90 Jahre

Großvater: _____ Jahre

☐ <50 Jahre
☐ 50-59 Jahre
☐ 60-69 Jahre
☐ 70-79 Jahre
☐ 80-89 Jahre
☐ >90 Jahre

26) Von meinen Großeltern väterlicherseits

☐ leben beide Großelternteile noch
☐ ist meine Großmutter verstorben, Todesjahr _____
☐ ist mein Großvater verstorben, Todesjahr _____
☐ sind beide Großelternteile verstorben
Todesjahr der Großmutter _____ Todesjahr des Großvaters _____

27) Denken Sie nun bitte an Ihre Kindheit zurück. Bis zu Ihrem 7. Lebensjahr war Ihre **Großmutter** überwiegend

☐ erwerbstätig ☐ vollzeitbeschäftigt
☐ teilzeitbeschäftigt
☐ nicht erwerbstätig, aber auf Arbeitssuche

☐ in Ausbildung
☐ ausschließlich haushaltsführend
☐ in Pension
☐ arbeitsunfähig
☐ weiß ich nicht
☐ keine Angabe, da schon vor meiner Geburt verstorben

28) Denken Sie nun bitte an Ihre Kindheit zurück. Bis zu Ihrem 7. Lebensjahr war Ihr **Großvater** überwiegend

☐ erwerbstätig ☐ vollzeitbeschäftigt
☐ teilzeitbeschäftigt
☐ nicht erwerbstätig, aber auf Arbeitssuche
☐ in Ausbildung
☐ ausschließlich haushaltsführend
☐ in Pension
☐ arbeitsunfähig
☐ weiß ich nicht
☐ keine Angabe, da schon vor meiner Geburt verstorben

29) Meine leiblichen Großeltern väterlicherseits waren in meiner Kindheit, bis zu meinem 7. Lebensjahr,

☐ in einer Lebensgemeinschaft
☐ getrennt lebend
☐ verheiratet
☐ geschieden
☐ verwitwet
☐ weiß ich nicht
☐ keine Angabe, da beide verstorben sind

Fragen zu Ihrer Kindheit

Denken Sie nun bitte an Ihre Kindheit zurück. Folgende Fragen beziehen sich ausschließlich auf Ihre Lebensumstände und Erfahrungen bis zum 7. Lebensjahr.

30) Welche Großeltern lebten bis zu Ihrem 7. Lebensjahr? (*Mehrfachantworten möglich)*

☐ die Großmutter mütterlicherseits
☐ der Großvater mütterlicherseits
☐ die Großmutter väterlicherseits
☐ der Großvater väterlicherseits

31) Bei wem sind Sie bis zu Ihrem 7. Lebensjahr vorwiegend aufgewachsen?

☐ Bei meinen leiblichen Eltern
☐ Bei meiner allein erziehenden Mutter (ohne Partner im Haushalt)
☐ Bei meiner Mutter und ihrem Partner (Stiefvater)
☐ Bei meinem allein erziehenden Vater (ohne Partnerin im Haushalt)
☐ Bei meinem Vater und seiner Partnerin (Stiefmutter)
☐ Bei meinen Großeltern (ohne Elternteil im Haushalt) ☐ mütterlicherseits
☐ väterlicherseits
☐ Bei meinen Großeltern (mit einem Elternteil im Haushalt) ☐ mütterlicherseits
☐ väterlicherseits
☐ Bei anderen Personen, nämlich _____

32) Wer war in Ihrer Kindheit(bis zum 7. Lebensjahr) Ihre Hauptbezugsperson?
(*Mehrfachantworten möglich)*

☐ meine Mutter
☐ mein Vater
☐ meine Großmutter mütterlicherseits
☐ mein Großvater mütterlicherseits
☐ mein Großmutter väterlicherseits
☐ mein Großvater väterlicherseits
☐ andere Personen, nämlich _____

33) Wie weit lag der Wohnort Ihrer Großeltern von Ihrem entfernt?
Beziehen Sie sich bitte auf alle Großelternteile, die während ihrer Kindheit, im Zeitraum bis zu Ihrem 7. Lebensjahr, lebten.

