

Frontiers of Aging
In A
New Millenium

Symposia from the
Eleventh Annual Student Convention
In Gerontology and Geriatrics

Evelyn Hubbard

Editor

Frontiers of Aging

In A

New Millenium

Symposia from the Eleventh Annual Student Convention

In Gerontology and Geriatrics

Co-Sponsored by:

The University of Georgia

Georgia State University

Georgia Southern University

Armstrong Atlantic State University

North Georgia College and State University

Columbus State University

State University of West Georgia

Evelyn Hubbard

Editor

Published in 2000 by

The Gerontology Program at the State University of West Georgia

Copyright @ 2000

The State University of West Georgia Gerontology Program

All rights reserved.

No portion of this report or the data which it contains
may be reproduced without the express written consent of the
State University of West Georgia Gerontology Program.

Copies of this report may be obtained from:

The State University of West Georgia Gerontology Program

Department of Sociology

Carrollton, Georgia 30118

Telephone: (770) 836-4590

Fax: (770) 838-3036

[http:// www.westga.edu/~socant](http://www.westga.edu/~socant)

This report is also available as a series of *.pdf* files from

The UGA Gerontology Center Web site at:

[http:// www.geron.uga.edu](http://www.geron.uga.edu)

Table of Contents

Preface

Patricia P.Lynott, Ph.D.

Contributors

Foreword

Evelyn Hubbard, B.S.

Keynote Address: Constructing the Future of Aging

George L. Maddox, Ph.D.

Symposium 1

Large-scale Studies of Mortality in Fruit Flies as a Model for the Biology of Aging

Daniel Promislow, D.Phil.

Maternal Age and Delayed Mating Effects on Adult Life Expectancy

In Heterogeneous Populations of *Drosophila melanogaster*.

Nicholas K. Priest, B.Sc., Ben Mackiowak, and Daniel E.L. Promislow, D.Phil.

The Effects of Laboratory Fly Culture on Aging Patterns

C. Ramsey, B.Sc. and Daniel Promislow, D.Phil.

Symposium 2

Marital Adjustment and Religiosity:

A Comparison of Those Under Age 65 with Those Age 65 and Older

Larry C. Mullins, Ph.D., Daniel Pruett, B.A., Kimberly Brackett, Ph.D.

And Danny Harrison, Ph.D.

Discussion of Symposium 2

Laura Dylus and Julie Hall

Preface

The eleventh annual Student Convention in Gerontology and Geriatrics experienced both continuity and change this year. It continued its long-standing tradition of faculty-student collaboration. This year, for the first time, students presented their posters to the entire audience during a session devoted to posters. Attendees agreed that it was an impressive array of gerontology research. This year, the list of sponsors grew to seven: the University of Georgia, Georgia State University, Georgia Southern University, Armstrong Atlantic University, the State University of West Georgia, Columbus State University, and North Georgia College & State University. The 2000 convention was hosted by Columbus State University faculty and students.

As in previous years, approximately 100 students and faculty attended the two-day convention. The keynote address was presented by George Maddox from Duke University. The symposia were conducted by student/faculty research teams from the University of Georgia and Auburn University Montgomery. This monograph is the compilation of the proceedings of that convention.

The editor of this year's monograph is Evelyn Hubbard of the State University of West Georgia. At last year's convention, Evelyn was a discussant. Based on her work as a discussant, the planning committee asked her if she would be willing to be the editor for the 2000 monograph. The request was a testament to Evelyn's scholarship, professionalism, and work ethic. You should know that Evelyn also completed her Master's thesis during this time! She did a wonderful job editing this monograph and it

was a pleasure acting as faculty advisor. We know that you will enjoy reading the research presented here by student and faculty gerontologists in the South.

Patricia P. Lynott, Ph.D.

Director, Gerontology Program

State University of West Georgia

Contributors

Contributors (from left to right): First row: Laura Dylus, Julie Hall, Susan Barrett, Reni DeSort; Second Row: Daniel Promislow, George Maddox, Catherine Ramsay, Candice Vickers, Evelyn Hubbard; Third Row: Nicholas Priest, Larry Mullins, and Daniel Pruett.

Foreword

Gerontology is a multidisciplinary field that attracts scholars from many different disciplines. These include psychology, sociology, biology, social work, nursing, and business, law, and political science. At the same time, gerontological issues influence many different fields of endeavor. For instance, medicine and nursing are now concerned with the overwhelming numbers of older adults that now constitute their clientele. For these reasons, the interdisciplinary sharing of knowledge has become essential for those concerned with aging in the new millennium.

The theme of the Eleventh Annual Southern Regional Student Convention in Gerontology and Geriatrics, "Frontiers of Aging in a New Millennium," illustrates the changes that are occurring in our society due to our aging population. These changes will require people who are educated as gerontologists with the skills and knowledge to meet the needs of older adults. They will also require people who are willing to look outside

the boundaries of their own discipline for ideas, as well as people who are willing to share their expertise with others.

The Annual Student Convention in Gerontology and Geriatrics has always been a forum for the interdisciplinary sharing of knowledge. This year, the student presenters represented the disciplines of Genetics and Sociology, and the Posters represented disciplines too numerous to mention. Although they represented very different areas of endeavor, the participants shared a common goal of doing research to better understand and to improve the chances for a longer and happier life for older adults. This is, after all, a primary goal for all gerontologists.

This monograph tells the story of the true meaning of interdisciplinary collaboration. Students and faculty from seven different institutions worked together to nurture the latent talent of future gerontologists by presenting their research and posters. The keynote speaker, Dr. George Maddox, set the tone of the convention by describing some very exciting predictions for those involved in the field of aging. Everyone involved contributed their time and expertise in the highest example of true interdisciplinary collaboration.

I would like to express my appreciation to the student contributors and to the faculty members for all of their diligent work. The sponsoring schools, as always, shared their resources in making this convention a success. Columbus State University did an outstanding job of hosting the Convention. I would also like to recognize the other member schools for all of their many contributions. These include: The University of Georgia, Georgia State University, Georgia Southern University, North Georgia State

College and University, and Armstrong State University, as well as my colleagues from the State University of West Georgia.

Finally, I would especially like to thank Dr. Patty Lynott for her many hours of assistance and guidance with this project. Without her help and encouragement, this monograph may never have become a reality.

Evelyn Hubbard, Editor

Gerontology Program

State University of West Georgia

May 2000

**Maternal age and delayed mating effects on adult life expectancy in
heterogeneous populations of *Drosophila melanogaster*.**

Nicholas K. Priest, B.Sc.

Ben Mackiowak

Daniel E. L. Promislow, D.Phil.

University of Georgia

Address correspondence to D. Promislow, Department of Genetics, University of Georgia, Athens, GA

30602-7223 (email: promislow@uga.edu)

Abstract

The age and mating history of a mother can have a dramatic effect on the longevity of her offspring. We examined the effect of maternal age, paternal age and mating history (whether the parents continuously mated throughout life or were held as virgins until mating) on the life expectancy of offspring in a wild-caught strain and a laboratory strain of the fruit fly, *Drosophila melanogaster*. In the wild-caught strain we found significant maternal age and mating history effects on life expectancy of male and female offspring. In the laboratory strain we found significant maternal age effects but no mating history effects on male life expectancy and no effects on female life expectancy. Our results from the wild strain indicate that old mothers produce offspring with lower survival if their reproduction is delayed to late ages and produce offspring with higher life expectancy if their reproduction is continuous throughout life. Our results from the laboratory strain show that mothers with continuous reproduction produce offspring with higher life expectancy than mothers with delayed reproduction. We argue that selection due to laboratory culture over many generations maintains maternal mating effects, but produces maternal age effects that are not representative of maternal effects exhibited in natural populations. The results presented here confirm that maternal age can influence patterns of aging in offspring.

Introduction

In 1947 Albert Lansing demonstrated that old female rotifers produce offspring with significantly reduced longevity. In the 1950's and 1960's, investigators found maternal age effects on offspring longevity in a wide variety of species, including duckweed (Ashby, 1954), mealworms (Ludwig, 1960), stink bugs (Kiritani, 1967), crustaceans (Murphy, 1972), house flies (Callahan, 1962), and fruit flies (O'Brian, 1965) (but see Verdone-Smith (1982) for exceptions in rotifers). Redfield (1966) and Tokunaga (1969) demonstrated in fruit flies that delayed mating of mothers (holding mothers as virgins) had dramatic effects on the rate of recombination and non-disjunction in their offspring. Though many studies show that maternal age and maternal mating history affect offspring character, the importance of these effects has largely gone unrecognized in the fields of genetics and biogerontology.

The findings of Lansing and other scientists suggest that non-genetic characteristics of the mother can influence the longevity of her offspring. Following Lansing's original work, there was a flurry of work on aging and maternal effects, but it effectively came to a halt by the early 1970's. Since then, the focus of maternal effect studies has been on the role that a mother's environment plays on the early development of her offspring (Fox & Mousseau, 1998; Mousseau, 1998). Far too few studies have examined maternal-age effects on adult traits, and none have looked at these effects using large-scale demography.

Recently, biologists of aging have become interested once again in the role that maternal age might play on offspring longevity. However, this time, the focus has been on humans (Gavrilov et al., 1995, Gavrilov et al., 1997). While this work is important, it does not allow us to distinguish between genetic effects and cultural effects, nor can we do experimental manipulations to determine what causes this effect. Accordingly, we are now in the process of developing the fruit fly, *Drosophila melanogaster*, as a powerful model system to study both genetic and environmental causes and consequences of parental age effects on offspring longevity.

The aims of the following experiment were to determine how maternal age, paternal age, and mating history affects offspring longevity in two strains of *D. melanogaster*. We examine this effect in two strains—one that has been in the lab for over one thousand generations, and the other that was recently obtained from the wild. We chose to examine these strains so that we could examine the effect of laboratory culture on maternal age effects. As my colleagues discuss in the accompanying article (Ramsay &

Promislow, this volume), flies maintained in a typical two-week culture regime are artificially selected for high early reproduction (Promislow & Tatar, 1998). Most studies on the biology and evolution of aging involve lab-adapted strains (Zwann et al., 1995). If lab strains do not have maternal age effects and wild strains have strong effects, this would suggest that lab strains do not reflect the genetic structure found in natural populations.

Materials and Methods

Strains and Culture Conditions

We examined maternal age effects in a wild-caught and a laboratory strain of the fruit fly, *Drosophila melanogaster*. The wild-caught line, UGA98, was established by cultivating offspring of females collected in August, 1998 from a peach orchard in Watkinsville, GA. The lab strain, Canton-S, was obtained from the *Drosophila* stock center in Bloomington, Indiana. The original stock was caught in the 1930's. Offspring from both strains were maintained in 30-liter plexiglass population cages with 24 media bottles, rotated semi-weekly, for 30 weeks before the start of the experiment. Throughout the experiment the flies were maintained at 24° C. on a 12:12 light/dark cycle at a density of roughly 3,000 flies/cage. After 30 weeks, 24 fresh bottles were placed in both population cages and eggs were collected in the media over a two-day laying period. Flies that emerged from these bottles became the grandparents of the offspring on which the life expectancy analysis was done.

Generating Cohorts of Parents of Different Ages and Mating Histories

We designed the experiment so that we could create offspring from parents of different ages and mating environments simultaneously. To start the experiment, we collected flies (the eventual grandparents) three days after they started emerging from the 24 bottles that had been in population cages for two days. We dumped roughly 3,000 flies without anesthesia into three 3.8-L clear plastic jars designed for holding large numbers of flies (modified from Fukui & Kirscher, 1992). The jars have a 10x10 cm screen of mosquito netting, a gusseted aperture for removing dead flies, and a hard plastic top with three holes for fixing glass scintillation vials with food media. The vials were replaced daily.

After one week, we isolated male and female flies from the holding jars under light CO₂ anesthesia and filled 96 half-pint plastic bottles (Applied Scientific) with 20 male and 20 female flies. Flies were allowed to lay eggs for two days and then dumped.

The flies that emerged 8 to 10 days later were the parents of the offspring whose longevity would be measured. We collected these flies as virgins over a two-day period. We isolated 4,500 virgin males and 4,500 virgin females under light CO₂ anesthesia and placed them in food vials at a density of 50 virgin flies/vial. The following day, the flies were grouped and arranged to constitute the parental age and mating treatments (see below). The 4,500 virgin males and females were divided among nine jars, three as delayed mating male holding jars (1,000 virgin males each), three as delayed mating female holding jars (1,000 virgin females each), and three as continuous mating holding jars (containing 500 male and 500 females).

We repeated this grandparent-to-parent generation procedure every two weeks, by which time we had holding jars with virgin or mated flies of ages 1, 3, 5, 7 and 9 weeks, and with flies of two different mating conditions (virgin or continuously mated). The procedures for UGA98 and Canton-S were identical, with the exception that we did not have a 9-week treatment for Canton-S, since these flies did not live that long.

Mating parents according to the experimental design

To generate offspring from parents of different ages, we mated the delayed mating and continuously mating females and males for the two strains as depicted in Figure 1. We mated parents of different ages and mating histories to allow us to test three distinct hypotheses: 1) Offspring longevity is correlated with maternal age independent of paternal age. To test this hypothesis, we crossed mothers of five different ages (1,3,5,7,9 weeks old) to 1 week old fathers, with all flies held as virgins before mating. 2) Offspring longevity is correlated with paternal age independent of maternal age. Here we used a design similar to the previous experiment, but crossed fathers of different ages (1, 3, 5, 7, 9 weeks old) to 1 week old mothers, with all flies held as virgins before mating. 3) Offspring longevity is affected by the mating status of a fly prior to our egg collection. To test this, we collected offspring from known-age mothers who had been maintained either as continuously mated or virgin individuals. For this test, we set up two different crossing regimes. In the first regime, we crossed same-age virgin males and virgin females (ages 1x1, 3x3, 5x5, 7x7, and 9x9 weeks). In the second regime, we collected offspring from females that had been held in

mixed-sex cages with same-age males that were 1, 3, 5, 7, or 9 weeks old. The full design is shown in Figure 1.

For all crosses we isolated flies from the holding jars under light CO₂ anesthesia and filled 1,728 bottles of food (48 bottles for each of 18 treatment and 2 strains) with 20 mothers and fathers according to parental treatment. Egg density can affect patterns of mortality (Luckinbill & Clare, 1986). Though it was not feasible for us to precisely control for egg density, given the number of bottles of food required for the experiment, we controlled for egg density in the following way: After two days of egg laying, four bottles were sampled from each treatment and checked for egg density. Adults from treatments that had more than 200 eggs visible were removed and all others were given one further day for egg laying. Effectively this meant that the adults from all treatments with maternal age = 1 were removed. After three days of egg laying, the samples from remaining treatments were checked and were found to have more than 200 eggs.

Demographic setup and assay

After the first day of emergence, we collected offspring without CO₂ anesthesia emerging within a 24-hour window. We placed offspring in mortality cages (see below) by weighing out 0.41 ± 0.01 grams of flies (which amounted to 350 flies in sample trials). This procedure ensured that the mass of the flies was the same for all cages, though the ratio of males to female was not controlled for. We collected over three 24 hour periods (though primarily over the second and third day of emergence) and obtained approximately 115,000 for survival analysis. We set up a total of 338 cages. To account for block effects in the incubator the different replicates of treatments were divided evenly among 13 trays that held 26 mortality cages.

The mortality cages that we used were designed for mortality assays (modified from Fukui & Kirscher, 1992). The cages consist of 32-oz clear plastic containers, with a 40-mm radius screen of mosquito netting on the lid, a gusseted aperture for removing dead flies, and a 25 mm-diameter plastic tube to which we can attach a standard 8-dram vial with fly medium.

Every two days we removed dead flies, exchanged food vials and recorded whether any flies had escaped or were killed accidentally. For every cage we determined d_x , the number of deaths at age x . We calculated life expectancy at day 5 using standard demographic procedures (see Promislow, this volume).

Linear regression of parental age and mating history effects on day three life expectancy for the two strains was performed in JMP (SAS institute). For all three experiments the reduced models are presented in Table 1. For the analysis presented here we have not controlled for multiple comparisons (Sokal & Rohlf, 1995).

Results

We found significant effects in all of the three experiments for the two strains. In UGA98, the wild-caught strain, we found significant and strong maternal age, paternal age and mating history effects on life expectancy of male and female offspring (Table 1, figures 2, 3, 4 and 5). When mothers are held as virgins, life expectancy was significantly lower in offspring of old mothers than in those from younger mothers ($P < 0.0006$). In marked contrast, offspring from older fathers held as virgins had *greater* life expectancy than cohorts produced by younger fathers ($P = 0.0089$). Finally, if mothers and fathers are held in mixed-sex cohorts where mating is possible throughout life, for a given age, offspring have lower life expectancy than when parents are held as virgins until later age (Table 1).

The patterns that we observed in the lab strain, Canton-S, were quite different from those seen in UGA98. In Canton-S, we found significant but weaker maternal age, paternal age and mating history effects. For both mothers and fathers, older individuals produce offspring that are longer-lived than those produced by younger parents (maternal age effect: $P = 0.0038$; paternal age effect: $P = 0.0226$; figures 2 and 3). As with UGA98, offspring of parents held with continuous reproduction have a greater life expectancy than offspring of parents with delayed mating (Table 1, figures 4 and 5).

Discussion

Initial work by Lansing and subsequent work of others indicated that offspring of older parents do not live as long as those produced by younger parents. The result was reiterated in a variety of species. However, some thirty years ago, study of the Lansing effect ceased. Although there has been a recent resurgence of interest in the Lansing effect based on studies of humans, in our own studies, we are beginning to develop a powerful, genetically and demographically tractable model system to study the Lansing effect, and to determine its genetic basis.

The work here is just a beginning. The results demonstrate that there are strong maternal age and strong mating effects in UGA98, while the effects in Canton-S are somewhat weaker. These effects confirm that the environment and genotype of a mother can determine the life expectancy of her offspring. Interestingly, the picture is somewhat more complicated than we had originally anticipated. Our *a priori* prediction was that older flies will produce offspring that do not live as long. However, in some cases we found just the opposite—older Canton-S mothers produced offspring that lived longer than did younger-aged mothers. This effect may be due to cohort heterogeneity (Vaupel & Yashin, 1995)—a factor that is now currently under investigation in our lab.

The results we obtained validate our *a priori* prediction that flies maintained under two-week laboratory culture express weaker maternal age effects than lab-caught populations. We are currently designing experiments to determine just how and why this difference occurs. Though we found maternal mating effects in both strains, we did not find parental age*mating history interaction effects in the Canton-S strain.

The power of large-scale mortality experiments will enable us to understand the biological basis of parental-age effects in a way that was not previously possible. This biodemographic approach, combined with the powerful genetic tools available for studies in *Drosophila*, should help us to unlock the key to these intriguing correlations.

References

- Ashby, E. & Wangerman, E. (1954). The effects of maternal aging on the morphology and behavior of fronds in *Lemna minor*. *Annals of the New York Academy of Science* 57, 476-483.
- Callahan, R. F. (1962). Effects of parental age on the life cycle of the house fly, *Musca domestica linnaeus*. *Journal of the New York Entomological Society* 70, 150-158.
- Fox, C. W., & Mousseau, T. A. (1998). Maternal effects as adaptations for transgenerational phenotypic plasticity in insects. In *Maternal Effects as Adaptations*, C. W. Fox & T. A. Mousseau (Eds.). New York: Oxford University Press, pp. 159-177.
- Gavrilov, L. A., N. S. Gavrilova, V. G. Semenova, G. N. Evdokushkina, V. N. Krut'ko, A. L. Gavrilova, N. N. Evdokushkina & E. V. Lapshin. (1997). Maternal age and lifespan of the offspring (in Russian). *Dokl Akad Nauk* 354, 569-72.
- Gavrilov, L. A., N. S. Gavrilova, N. P. Snarskaia, V. G. Semenova, G. N. Evdokushkina, A. L. Gavrilova, E. V. Lapshin & N. N. Evdokushkina. (1995). Paternal age and lifespan of the offspring (in Russian). *Dokl Akad Nauk* 341, 566-8.

- Hassold, T., Chen N., Funkhouser, J., Jooss, T., Manuel, B., Matsuura, J., Matsuyama, A., Wilson, C., Yamane, J. A., Jacobs, P. A. (1980). A Cytogenetic Study of 1000 Spontaneous-Abortions. *Annals of Human Genetics* 44, 151-178.
- Hassold, T. J. & Jacobs, P. A. (1984). Trisomy in man. *Annual Review of Genetics* 18, 69-97.
- Kiritani, K. & Kimura, K. (1967). Effects of parental age on the life cycle of the Southern green stink bug, *Nezara viridula*. *Applied Entomological Zoology* 2, 69.
- Lansing, A. I. (1947). A transmissible, cumulative, and reversible factor in aging. *J Gerontology* 2, 228-239.
- Lee, E. T. (1992). *Statistical Methods for Survival Data Analysis* (2nd Ed.). New York: John Wiley & Sons.
- Luckinbill, L. S. & M. J. Clare. (1986). A density threshold for the expression of longevity in *Drosophila melanogaster*. *Heredity* 5, 329-335.
- Ludwig, D., Fiore, C. (1960). Further studies on the relationship between parental age and the life cycle of the mealworm, *Tenebrio molitor*. *Annals of the Entomological Society of America* 53, 595.
- Lynch, M. (1989). The Life-History Consequences of Resource Depression in *Daphnia-Pulex*. *Ecology* 70, 246-256.
- Mousseau, T. A., Fox, C. W. (1998). The adaptive significance of maternal effects. *Trends in Ecology & Evolution* 13, 403-407.
- Mousseau, T. A. & Dingle, H. (1991). Maternal effects in insect life histories. *Annual Review of Entomology* 36, 511-534.
- Murphy, J. S. & Davidoff, M. (1972). *Biological Bulletin* 142, 302.
- O'Brian, D. M., Yablonsky, C. & Gillooly, C. (1965). The effects of parental age on egg production, hatchability of the eggs and survival of the offspring in *Drosophila melanogaster*. *Proceedings of the Indiana Academy of Science* 74, 386-392.
- Promislow, D. E. L. & Tatar, M. (1994). Comparative approaches to the study of senescence: bridging genetics and phylogenetics. In *Genetics and Evolution of Aging*, M. R. R. & C. E. Finch (Eds.) Boston: Kluwer Academic Publishers, pp. 45-53.
- Sauer, M. V. (1997). Infertility and early pregnancy loss is largely due to oocyte aging, not uterine senescence, as demonstrated by oocyte donation. *Annals of the New York Academy of Sciences* 828, 166-174.
- Sokal, R. R. & F. J. Rohlf. (1995). *Biometry* (3rd ed.). NY: W.H. Freeman & Co.
- Tatar, M., Khazaeli, A. A., & Curtsinger, J. W. (1997). Chaperoning extended life. *Nature* 390, 30-30.
- Vaupel, J. W. (1990). Relatives' risk: frailty models of life history data. *Theoretical Population Biology* 37, 176-195.
- Vaupel, J. W. & A. I. Yashin. (1985). Heterogeneity's ruses: Some surprising effects of selection on population dynamics. *American Statistician* 39, 176-195.