Wohnort meiner Großmutter mütterlicherseits:

☐ im Haus
☐ in der Nachbarschaft
☐ in der Nähe(z.B. Dorf oder Stadtviertel)
☐ in der Stadt oder im Nachbardorf
☐ im Umland
☐ in der Region
☐ Tagesbesuch noch möglich
☐ Tagesreise entfernt
☐ Fernreise
☐ Flugreise

Wohnort meines Großvaters mütterlicherseits:

☐ im Haus
☐ in der Nachbarschaft
☐ in der Nähe(z.B. Dorf oder Stadtviertel)
☐ in der Stadt oder im Nachbardorf
☐ im Umland
☐ in der Region
☐ Tagesbesuch noch möglich
☐ Tagesreise entfernt
☐ Fernreise
☐ Flugreise

Wohnort meiner Großmutter väterlicherseits:

☐ im Haus
☐ in der Nachbarschaft
☐ in der Nähe(z.B. Dorf oder Stadtviertel)
☐ in der Stadt oder im Nachbardorf
☐ im Umland
☐ in der Region
☐ Tagesbesuch noch möglich
☐ Tagesreise entfernt
☐ Fernreise
☐ Flugreise

Wohnort meines Großvaters väterlicherseits:

☐ im Haus
☐ in der Nachbarschaft
☐ in der Nähe(z.B. Dorf oder Stadtviertel)
☐ in der Stadt oder im Nachbardorf
☐ im Umland
☐ in der Region
☐ Tagesbesuch noch möglich
☐ Tagesreise entfernt
☐ Fernreise
☐ Flugreise

34) Wie häufig hatten Sie Kontakt zu Ihren Großeltern?
Beziehen Sie sich bitte auf ihre Kindheit.

Großmutter mütterlicherseits:

☐ Täglich
☐ Mehrmals in der Woche
☐ Einmal in der Woche
☐ Mehrmals im Monat
☐ Weniger als einmal im Monat
☐ Mehrmals im Jahr
☐ Einmal im Jahr
☐ Seltener

☐ Mindestens einmal im Monat
☐ Kontakt abgebrochen

Großvater mütterlicherseits:

☐ Täglich
☐ Mehrmals in der Woche
☐ Einmal in der Woche
☐ Mehrmals im Monat
☐ Mindestens einmal im Monat
☐ Weniger als einmal im Monat
☐ Mehrmals im Jahr
☐ Einmal im Jahr
☐ Seltener
☐ Kontakt abgebrochen

Großmutter väterlicherseits:

☐ Täglich
☐ Mehrmals in der Woche
☐ Einmal in der Woche
☐ Mehrmals im Monat
☐ Mindestens einmal im Monat
☐ Weniger als einmal im Monat
☐ Mehrmals im Jahr
☐ Einmal im Jahr
☐ Seltener
☐ Kontakt abgebrochen

Großvater väterlicherseits:

☐ Täglich
☐ Mehrmals in der Woche
☐ Einmal in der Woche
☐ Mehrmals im Monat
☐ Mindestens einmal im Monat
☐ Weniger als einmal im Monat
☐ Mehrmals im Jahr
☐ Einmal im Jahr
☐ Seltener
☐ Kontakt abgebrochen

35) Von wem ging der Kontakt vorwiegend aus?
Beziehen Sie sich bitte auf ihre Kindheit.

Kontakt zu meinen Großeltern mütterlicherseits:
☐ Von meiner Mutter
☐ Von meinem Vater
☐ Von meiner Großmutter mütterlicherseits
☐ Von meinem Großvater mütterlicherseits

Kontakt zu meinen Großeltern väterlicherseits:
☐ Von meiner Mutter
☐ Von meinem Vater
☐ Von meiner Großmutter väterlicherseits
☐ Von meinem Großvater väterlicherseits

36) Wie intensiv haben sich Ihre Großeltern um Sie gekümmert?
Beziehen Sie sich bitte auf ihre Kindheit.