Verdone-Smith, C. & Enesco, H. E. (1982). Maternal age and lifespan do not influence longevity in the rotifer *Asplanchna brightwelli*. *Experimental Gerontology* 17, 263-266.

TABLE 1**Canton-S****UGA98**Maternal Age EffectMaternal Age Effect

Parameter	Estimate	F statistic	P Value	Parameter	Estimate	F statistic	P value
Intercept	50.727			Intercept	74.160		
Maternal Age	0.6306	8.872	0.0038	Maternal Age	-0.9615	13.04	0.0006
Sex[F-M]	-12.329	429.3	<0.0001	Sex[F-M]	-8.2785	121.040	<0.0001

Paternal Age EffectPaternal Age Effect

Parameter	Estimate	F statistic	P value	Parameter	Estimate	F statistic	P value
Intercept	52.5319			Intercept	65.683		
Paternal Age	0.3543	5.4172	0.0226	Paternal Age	0.6787	7.2240	0.0089
Sex[F-M]	-13.416	959.05	<0.0001	Sex[F-M]	7.944	161.622	<0.0001
				Day{1-2}	-2.609	12.167	0.0008

Parental Age and Mating History EffectParental Age and Mating History Effect

Parameter	Estimate	F statistic	P value	Parameter	Estimate	F statistic	P value
Intercept	54.7643			Intercept			
Parental Age	0.01515	0.0082	0.9279	Parental Age	0.32209	3.2627	0.07290
Mating [M-V]	1.8476	18.990	<0.0001	Mating [M-V]	-5.0208	23.488	<0.0001
Sex F-M]	-12.519	978.03	<0.0001	Sex [F:M]	-8.2206	267.7066	<0.0001
Day [2-3]	-2.5941	8.2264	0.0004	Age*Mating	0.84113	22.2511	<0.0001

Figure 1. Diagram of the crosses carried out for this experiment. Females of one particular age (rows) were crossed with males of another age (columns) to enable us to determine the effects of both maternal age and paternal age on offspring longevity.

Figure 2. The relationship of life expectancy in offspring and age of the mother for two different strains of fruit fly. In this case, mothers were held as virgins and then crossed with 1-week-old males.

Figure 3. The relationship of life expectancy in offspring and age of the father for two different strains of fruit flies. In this case, fathers were held as virgins and then crossed with 1-week-old virgin females.

Figure 4. Life expectancy versus parent age for two strains of flies. In this figure, both mothers and fathers were held as virgins, and then mated to individuals of the same age to produce offspring (see Table 1).

Figure 5. Life expectancy versus parent age for two strains of flies. In contrast to the results shown in Figure 4, where parents were held as virgins until they reached the desired age, in this case, parents were held in mixed-sex cages until collection of offspring at different parental ages (see Table 1).

		Age (in weeks)					Age (in weeks)					
		Male					Male					
Female		1	3	5	7	9	Female	1	3	5	7	9
	1	X	X	X	X	X		1	X			
	3	X	X					3		X		
	5	X		X				5			X	
	7	X			X			7				X
	9	X				X		9				X

Delayed Mating
Continuous Mating

Figure 1

Maternal Age Effect

Delayed Mating

Virgin mothers of different ages mated to 1 week old males

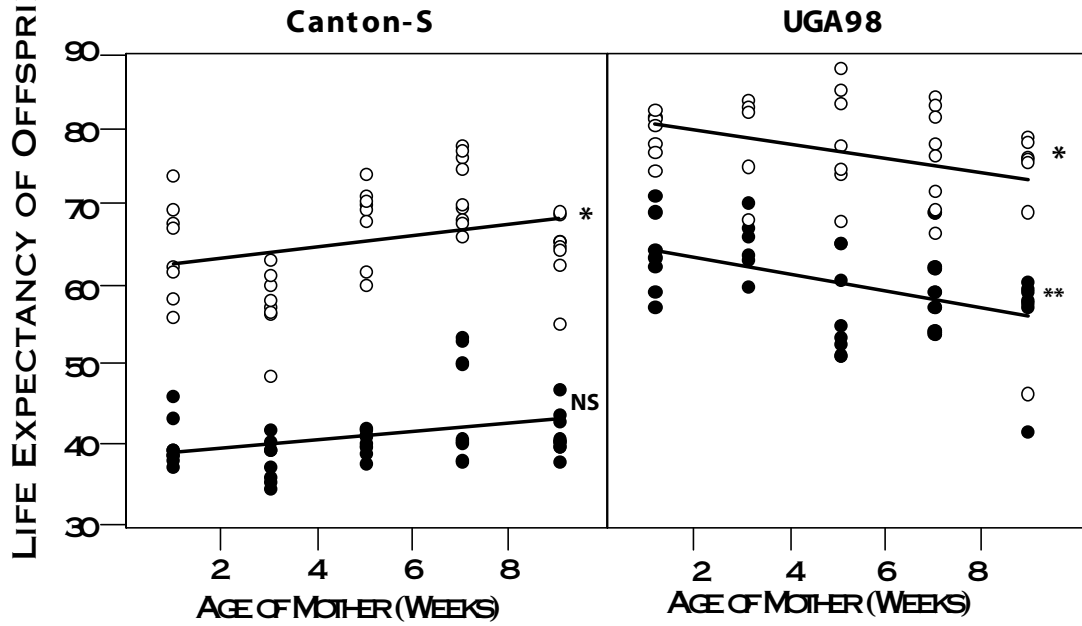


FIGURE 2. PRIEST AND PROMISLOW

Paternal Age Effect

Delayed Mating

Virgin fathers of different ages mated to 1 week old females

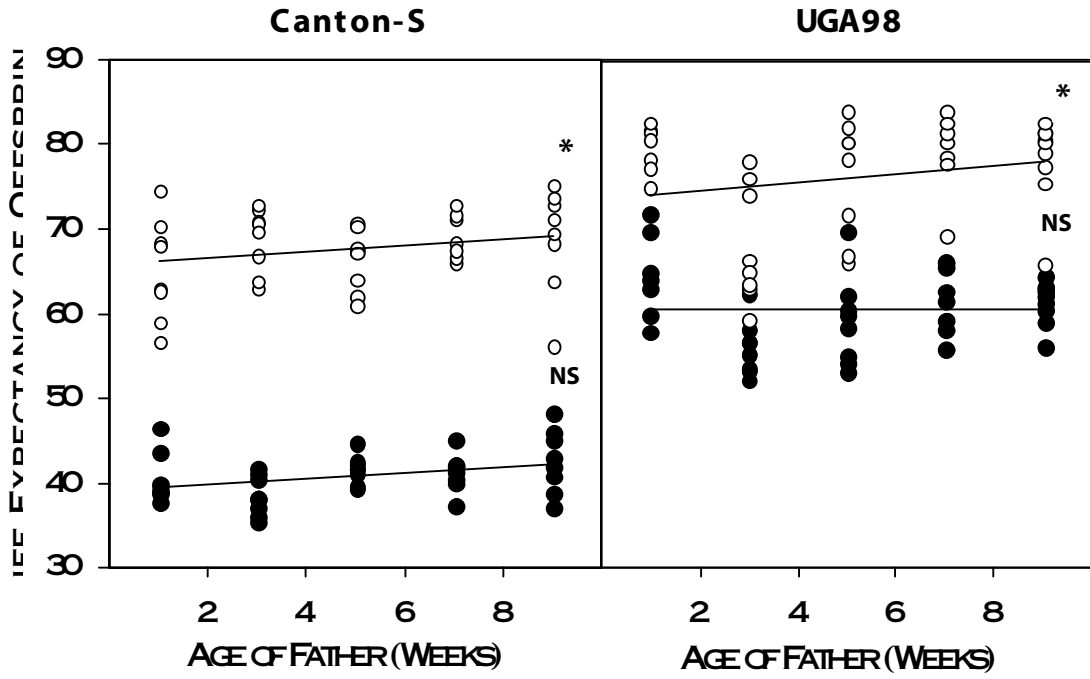


FIGURE 3

Mating History Effect

Delayed Mating

Parents held as virgins until same age mating

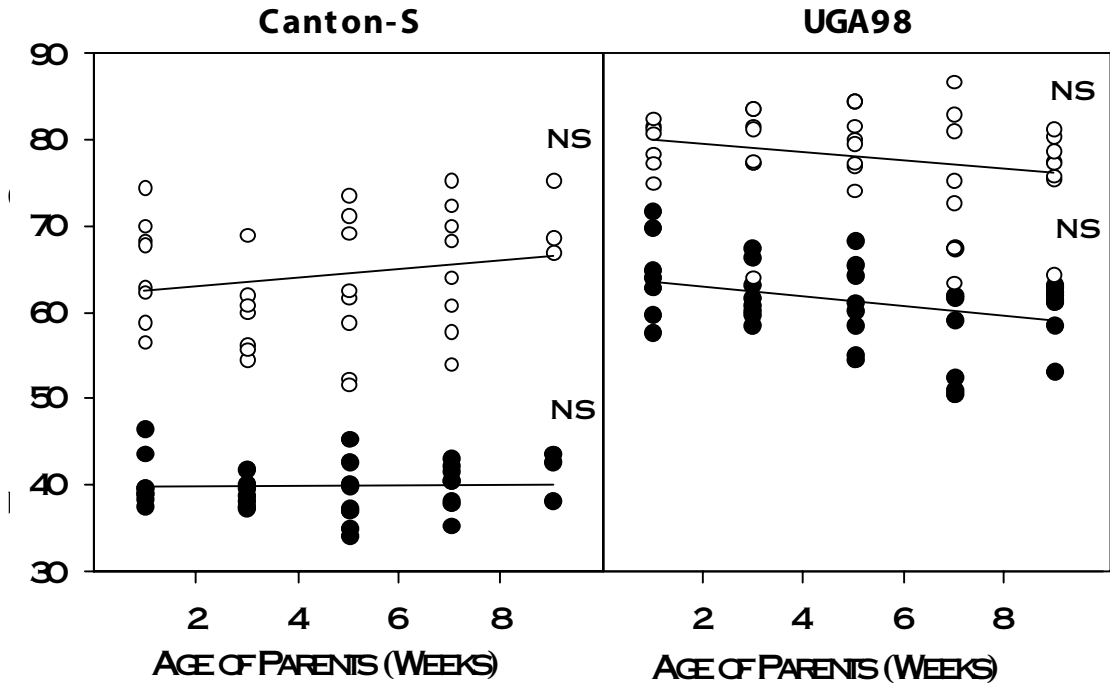


FIGURE 4

Mating History Effect

Continuous Mating

Parents held in mixed-sex cages until same age mating

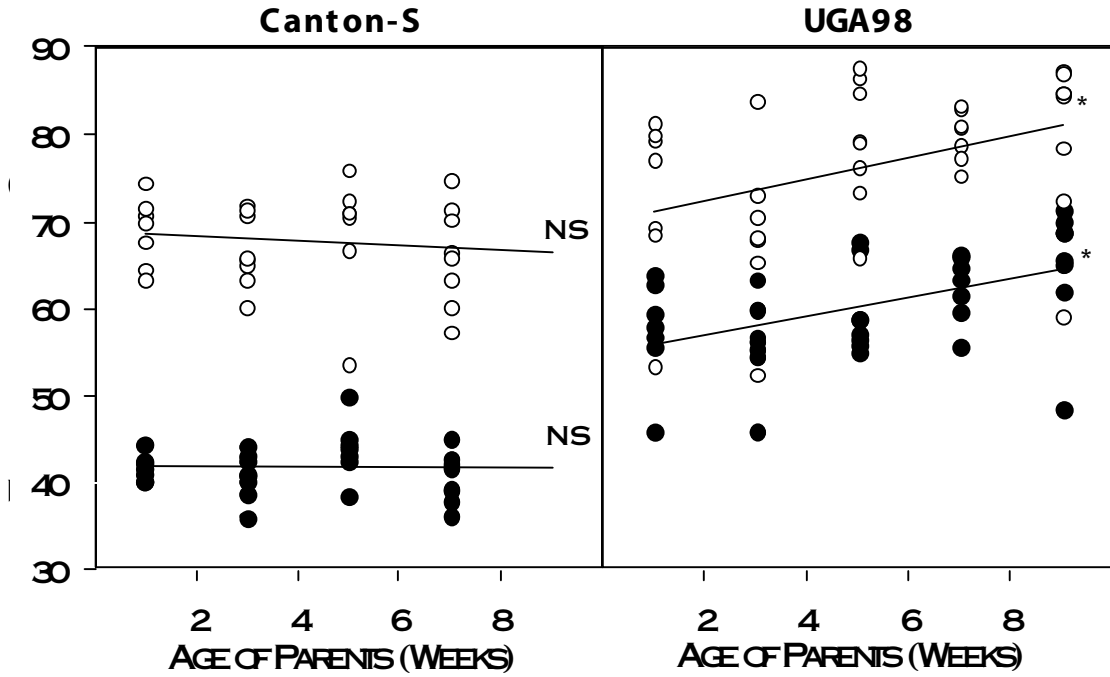


FIGURE 5

The Effects of Laboratory Fly Culture on Aging Patterns

C. Ramsay, B.Sc. and D. E. L. Promislow, D.Phil.

University of Georgia

Address correspondence to D. Promislow, Department of Genetics,
University of Georgia, Athens, GA 30602-7223 (email:
promislow@uga.edu)

Introduction

In the 1920s, Pearl and colleagues published the first systematic experimental studies on the inheritance of life span in *Drosophila melanogaster* (Pearl, 1922; Pearl & Parker, 1922; Gonzales, 1923). Since the publication of these seminal papers, *Drosophila* has become the most widely used model organism to study aging, which is defined here as a persistent decline in age-specific fitness components due to internal physiological deterioration (Rose, 1991). Studies with *Drosophila* have been particularly useful to test evolutionary theories of aging. As described in a companion article (Promislow, this volume), evolutionary theory posits that aging results from the age-related decline in the force of natural selection (Medawar, 1946; Medawar, 1952), leading to the inevitable accumulation of germ-line deleterious mutations over evolutionary time. In an extension of Medawar's "mutation accumulation" theory, Williams (1957) suggested in his "antagonistic pleiotropy" model that the late-acting deleterious mutations suggested by Medawar may actually have *beneficial* effects early in life, and so be favored by natural selection. Over the past 20 years, a series of studies using *Drosophila* has tested these models (e.g. Rose & Charlesworth, 1981a; Luckinbill et al., 1984; Rose, 1984; Mueller, 1987; Partridge & Fowler, 1992; Hughes & Charlesworth, 1994).

Despite the many advantages of using *Drosophila* in aging research (Promislow, 2000), there are also some problems with the use of lab organisms, in general, and insects in particular, for the study of aging. First, aging in *Drosophila* depends to a large extent on environmental conditions. Second, the laboratory conditions under which *Drosophila* are kept are often highly controlled, contrived conditions that do not reflect natural conditions and may cause misleading results.

As Parsons (1978) pointed out, *Drosophila* aging studies are only relevant to the environment in which they are performed. Several environmental conditions are known to affect aging in *Drosophila*. The two most important environmental factors appear to be temperature (e.g. Hollingsworth, 1966, 1969; Miquel et al., 1976; Parsons, 1978) and nutrition (e.g. Robertson & Sang, 1944; Herrewege, 1974). For example, by reducing ambient temperature, one can easily double or triple the life expectancy of most insects. Other factors that have been shown to influence aging in *Drosophila* include light regime (e.g. Allemand et al., 1973), larval density (Lewontin, 1955; Lints & Lints, 1969), oxygen level (Kloek et al., 1976), and the ecology of lab culture (Robertson & Sang, 1944; Mueller, 1985). These problems can be alleviated somewhat by highly controlled conditions. Unfortunately, such controls pose a suite of new problems to *Drosophila* research.

It is well known that laboratory conditions are not equivalent to natural ones, a sacrifice necessary for controlled experimental studies. However, some laboratory conditions in *Drosophila* aging research are so far from natural conditions that they may actually alter the genetic structure of aging. For example, many studies on the genetics of aging have used inbred lines of flies (e.g. Giesel, 1979; Giesel et al., 1982). Inbred lines are often less fit than outbred lines because inbreeding can lead to an increased frequency of deleterious alleles that are normally rare. If some of these rare alleles affect aging components, inbreeding may alter the genetic makeup of aging in inbred populations. Inbreeding depression is a widely recognized problem, and most researchers are careful to use outbred lines. In fact, some researchers have gone so far as to use recently wild-caught lines of *Drosophila* in their research (Murphy et al., 1983; Stearns

1983; Bell 1984a, Bell 1984b). However, as Service and Rose argue in their 1985 paper, results from these studies are confounded by a genotype-by-environment interaction—flies that happen to fare relatively well or relatively poorly in a novel lab environment are likely to do so at all ages. This argument has been extremely influential, and most aging studies are careful to use lines of *Drosophila* that have been maintained in the lab for many generations. Unfortunately, this solution is far from perfect. In fact, using flies that have become adapted to laboratory maintenance regimes (specifically, two-week culture) may complicate matters even further. It is the effect of adaptation to laboratory culture that is the focus of the present study.

It has been recently suggested that flies maintained in two-week culture, a standard *Drosophila* maintenance regime, may be unsuitable for aging studies (Clark, 1987; Promislow & Tatar, 1998). In two-week culture, flies are allowed to lay eggs in bottles for several days before being removed, and the resulting progeny are collected exactly 14 days after the initial flies were placed in the bottle. This new cohort of adults is placed in a fresh bottle, and the cycle begins anew. Because the average egg-adult development time is 8-10 days, the adults collected on day 14 are rarely older than 5-6 days. Therefore, any deleterious germ-line mutation carried by these flies, but whose phenotypic effects are limited to ages later than 5-6 days, will be effectively neutral. Such mutations, acting after 5 or 6 days, can accumulate over time by drift. At the same time, this culture regime will create intense selection for high early fecundity. A fly that saves its eggs for later age will never have the opportunity to use them.

The combination of the absence of selection against deleterious genes acting at ages later than 5-6 days and intense selection on early reproduction will cause flies adapted to

two-week culture to have high early reproduction and increased mortality. Thus, populations adapted to two-week culture are not representative of natural populations, and many conclusions we draw from such populations may be invalid.

The specific goal of this study is to examine what effect, if any, two-week culture has on aging in *Drosophila*. To do so, we examined age-specific mortality rates in six lines of the fruit fly, *Drosophila melanogaster*, including one recently wild-caught line (UGA98), one line that had been maintained in two-week culture for over one thousand generations (Canton-S), two lines that had been under selection for increased life span (O1 and O2, Rose 1984), and two lines that were derived from the same stock as the selected lines, but maintained as a control in two-week culture for approximately five hundred generations (B1 and B2, Rose 1984). If the wild lines live a significantly longer time than the two-week culture lines, this would suggest that two-week culture does, in fact, change the genetic structure of aging in *Drosophila*, and conclusions from such studies may need to be reexamined.

Materials and Methods

We measured mortality rates in six lines of *Drosophila melanogaster*. The UGA98 line was obtained in August 1998 from a peach orchard at the University of Georgia horticultural farm in Watkinsville, GA. We maintained these flies as a large, outbred population in a 30-L plexiglass cage at relatively high densities (>5,000 flies) with overlapping generations. The Canton-S line was obtained from the *Drosophila* stock center in Bloomington, Indiana. Canton-S was originally collected in the 1930's, and so has been under lab domestication culture for well over a thousand generations. M. Rose (University of California, Irvine) provided the other four lines—O₁, O₂, B₁ and B₂. These

lines were derived from a population originally caught in Amherst, MA by P.T. Ives in 1975 and placed on a two-week culture regime (Rose & Charlesworth, 1981b). The O₁ and O₂ lines have been under selection for long life span since 1980, while the B₁ and B₂ lines have been maintained in two-week culture as controls since 1975 (Rose, 1984). These lines have been in our lab since April of 1997, and have been maintained in half-pint glass bottles under a relaxed selection regime (generation time: two to four weeks). All lines were kept at 24°C, 60% relative humidity, on a 12:12 light/dark cycle, and fed standard molasses-yeast-agar-cornmeal medium with propionic acid added as a fungicide.

To obtain mortality measurements, we collected large, age-synchronized populations of virgin males from each line. We placed 15 males and 15 females in 6 oz plastic bottles with yeasted medium for 2 days and collected virgin males from the resulting progeny under light CO₂ anesthesia no more than 8 hours after eclosion. With these flies, we set up 36 mortality cages with approximately 300 virgin males in each: 14 UGA98 cages, 14 Canton-S cages, and 2 cages for each of the Rose lines (O₁, O₂, B₁, and B₂). These cages were based on a modified “thanatometer” design (Fukui, 1992) and were maintained at 24°C, 60% relative humidity, and on a 12:12 light/dark cycle. Each day, we removed the dead flies from each cage. From this data, we constructed a mortality curve and calculated mean longevity for each line. We also used this data to fit Gompertz parameters to each line. The Gompertz curve describes a mortality trajectory that increases exponentially with age (Gompertz, 1825):

$$\mu_x = ae^{bx} \quad (1)$$

In this model, a is the age-independent intrinsic mortality rate and b is the rate at which mortality increases with age. On a log-linear plot, $\ln(a)$ is the y-intercept and b is the slope of the Gompertz curve (see Promislow, this volume).