Großmutter mütterlicherseits

überhaupt nicht	kaum	mittelmäßig	ziemlich	außerordentlich
☐	☐	☐	☐	☐

Großvater mütterlicherseits

überhaupt nicht	kaum	mittelmäßig	ziemlich	außerordentlich
☐	☐	☐	☐	☐

Großmutter väterlicherseits

überhaupt nicht	kaum	mittelmäßig	ziemlich	außerordentlich
☐	☐	☐	☐	☐

Großvater väterlicherseits

überhaupt nicht	kaum	mittelmäßig	ziemlich	außerordentlich
☐	☐	☐	☐	☐

37) Wie würden Sie die Beziehung zu Ihren Großeltern beurteilen?

Großmutter mütterlicherseits

sehr schlecht	eher schlecht	mittelmäßig	eher gut	sehr gut
☐	☐	☐	☐	☐

Großvater mütterlicherseits

sehr schlecht	eher schlecht	mittelmäßig	eher gut	sehr gut
☐	☐	☐	☐	☐

Großmutter väterlicherseits

sehr schlecht	eher schlecht	mittelmäßig	eher gut	sehr gut
☐	☐	☐	☐	☐

Großvater väterlicherseits

sehr schlecht	eher schlecht	mittelmäßig	eher gut	sehr gut
☐	☐	☐	☐	☐

38) Am Nächsten fühle ich mich

☐ meiner Großmutter mütterlicherseits
☐ meinem Großvater mütterlicherseits
☐ meiner Großmutter väterlicherseits
☐ meinem Großvater väterlicherseits

39) Was führt zu der bei Frage 38) getroffenen Entscheidung?

☐ Kontakt in der Kindheit
☐ Kontakt heute
☐ emotionale Nähe
☐ Zusammenwohnen
☐ finanzielle Zuwendungen
☐ Geschenke
☐ keine anderen Großeltern vorhanden
☐ andere Gründe, nämlich _____

40) Hatten Sie als Kind das Gefühl anderen Enkelkindern bevorzugt zu werden?

Bevorzugung?

Großmutter mütterlicherseits ☐ ja → ☐ nein

In Bezug auf wen hatten Sie das Gefühl bevorzugt zu werden?

☐ Bruder
☐ Schwester
☐ Kinder der Onkel mütterlicherseits
☐ Kinder der Tanten mütterlicherseits
☐ Kinder der Onkel väterlicherseits
☐ Kinder der Tanten väterlicherseits

Großvater mütterlicherseits ☐ ja → ☐ nein

In Bezug auf wen hatten Sie das Gefühl bevorzugt zu werden?

☐ Bruder
☐ Schwester
☐ Kinder der Onkel mütterlicherseits
☐ Kinder der Onkel väterlicherseits
☐ Kinder der Tanten mütterlicherseits
☐ Kinder der Tanten väterlicherseits

Großmutter väterlicherseits ☐ ja → In Bezug auf wen hatten Sie das Gefühl bevorzugt zu werden?
☐ nein

☐ Bruder
☐ Schwester
☐ Kinder der Onkel mütterlicherseits
☐ Kinder der Onkel väterlicherseits
☐ Kinder der Tanten mütterlicherseits
☐ Kinder der Tanten väterlicherseits

Großvater väterlicherseits ☐ ja → In Bezug auf wen hatten Sie das Gefühl bevorzugt zu werden?
☐ nein

☐ Bruder
☐ Schwester
☐ Kinder der Onkel mütterlicherseits
☐ Kinder der Onkel väterlicherseits
☐ Kinder der Tanten mütterlicherseits
☐ Kinder der Tanten väterlicherseits

41) Hatten Sie als Kind das Gefühl anderen Enkelkindern gegenüber benachteiligt zu sein?

Benachteilung?