We were able to parameterize Gompertz curves for each of the six lines using Winmodest, a maximum likelihood estimator program designed by S. Pletcher (Pletcher, 1999). In addition, we used Winmodest to test for differences in parameter values between lines and to determine the relative contribution of each parameter to variation in longevity between lines.

Results

The mean longevity (life expectancy at eclosion) of the UGA98 line, 83.3 d, was similar to the O_1 and O_2 lines, which had mean longevities of 88.4 and 83.6 d, respectively. In contrast, the Canton-S, B_1 , and B_2 lines had much shorter longevities than the other three lines with mean values of 59.8, 56.2, and 53.0 d, respectively. Each line in the long-lived group (UGA98, O_1 , and O_2) differed significantly from each line in the short-lived group (Canton-S, B_1 , and B_2) with respect to longevity.

The mortality curves are presented in figure 1 with a three-day bin to reduce zero values (see Promislow, this volume, for further explanation). For approximately the first 25 days, mortality rates were low in each of the six lines, and a clear Gompertz-type pattern was not evident. Accordingly, we censored the first 25 days of deaths for each line, which represented an average of 5% of the individuals from each line, and then fit the Gompertz curve to the remaining data. Also, at day 87, our incubator reached extremely high temperatures (35°C for several hours) and caused a large increase in mortality for the UGA98 (23% mortality), O_1 (28% mortality), and O_2 (55% mortality) lines. The Canton-S, B_1 , and B_2 lines had mostly died off by then, so the pattern was not evident in these groups. Accordingly, we censored the deaths from day 87 in our statistical analysis.

The intercept values (the ' a ' value in the Gompertz curve) for each of the six lines followed a similar pattern to the mean longevity values. The UGA98, O_1 , and O_2 lines had intercept values of 2.94E-05,

3.55E-05, and 5.40E-05 compared with intercept values of 2.72E-04, 5.55E-04, and 8.75E-04 for the Canton-S, B₁, and B₂ lines. The low intercept values for the long-lived lines (UGA98, O₁, O₂) implies low age-independent intrinsic mortality rates in those lines. All lines were significantly different from one another with respect to intercept in all but one case (O₁ vs. O₂). However, the degree of difference was many times smaller between lines of similar longevity (e.g. UGA98 vs. O₁ or Canton-S vs. B₁) than between lines of dissimilar longevity (e.g. UGA98 vs. Canton-S or O₁ vs. B₂). When we compared slope values, we found much less variation between lines. In most cases, rates of aging were not statistically different between lines. It is not surprising, then, that the longevity decomposition revealed that most of the differences in longevity were due to variation in the intercept parameter. Thus, long-lived and short-lived lines differ in the underlying, age-independent force of mortality. They do not differ, however, in the actual rate of senescence.

Discussion

Mean longevity in the recently wild-caught line, UGA98, was not significantly different from either of the lines that had been selected for increased life span (O₁ and O₂). Likewise, mean longevity in the two-week culture line, Canton-S, differed very little from the lines that had been used as controls for the selected lines (B₁ and B₂). In marked contrast, the difference between the UGA98, O₁, and O₂ lines and the Canton-S, B₁, and B₂ lines was dramatic—lines in the long-lived group lived from 40%-70% longer than lines in the short-lived group. Examination of the Gompertz parameters revealed that a large portion of these differences can be explained by variation in the intercept, or age-independent mortality, parameter.

The substantial differences in life span between the long and short-lived lines is perhaps best understood when we examine the maintenance regimes of each of the lines. The UGA98 line was recently obtained from the wild and had been kept in population cages with overlapping generations for fewer than ten generations. Thus, the UGA98 line had experienced little direct selection or mutation accumulation on fitness components (Sgrò & Partridge, in press). To create the long-lived O lines, Rose (1984), delayed reproduction in lines that had been maintained in two-week culture for many generations. These lines experienced both relaxed selection on early fecundity and indirect selection on life span, which may have decreased the load of mutations accumulated under the two-week culture regime. On the other hand, the

Canton-S and B lines have been maintained in a discrete two-week culture regime for hundreds of generations, which selects heavily on early reproduction and allows mutation accumulation after ages of 6 days (Clark, 1987; Promislow & Tatar, 1998). It is important to point out that the O- and B-lines had been kept under a relaxed selection regime for approximately eighteen months prior to the start of this experiment. We interpret our results with this in mind and note that selection and mutation accumulation in the O-lines may have led us to underestimate the difference between the O-lines and the UGA98 lines. However, we also note that the difference we observed between the O- and B-lines (approximately 58%), was comparable to a 64% difference observed in a previous analysis of these lines (Chippindale et al., 1993).

When we overlay mean longevity with maintenance regime in each of the six lines, our results suggest strongly that two-week culture may change the genetic architecture of aging in *Drosophila*. The lines that had been maintained in two-week culture have much shorter life spans than the recently wild-caught strain. This may be explained by absence of selection on life span after day 6. Coupled with intense selection on early reproduction, mutation accumulation after day 6 may substantially alter the way *Drosophila* ages as it becomes adapted to two-week culture. Thus, when we use two-week culture lines in aging research, we may obtain spurious results.

These results suggest that two-week culture is an important issue in *Drosophila* research that warrants further investigation. First, it would be extremely useful to examine life span in several different lab strains and in wild-caught strains caught from several geographic regions. Second, although we have provided evidence that lab strains have reduced life span, we still need to determine whether this reduction is due to weakened selection on life span or to costs of increased early reproduction. Third, our results suggest that it is now necessary to reinterpret results from studies that have used flies adapted to two-week culture. And finally, we need to develop new methods to maintain *Drosophila* in the lab such that we avoid both the drastic changes in aging that accompany adaptation to two-week culture and the genotype-by-environment interactions described by Service and Rose (1985). Recent work by Sgrò and Partridge (in press) suggests that this may be achieved in population cages with high densities and overlapping generations.

References

- Allemand, R., Y. Cohet, & J. David. (1973). Increase in the longevity of adult *Drosophila melanogaster* kept in permanent darkness. *Exp. Gerontol.* 8:279-283.
- Bell, G. (1984a). Measuring the cost of reproduction I. The correlation structure of the life table of a planktonic rotifer. *Evolution* 38: 300-313.
- Bell, G. (1984b). Measuring the cost of reproduction. II. The correlation structure of the life tables of five freshwater invertebrates. *Evolution* 38: 314-326.
- Chippindale, A. K., A. M. Leroi, S. B. Kim & M. R. Rose. (1993). Phenotypic plasticity and selection in *Drosophila* life-history evolution. I. Nutrition and the cost of reproduction. *J. evol. Biol.* 6:171-193.
- Clark, A. G. (1987). Senescence and the genetic correlation hang-up. *Amer. Natur.* 129:932-940.
- Fukui, H. H. and A. W. Kirscher. (1992). Thanatometer II: A chamber designed for large mixed-sex populations of *Drosophila melanogaster*. *Drosophila Information Service* 72:72-73.
- Geisel, J. T. (1979). Genetic co-variation of survivorship and other fitness indices in *Drosophila melanogaster*. *Exp. Gerontol.* 14:323-328.
- Giesel, J. T., P. A. Murphy, and M. N. Manlove. (1982). The influence of temperature on genetic interrelationships of life history traits in a population of *Drosophila melanogaster*. *Amer. Natur.* 119:464-479.
- Gompertz, B. (1825). On the nature of the function expressive of the law of human mortality and on a new mode of determining life contingencies. *Phil. Trans. Roy. Soc. Lond.* 1825:513-585.
- Gonzalez, B. M. (1923). Experimental studies on the duration of life. VIII. the influence upon duration of life of certain mutant genes of *Drosophila melanogaster*. *Amer. Natur.* 57:289-325.
- Herrewege, J. (1974). Nutritional requirements of adult *Drosophila melanogaster*: The influence of the casein concentration on the duration of life. *Exp. Gerontol.* 9:191-198.
- Hollingsworth, M. J. (1966). Temperature and the rate of ageing in *Drosophila subobscura*. *Exp. Gerontol.* 1:259-267.

- Hollingsworth, M. J. (1969). The effect of fluctuating environmental temperatures on length of life of adult *Drosophila*. *Exp. Gerontol.* 4:159-167.
- Hughes, K. A. & B. Charlesworth. (1994). A genetic analysis of senescence in *Drosophila*. *Nature* 367:64-66.
- Kloek, G. P., D. B. Ralin, & G. C. Ridgel. (1976). Survivorship and gene frequencies of *Drosophila melanogaster* populations in abnormal oxygen atmospheres. *Aviat. Space Environ. Med.* (March):272-279.
- Lewontin, R. C. (1955). The effects of population density and composition on viability in *Drosophila melanogaster*. *Evolution* 9:27-41.
- Lints, F. A. (1988). Aim and scope of *Drosophila* ageing research. Pages 3-16 in F. A. Lints and M. H. Soliman, Eds. *Drosophila as a model organism for ageing studies*. Blackie and Son Ltd, Glasgow and London.
- Lints, F. A. & C. V. Lints. (1969). Influence of preimaginal environment on fecundity and ageing in *Drosophila melanogaster* hybrids. I. Preimaginal population density. *Exp. Gerontol.* 4:231-244.
- Luckinbill, L. S., R. Arking, M. J. Clare, W. J. Cirocco & S. A. Buck. (1984). Selection for delayed senescence in *Drosophila melanogaster*. *Evolution* 38:996-1003.
- Medawar, P. B. (1946). Old age and natural death. *Modern Quart.* 2:30-49.
- Medawar, P. B. (1952). *An Unsolved Problem of Biology*. H. K. Lewis, London.
- Miquel, J., P. R. Lundgren, K. G. Bensch, and H. Atlan. (1976). Effects of temperature on the life span, vitality and fine structure of *Drosophila melanogaster*. *Mech. Ageing Dev.* 5:347-370.
- Mueller, L. D. (1985). The evolutionary ecology of *Drosophila*. *Evol. Biology* 19:37-98.
- Mueller, L. D. (1987). Evolution of accelerated senescence in laboratory populations of *Drosophila*. *Proc. Nat. Acad. Sci. USA* 84:1974-1977.
- Murphy, P. A., J. T. Giesel & M. N. Manlove. (1983). Temperature effects on life history variation in *Drosophila simulans*. *Evolution* 37:1181-1192.

- Parsons, P. A. (1978). The effect of genotype and temperature on longevity in natural populations of *Drosophila melanogaster*. *Exp. Gerontol.* 13:167-169.
- Partridge, L. & K. Fowler. (1992). Direct and correlated responses to selection on age at reproduction in *Drosophila melanogaster*. *Evolution* 46:76-91.
- Pearl, R. 1922. *The Biology of Death, Being a Series of Lectures Delivered at the Lowell Institute in Boston in December 1920.* J. B. Lippincott, Philadelphia and London.
- Pearl, R. & S. L. Parker. (1922). Experimental studies on the duration of life. II. Hereditary differences in duration of life in live-breed strains of *Drosophila*. *Amer. Natur.* 56:174-187.
- Pletcher, S. D. (1999). Model fitting and hypothesis testing for age-specific mortality data. *Journal of Evolutionary Biology* 12:430-440
- Promislow, D. E. L. (2000). Large-scale studies of mortality in fruit flies as a model for the biology of aging. *Symposia for the eleventh annual student convention in gerontology and geriatrics.*
- Promislow, D. E. L. & M. Tatar. (1998). Mutation and Senescence: Where Genetics and Demography Meet. *Genetica* 102/103:299-314.
- Robertson, F. W. & J. H. Sang. (1944). The ecological determinants of population growth in a *Drosophila* culture. I. Fecundity of adult flies. *Proc. R. Soc. Lond. B.* 132:258-277.
- Rose, M. (1984). Laboratory evolution of postponed senescence in *Drosophila melanogaster*. *Evolution* 38:1004-1010.
- Rose, M. (1991). *Evolutionary Biology of Aging.* Oxford University Press, New York.
- Rose, M. & B. Charlesworth. (1981a). Genetics of life-history evolution in *Drosophila melanogaster*. II. Exploratory selection experiments. *Genetics* 97:187-196.
- Rose, M. R. & B. Charlesworth (1981b). Genetics of life-history evolution in *Drosophila melanogaster*. I. Sib analysis of adult females. *Genetics* 97:173-186.
- Service, P. M. & M. R. Rose. (1985). Genetic covariation among life-history components: the effects of novel environments. *Evolution* 39:943-945.

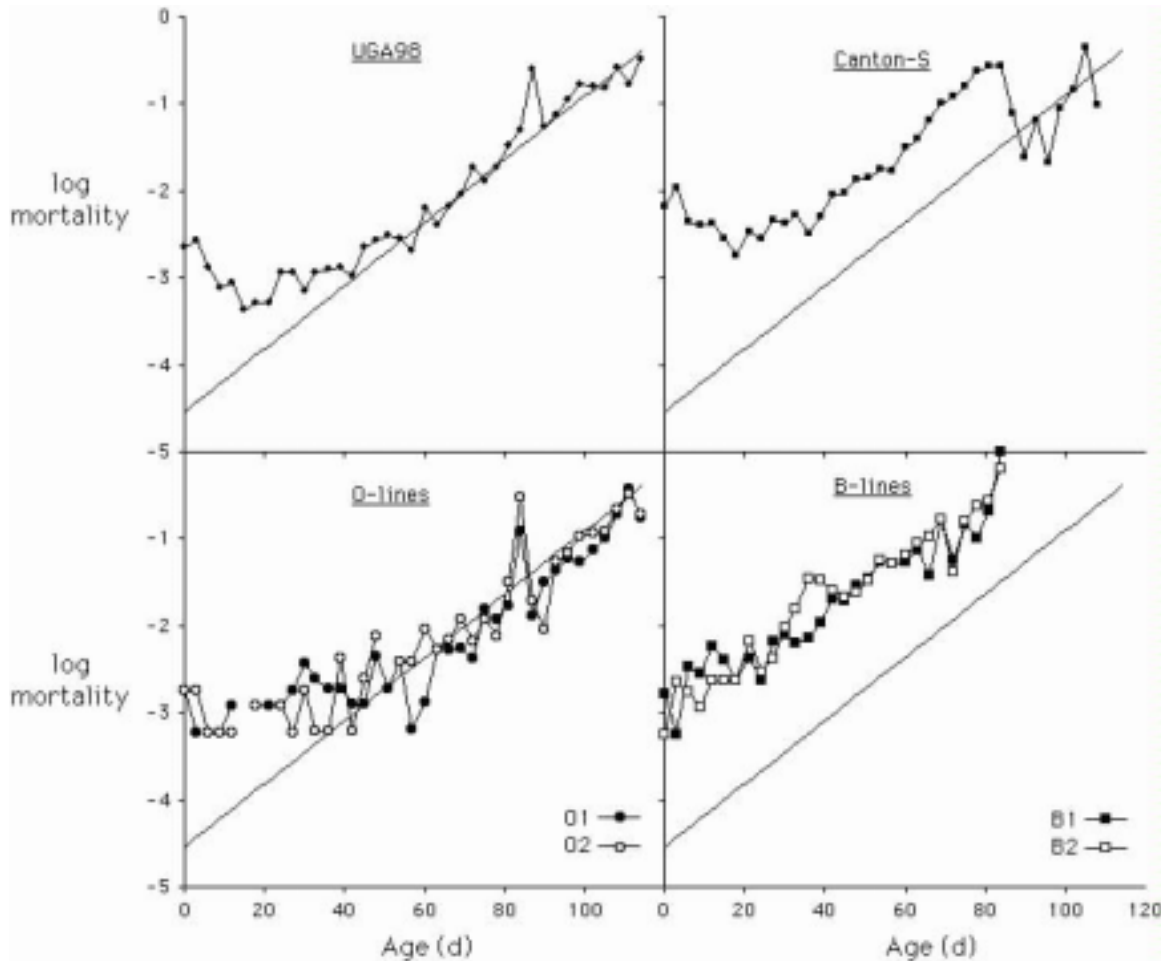
Sgrò, C. M. & L. Partridge. (In press). Evolutionary responses of the life history of wild-caught *Drosophila melanogaster* to two standard methods of laboratory culture. *American Naturalist*.

Stearns, S. C. (1983). The genetic basis of differences in life-history traits among six populations of mosquitofish (*Gambusia affinis*) that shared ancestors in 1905. *Evolution* 37:618-627.

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

Figure legend

Figure 1. Log_{10} mortality rate as a function of age for UGA98, Canton-S, B-lines and O-lines. The solid line in each figure is the maximum likelihood estimated Gompertz line (see text) for UGA98. Note that there is no significant difference between the O-lines, which were selected for long life span, and wild-caught flies from Georgia.



Constructing the Future of Aging

George L. Maddox, Ph.D.
Duke University

Abstract

In constructing the future of aging and possible careers in aging, consider three revolutions

- I. A revolution of demographics and social institutions
- II. A revolution of knowledge about aging.
- III. A revolution of hope and expectations for older adults and the next generation of younger professionals in aging.

I. A Revolution of Demographics and Social Institutions

- A. Long life is bittersweet: We cannot depend on dying conveniently or well.
- B. Two major challenges of population aging
 1. Maintenance of functional capacity: the Fries/anti-Fries debate

(Exhibit A here)

2. Restructuring social institutions to accommodate older adults who age well: income security, health care, lifelong learning, transportation, housing
- 3.

II. A Revolution of Knowledge

- A. DIVERSITY: Important implications for recurrence and policy.
- B. CONTINUITY WITHIN CHANGE: Why longitudinal research is necessary and why gerontologists are life-span developmentalists.
- C. MODIFIABILITY OF AGING PROCESSES & EXPERIENCES
MAXIM: “If you want to understand something try to change it.”

(Exhibit B)

- D. CONTEXT MATTERS: Access to resources matters; Collective Efficacy can provide compensatory care for frail adults
- III. A Revolution of hope and expectations for both new older adults – but more importantly – for your careers in aging

Predictions you can count on:

- A. SELF-EFFICACY: The new millennium as in the 1960’s will feature self-efficacy, community collective efficacy: You will listen and learn in order to empower and enable older adults to enhance their social capital and their sense of efficacy.

AN INTERDISCIPLINARY IMPERATIVE: Knowledge about and working with other disciplines are required to be a leading edge researcher/clinician.

- C. ETHICAL IMPERATIVES: Purposive interventions to generate knowledge about quality of life and care in late life will have high priority.
- D. MORE AND MORE LEARNING AND WORK AS RESEARCHER/CLINICIAN ON INTERNET: Distance learning, tool

boxes, networking, data sets, preparing to work in Learning Organizations will increase.

- E. EXPERIENTIAL LEARNING (INTERFACING KNOWLEDGE AND ITS APPLICATION): Mentored experience will be essential and invaluable.

**MARITAL ADJUSTMENT AND RELIGIOSITY:
A COMPARISON OF THOSE UNDER AGE 65
WITH THOSE AGE 65 AND OLDER**

LARRY C. MULLINS, PH.D.

DANIEL PRUETT, B.A.

KIMBERLY BRACKETT, PH.D.

DANNY HARRISON, PH.D.

AUBURN UNIVERSITY MONTGOMERY

**Address correspondence to Larry C. Mullins, Ph.D., School of Liberal Arts, P.O. Box
244023, Auburn University Montgomery, Montgomery, AL 36124-4023**

Abstract

In order to further understand the association between religion and marriage this study examines how feelings of religiosity and other variables influence feelings of marital adjustment for those in the overall sample, those under age 65, and those 65 and over. Results are based on responses from 169 intact couples (338 individuals) that were selected through a multistage sampling design in the city of Montgomery, Alabama. The stepwise multiple regression results show that increasing age, greater income and greater religiosity are significantly related to greater expressions of marital adjustment. For the under age 65 subsample only an expression of better health is related to greater marital adjustment. For the 65+ subsample only greater religiosity is related to greater marital adjustment. In conclusion, and consistent with previous research, religiosity seems to have a meaningful, though weak, impact on marriage. The findings here suggest that the impact of religion on marriage is more substantial among those who are older.

Introduction

This article examines the association between the expression of marital adjustment and several potentially related factors, especially religiosity, among persons under age 65 and those aged 65 and older. The general issue investigated concerns to what extent does religiosity influence feelings of marital adjustment among those who are relatively younger and those relatively older.

As we end the 20th century and begin the 21st century, the American family continues in its struggle to survive. Because ours is a country with one of the highest divorce rates of any industrialized nation in the world, social scientists, therapists, counselors, pastors, politicians and laypersons all want to know and understand the dynamics of marriage. Each area of investigation has produced its own results, but only now are we beginning to realize the complexity of those factors influencing marital success.

Religiosity and Marital Satisfaction

There are many factors which contribute to the maintenance or dissolution of a marriage. Changes in the economy, in governmental programs, in the education system, and in religion can all add stress to the family (Lauer, 1995). It is also possible that the institution of no-fault divorce laws have resulted in an increase in divorce rates and a comfortable acceptance of divorce and serial monogamy, regardless of religious affiliation. Heaton and Cornwall (1989) applied secularization theory in their study which related marriage to various other social factors and posed an interesting question: Does our religion shape social institutions or do our social

institutions shape religion? Chi and Houseknecht (1985) found as one example that congruency in religious affiliation and ideology led to more harmonious and satisfying marriages. But the same study also found that, among the different denominations, Protestant fundamentalists had the highest marital dissolution (separation and divorce) rate when controlling for race, age at marriage, education, and marital interval. Also, it was found that incongruent spousal religions made fundamentalists of any denomination more likely to be dissatisfied with their marriage than non-fundamentalists.

While there has been considerable exploration of the relationship between various measures of religiosity and marital satisfaction, findings as to the extent and direction of those relationship have produced mixed results. Booth, Johnson, Branaman and Sica (1995) found little support for the idea that an increase in religious activity improved marital relations. They concluded that although increases in religiosity slightly decrease the likelihood of thinking about divorce, they do not enhance marital happiness or decrease problems thought to cause divorce. They did find, however, that an increase in marital happiness increases two dimensions of religiosity, i.e., church attendance and religion's influence on daily life.