Großmutter mütterlicherseits ☐ ja → In Bezug auf wen hatten Sie das Gefühl benachteiligt zu sein?
☐ nein

☐ Bruder
☐ Schwester
☐ Kinder der Onkel mütterlicherseits
☐ Kinder der Onkel väterlicherseits
☐ Kinder der Tanten mütterlicherseits
☐ Kinder der Tanten väterlicherseits

Großvater mütterlicherseits ☐ ja → In Bezug auf wen hatten Sie das Gefühl benachteiligt zu sein?
☐ nein

☐ Bruder
☐ Schwester
☐ Kinder der Onkel mütterlicherseits
☐ Kinder der Onkel väterlicherseits
☐ Kinder der Tanten mütterlicherseits
☐ Kinder der Tanten väterlicherseits

Großmutter väterlicherseits ☐ ja → In Bezug auf wen hatten Sie das Gefühl benachteiligt zu sein?
☐ nein

☐ Bruder
☐ Schwester
☐ Kinder der Onkel mütterlicherseits
☐ Kinder der Onkel väterlicherseits
☐ Kinder der Tanten mütterlicherseits
☐ Kinder der Tanten väterlicherseits

Großvater väterlicherseits ☐ ja → In Bezug auf wen hatten Sie das Gefühl benachteiligt zu sein?
☐ nein

☐ Bruder
☐ Schwester
☐ Kinder der Onkel mütterlicherseits
☐ Kinder der Onkel väterlicherseits
☐ Kinder der Tanten mütterlicherseits
☐ Kinder der Tanten väterlicherseits

Vielen Dank, dass Sie sich die Zeit genommen haben, den Fragebogen auszufüllen!

Zusammenfassung

Um Aussagen über großelterliches Investment treffen zu können, wurde in dieser Studie großelterliche Fürsorge als Näherungsvariable verwendet. Die Hypothese von diskriminativer großelterlicher Fürsorge (Euler & Weitzel, 1996) nimmt an, dass das Ausmaß der Fürsorge, die Großeltern ihren Enkelkindern zukommen lassen, einerseits von der geschlechtsspezifischen Reproduktionsstrategie ihrer Kinder und andererseits von der Verwandschaftssicherheit beeinflusst wird. Die in dieser Hypothese formulierten Vorhersagen wurden in einer abgewandelten Form überprüft: Erstens, die vier Großeltern kümmern sich nicht im gleichen Ausmaß um ihre Enkelkinder. Zweitens, die Großeltern mütterlicherseits kümmern sich intensiver um ihre Enkelkinder als die Großeltern väterlicherseits. Drittens, innerhalb eines Großelternpaares kümmern sich Großmütter intensiver um ihre Enkelkinder als Großväter.

Um diese Vorhersagen zu prüfen, wurde zunächst eine Datenerhebung mit Fragebögen durchgeführt, bei der 276 Studierende der Universität Wien über die Fürsorge, die sie im Kindesalter von ihren Großeltern erfahren haben, Angaben machten. Die erhobenen Daten wurden anschließend mithilfe deskriptiver Analysen, Regressionsanalysen und Korrelationsanalysen untersucht. Es hat sich gezeigt, dass Großmütter mütterlicherseits am fürsorglichsten sind und zugleich auch jene Großelternteile sind, denen sich die Enkelkinder am nächsten fühlen, gefolgt von Großmüttern väterlicherseits, Großvätern mütterlicherseits und schließlich Großvätern väterlicherseits. Diese Ergebnisse deuten darauf hin, dass das Muster großelterlicher Fürsorge einerseits die Abstufungen an Verwandschaftssicherheit widerspiegelt, und andererseits auch von sozialen Rollen beeinflusst wird. Differentielles großelterliches Investment scheint ein robustes Phänomen zu sein, da sich weder das Geschlecht des Enkelkindes, Wohnortdistanz, Alter der Großeltern noch Anzahl vorhandener Großeltern oder Anzahl vorhandener Enkelkinder auf das Ausmaß der Fürsorge auswirken.

Curriculum Vitae

Beatrix Putz

Seit 2001

Studium an der Universität Wien: Lehramt Biologie und Umweltkunde und Französisch

2001

Reifeprüfung; Gymnasium Hagenmüllergasse, Wien

1993- 2001

Gymnasium Hagenmüllergasse, Wien

1989- 1993

Volksschule Dietrichgasse, Wien

19. 05. 1983 geboren in Wien