Other studies have emphasized the importance of homogamy of religious beliefs. Again, the results have been mixed. Shehan and Bock (1990) reported that religiosity does have a positive impact on marital happiness, but only among homogamous Catholics. In one of the most definitive tests of this hypothesis Heaton and Pratt (1990) found that persons whose spouses are of the same religious affiliation do report higher levels of marital happiness than do those in heterogamous marriages. They found, however, that these differences proved to be almost entirely attributable to the positive effect of church attendance on marital happiness.

Thus, from the Heaton and Pratt findings, one can conclude that those who attend church more frequently are less likely to marry heterogamously and more likely to have happy marriages.

Considering the importance of ideological homogeneity (Etheridge, 1979), it is to be expected that consensus on religious matters would be higher among those couples whose religious beliefs are similar. Conversely, differences in ideology would lead to differences in other areas related to marital satisfaction. This may be especially true in the area of spousal communication.

There is remarkable agreement in America about what constitutes a good marriage. Bellah and colleagues (1985) described love and marriage as the most important source of meaning in life and individual satisfaction with life. Their respondents reported that self-expression, mutual understanding and emotional closeness characterized good marital relationships. Thus, effective communication is viewed as a key to developing and maintaining a good marriage. There has been very little investigation of the relationship between religiosity and spousal consensus on pertinent relationship issues. While focusing on Fundamentalist Protestants, Snow and Compton (1966) found that “higher ratings of marital satisfaction and satisfaction with communication in the marriage are related to higher self-reported importance of religion for each spouse.”

Communication serves two important functions in marriage. First, love is developed, nurtured and maintained through self-expression and mutual understanding, and which, in turn, can only come through self-expression and mutual understanding, which can only come through effective communication. Second, good communication is necessary to deal with the inevitable

“curve balls” that life inevitably throws. According to Lewis and Spanier (1979) and Sillars and Scott (1983), it is important for couples to establish a common language for communicating about important events and processes in their relationships. In addition, they conclude that the development of a shared reality may be the most crucial element in relationship adjustment. Certainly, an important part of such a shared reality is how couples communicate about religious matters.

Religiosity has been generally viewed as encompassing two broad areas: (1) religious affiliation (e.g., church membership, attendance, involvement in religious activities), and (2) religious beliefs. The focus on this study incorporates both issues in the conceptualization of religiosity. We generally assume that the greater the degree of consensus on religious matters, the greater the degree of consensus in aspects that relate to the marriage. We are further interested in whether religiosity has a similar or different influence on marital adjustment depending on the age of the persons responding. In other words, does age have an effect on the association between religiosity and marital adjustment?

Methods

Research Participants and Procedures

The data for this study were collected from 169 intact married couples (N=338 individuals) selected through a multi-stage sampling procedure in the city of Montgomery, Alabama. First, a twenty percent random sample of the 49 census tracts in the city yielded ten census tracts from which we selected the couples. Second, using the 1997 Polk City Directory, as many as eight streets were randomly selected within each of the tracts. From these streets married couples were identified based on the listings in the City Directory.

The actual number of couples contacted for inclusion in the study was based on the proportionate number of couples within a census tract to the overall number of persons in the ten selected tracts relative to our goal of 175 intact married couples. For example, if Census Tract A had 20% of the total persons in all ten tracts, then 20% of the goal of the 175 intact married couples, (i.e., 35 intact couples) came from Census Tract A.

Each selected couple was first sent a letter explaining the project and that they had been chosen as a possible participant. It was further stated that a member of the research team would be calling them in a few days to talk with them about the project. Upon making telephone contact, the selected couples were asked if they would agree to participate. If they agreed, a package was sent to the couple consisting of two questionnaires - - one labeled "husband" and another labeled "wife." They were instructed to complete the instrument without help from their spouse and return the instrument in the provided stamped and addressed envelope - - a separate one for each spouse. After sending the questionnaire, if it had not been returned within a seven-day period, as many as two follow-up calls were made to encourage completion and return.

The 169 responding couples represent 68% of the 250 couples to whom instruments were actually sent. Of these 169 couples, we received completed instruments from both spouses from 157 couples, i.e., 63% of the total couples to whom instruments were sent. We received 22 responses (5%) from individuals, either husbands or wives, but not both from within a couple who returned the instrument.

The demographic characteristics associated with the people in the ten selected census tracts were quite representative of the city as a whole. As such, it would be expected that the characteristics associated with people in the ten selected census tracts were quite representative,

also. Unfortunately, in several instances, the characteristics of the couples do not reflect the general characteristics of the city population. The couples in this study are somewhat older, there are proportionately more Whites and fewer African Americans; and they are somewhat better educated and have higher incomes.

Instruments

Marital Adjustment, the dependent variable, is measured using the Revised Dyadic Adjustment Scale (Busby, Christenson, Crane & Larson, 1995), which is a revision of a scale developed by Spanier (1976). The scale purportedly identifies three dimensions of marital adjustment: dyadic consensus, dyadic satisfaction and dyadic cohesion. Here, we are using the scale as simply measuring marital, i.e., dyadic, adjustment. Overall, this measure used the combined responses to two sets of items. 1) The first set of items shows the approximate extent of agreement or disagreement between partners within six areas, i.e., religious matters, demonstration of affection, making major decisions, sex relations, conventionality, and career decisions. The coded response categories are: Disagree (1), Occasionally Agree (2), Almost Always Agree (3), and Always Agree (4). 2) The second set of items generally show how often eight particular events occur, e.g., "How often do you and your partner argue?" The coded responses here are: Somewhat (1), Rarely (2), and Never (3). Scores could range from 14 to 84. The Cronbach's coefficient alpha for reliability was .86 for the fourteen items.

Age indicated the chronological age of the respondent. Sex identified the respondents as either Male (0) or female (1). Race was coded as Black (0) or White (1) - - the few nonBlacks and nonwhites were excluded from the analysis.

Educational Background was coded as Less Than High School (1), High School Graduate or GED (2), Some College (3), College Graduate(4), Some Graduate Work (5), Graduate Degree (6). The Annual Income measure consisted also of six categories: Less than \$10,000 (1), \$10,000-19,999 (2), \$20,000-29,999, (3), \$30,000-49,999 (4), \$50,000-79,999 (5), over \$80,000 (6). Length of Marriage was the respondent's indication of the number of years of marriage (converted to months). Times Married indicated the number of marriages of the respondents. Parents Divorced was the respondent's indication of whether his/her parents Are Not (0) or Are (1) divorced. Number of Children from Current Marriage was an indication of the number children these couples had in their current marriage. Rate Health was the respondents' self-assessed health rating of Poor (1), Fair (2), Good (3), or Excellent (4). Religiosity was measured using a 31-item index developed by Faulkner and DeJong (1966) based on the five dimensions of religiosity detailed by Glock (1962). This index included five subscales that consider the ideological, intellectual, ritualistic, experiential and consequential dimensions of the state of being religious. For this study we use the scale as simply measuring religiosity without examining the subscale dimensions. The scores were calculated by summing over the 31 items in the index. Scores could range from 17 to 82 with higher scores indicating greater religiosity. The Cronbach's alpha reliability coefficient for these items was .90.

RESULTS

Descriptive Characteristics of the Sample

Table 1 shows the general characteristics of the sample in three ways: overall, for those less than 65 years of age, and those 65 years of age and older. Overall, the average age of the

sample was around 56 years of age; 50% were male; 72% were white; educationally they, on average, had more than “some college” and their annual income was in the \$30,000-\$40,000 range. Regarding social relationship issues, the respondents had been married for an average of 29.07 years; they had been married 1.24 times; 13% had parents who were divorced; and they had an average of 2.48 children per couple. Their self health rating was in the good to excellent range. The mean score on the religiosity scale of 59.02 shows scores on average were in the upper third of the scale score range - - indicating a moderately high level of expressed religiosity. Similarly, in the moderately high range were the scores on the marital adjustment scale - - again the mean score of 33.08 was in the upper third of the scale scores.

[Table 1 About Here]

Simple ANOVA Results Comparing Those Under 65 and Those 65+

Table 2 shows the simple ANOVA results of whether the difference in the mean scores for each included variable was different for persons under 65 in comparison to those aged 65 and over. The statistically significant results show that those persons 65 and over had: lower income, had been married longer, have been married fewer times, had a lower percentage of parents who were divorced, had more children from their current marriage, had less positive health ratings, had greater feelings of religiosity, and had more positive feelings of marital adjustment.

[Table 2 About Here]

Chi-Square Results

A direct examination of the association between level of religiosity and level of marital adjustment controlling for age is shown in Table 3. It is shown here that the pattern of the association between marital adjustment and religiosity is much the same for those under 65 and those 65 and over: higher (or lower) levels of religiosity is associated with higher (or lower) levels of marital adjustment. The association, however, for those aged 65 and older is stronger and statistically significant, while the association between the two variables for those under age 65 is nonsignificant.

Zero-Order Correlation

Table 4a, 4b and 4c show the zero-order correlation results and number of cases on which subsequent regression analyses were based. With regard to the variables related to marital adjustment, it is shown that using the overall sample (Table 4a), greater scores on marital adjustment is significantly correlated with increasing age, greater annual income, a longer time married and a greater indication of religiosity.

[Tables 4a, 4b, 4c About Here]

When the sample is split into the two age groups, it is seen that among those under 65 years of age (Table 4b), that greater scores on marital adjustment is significantly correlated with

being married only once, having a better self-health rating, and a greater indication of religiosity. For those aged 65 and older, the results show that a greater indication of marital adjustment is significantly correlated only with a greater indication of religiosity (Table 4c). A note must be made here that, while statistical significance is attained, the actual magnitudes of the correlations are low to, at best, moderately low.

Stepwise Multiple Regression Results

Since this is essentially an exploratory analysis, it seems appropriate to utilize an approach that identifies the set of variables that are significantly related to marital adjustment. In this way the variables in the regression equations that are minimally related to the dependent variable are not obscuring the influence of those that are influential.

Table 5a shows, for the overall sample, that greater marital adjustment scores are significantly related to increasing age, greater income and greater religiosity. However, when the sample is split into the two age categories, for those under age 65 (Table 5b) only self-rated health emerges as a significant predictor of marital adjustment. The more positive the self-rated health, the better the sense of marital agreement. For those 65 years of age and older greater marital consensus is significantly related only to higher levels of religiosity (Table 5c).

[Tables 5a, 5b, 5c About Here]

Conclusion

The results here point to a relatively weak, but clear, link between religious commitment, involvement, ideology and related aspects and a greater degree of what has been called here

marital adjustment, especially among older persons. Booth et al. (1995) stated that “social scientists have a long history of research attempting to explain how religious sentiment directs social action” (p. 661). They go on to say that “more recently. . . scholars have questioned religion’s capacity to serve as a socially integrative force in contemporary society” (p. 661).

The results suggest there may be a cohort difference in the way that religion influences marriage. Durkheim (1951), in an extension of his early sociological examination on suicide, emphasized that both religion and marriage are independent integrative forces in the reduction of destructive tendencies, or conversely in the enhancement of constructive tendencies (though this was not tested). Religion as a factor in social integration could influence marital quality on a structural level in that it provides a context within which the marriage or the relationship is defined. The religious context could be the frame on which the marriage as an institution rests. On a social psychological level the religious involvement, used as means for the interpretation of the meaning of life or as a model for behavior, could serve to guide the individual in his or her relationship with the spouse.

Seminal work in the past several decades (D’ Antonio, Newman & Wright, 1982; Thomas, 1988a, 1988b; Thomas & Cornwall, 1990; Thornton, 1985) suggest on a theoretical level that marriage and religion work as both social control and social support mechanisms. Thomas and Cornwall (1990) state: “The social support dimension emphasizes that religion supports family life through norms that encourage love, family solidarity, and marital satisfaction [while] the social control mechanism emphasizes the impact of religion as constraining behavior” (p. 986).

Could it be that the lack of impact of religion on marital adjustment among the younger subgroup in the present study indicates the suspected impact of what many believe is a more secular society? Results for the older subgroup show the weak, but significant, impact of religion on the marital relationship. Perhaps, this may be part of the explanation, but there are other ideas to consider. It could be that those who are older have found that religion is a social institution that contains provisions for a structured life, or religion is a mechanism that provides meaning to life within the context of the relationships one has. Religion is now a more relevant aspect of life. Those who are younger simply do not find the time for, or do not see the current relevance of, religion in the lives they lead.

On a social psychological level another issue is of possible relevance, also. Is communication, and therefore the marriage, influenced by the relevance of religion and religious activities? An interesting study by Snow and Compton suggests that “when religion is important to a spouse, it may affect marital communication by increasing empathy for one’s partner and decreasing hostile communication” (p. 985). Echoing some things stated in the introduction, the development of a shared reality about many aspects of life, including religion, is crucial to a positive marital relationship.

REFERENCES

- Bellah, R., & Madsen, R., & Sullivan, S., & Swidler, A., & Tipton, S. (1985). Habits of the heart: Individualism and commitment in American life. New York: Harper and Row.
- Booth, A. and Johnson, D., and Branamann, A., & Sica, A. (1995) Belief and bahavior: Does religion matter in today's marriage? Journal of Marriage and the Family, 57, 661-673.
- Busby, D., & Christenson, C., & Crane, D., & Larson, J. (1995) A revision of the dyadic adjustment scale for use with distressed and nondistressed couples: Construct hierarchy and multidimensional scales. Journal of Marriage and Family Therapy, 21, 298-308.
- Chi, S.K., & Houseknecht, S.K. (1985) Protestant fundamentalism and marital success: A comparative approach. Sociology and Social Research, 69, 351-373.
- D'Antonio, W.V., & Newman, W.M., & Wright, S.A. (1982) Religion and family life: How social scientists view the relationship. Journal for the Scientific Study of Religion, 21, 218-225.
- Durkheim, E. (1951) Suicide: A study in sociology. New York: Free Press.
- Etheridge, F. M. (1979) Varieties of fundamentalism: A conceptual and empirical analysis of two Protestant denominations. The Sociological Quarterly, 20, 49-48.
- Faulkner, J., & DeJong, G. (1966) Religiosity in 5-D: An empiricial analysis. Social Forces, 45, 246-254.
- Glock, C. (1962) On the study of religious commitment. Religious Education, 57, 98-110.
- Heaton, T., & Cornwall, M. (1989) Religious group variation in the socioeconomic status and family behavior of women. Journal for the Scientific Study of Religion, 28, 283-299.

- Heaton, T. & Pratt, E. L. (1990) The effects of religious homogamy on marital satisfaction and stability. Journal of Family Issues, 11, 191-207.
- Lauer, R. (1995) Social problems. Madison, WI: Brown & Benchmark.
- Lewis, R. A., & Spanier, G.B. (1979) Theorizing about the quality and stability of marriage. In W. H. Burn, R. Hill, F.I. Nye, & I. L. Reiss (eds) Contemporary theories about the family (Vol.1) (pp. 268-294) New York: Free Press.
- Shehan, C. L., & Bock, E. W. (1990) Religious heterogamy, religiosity, and marital happiness: The case of Catholics. Journal of Marriage and the Family. 52, 73-78.
- Sillars, A.L., & Scott, M. D. (1983) Interpersonal perception between intimates. Human Communication Research, 10, 153-176.
- Snow, T.S., & Compton, W.C. (1996) Marital satisfaction and communication in fundamentalist protestant marriages. Psychological Reports, 78, 979-985.
- Spanier, G, B, (1976) Measuring dyadic adjustment: New scales for assessing the quality of marriage and other dyads. Journal of Marriage and the Family, 38, 15-23.
- Thomas, D. L. (1988a) Future prospects for religion and family studies: The Mormon case. In D. L. Thomas (ed). The religion and family connection: Social science perspectives (pp. 357-382) Provo, UT: Religious Studies Center, Brigham Young University.
- Thomas, D.L. (1988b) The religion and family connection: Social science perspectives. Provo, UT: Religious Studies Center, Brigham Young University.
- Thomas, D. L. & Cornwall, M. (1990) Religion and family in the 1980's: Discovery and development. Journal of Marriage and the Family. 52, 983-992.
- Thornton, A. (1985) Reciprocal influences of family and religion in a changing world. Journal of marriage and the Family. 47, 381-397

Table 1. Descriptive Statistics: Overall, <65 years, ≥65 years

Variable	M			SD			N		
	Overall	<65	≥65	Overall	<65	≥65	Overall	<65	≥65
age	56.44	46.40	73.31	15.72	10.22	5.66	335	210	125
sex (M=1)	.50	.53	.45	.50	.50	.50	337	210	125
ethnic (W=1)	.72	.75	.66	.45	.44	5.82	285	182	103
educational background	3.93	4.10	3.63	1.54	1.44	1.65	335	210	125
annual income	3.47	3.63	3.21	1.65	1.60	1.69	320	202	118
how long married (months)	348.82	245.40	522.56	195.41	140.37	146.31	334	209	124
times married	1.24	1.20	1.31	.48	.46	.50	335	210	124
parents divorced	.13	.17	.06	.34	.38	.24	318	204	113
number children current marriage	2.48	2.18	3.04	1.59	1.30	1.9	282	185	97
always had religious preference	.62	.61	.66	.49	.49	.48	327	208	118
rate health	3.07	3.24	2.80	.69	.63	.71	334	210	122
religiosity	59.02	57.97	60.89	9.50	9.93	8.40	237	152	85
marital adjustment	33.08	32.38	34.40	5.64	5.43	5.82	270	177	93

Table 2. Simple ANOVA Results: Comparisons of Means of Included Variables: <65 Years vs ≥ 65 Years.

Variables	M	SD	N	F
Sex (F=1)				
< 65	.53	.50	210	
≥ 65	.45	.50	127	2.01
Race (W=1)				
< 65	.75	.44	182	
≥ 65	.66	.48	103	2.45
Education				
< 65	4.10	1.44	210	
≥ 65	3.63	1.65	125	7.38*
Annual Income				
< 65	3.63	1.60	201	
≥ 65	3.21	1.69	118	4.83*
Months of Marriage				
< 65	245.39	140.37	209	
≥ 65	521.74	146.00	125	294.16*
Number of Marriages				
< 65	1.20	.46	210	
≥ 65	1.32	.50	125	5.33*
Parents Divorced (Y=1)				
< 65	.17	.38	204	
≥ 65	.06	.24	114	7.86*
Number of Children Current Marriage				

	<65	2.18	1.30	185	
	≥65	3.04	1.92	97	19.89*
Subjective Health Rating					
	<65	3.24	.63	210	
	≥65	2.79	.71	124	35.88*
Always Had Current Religions Preference (Y=1)					
	<65	.61	.49	208	
	≥65	.66	.48	119	.19
Religiosity					
	<65	57.97	9.93	152	
	≥65	60.89	8.40	85	464.95*
Marital Adjustment					
	<65	32.38	5.43	177	
	≥65	34.41	5.82	93	249.86*

Table 3. Crosstabular Analysis: Marital Adjustment x Religiosity x Age

	<u>Marital Adjustment</u>	
	Lower	Higher
<u>< 65 Years</u>		
Low Religiosity	53 (63%)	31 (37%)
High Religiosity	28 (47%)	32 (53%)
Total	81 (56%)	63 (44%)
Chi square = 3.84 (1df); p=.05		
<u>≥65 Years</u>		
Low Religiosity	19 (54%)	16 (46%)
High Religiosity	10 (26%)	28 (74%)
Total	29 (40%)	44 (60%)

Chi square=5.95 (1df); p=.02

Table 4a. Correlation Matrix: Overall Sample

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
marital adjustment(1)	-	.18*	-.04	.01	.04	.11*	.17*	-.12*	-.09	.08	.02	.06	.20*
age (2)	270	-	-.12*	-.07	-.10*	-.04	.81*	.16*	-.17*	.23*	.05	-.29*	.02
sex (3)	270	335	-	-.06	-.06	.45*	-.02	-.08	.01	.04	.01	.03	.15*
ethnic (b/w) (4)	253	285	285	-	.07	.16*	-.10	.06	-.01	.12*	-.14*	.06	-.20*
educational background (5)	270	335	335	285	-	.46*	-.13*	-.06	-.07	.01	.07	.21*	-.14*
annual income (6)	258	320	320	272	320	-	.07	-.07	.04	.09	.01	.13*	-.23*
how long married (months) (7)	270	333	334	283	333	318	-	.25*	-.20*	.32*	.10*	-.25*	.09
times married (8)	270	334	335	284	334	319	333	-	.07	-.15	-.02	-.08	-.05

parents divorced (9)	256	317	318	270	317	305	316	317	-	-.07	-.10*	.07	-.13*
number children current marriage(10)	235	282	282	246	282	272	280	281	271	-	-.09	-.02*	.12*
always had religious preference(11)	265	326	327	279	326	312	325	326	310	275	-	-.06	-.05
rate health (12)	269	332	334	283	332	318	331	332	315	279	326	-	.07
religiosity (13)	217	237	237	226	237	230	236	236	226	267	233	237	-

*p<.05

Table 4b. Correlation Matrix: <65 Years

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
marital adjustment (1)	-	.05	-.02	-.04	.11	.11	.08	-.15*	-.08	.08	.04	.23*	.16
age(2)	177	-	-.63	-.09	.08	.14*	.79*	.13*	-.10	.15*	.06	-.07	-.20*
sex (3)	177	210	-	-.03	-.09	-.48*	.07	-.08	.00	.04	-.02	.05	.16*
ethnic (b/w) (4)	174	182	182	-	.18*	.15*	-.11	-.00	-.04	.02	-.14*	.02	-.22*
educational background (5)	177	210	210	182	-	.40*	-.01	-.05	-.14*	.17*	-.16*	.20*	-.09
annual income (6)	170	202	202	175	202	-	.01	-.05	-.12*	-.06	-.01	.12*	-.21*
how long married (months) (7)	177	209	209	181	209	201	-	-.27*	-.14*	.29*	.01	-.06	-.14*
times married (8)	177	210	210	182	210	202	209	-	.09	-.23*	.11	.01	-.02
parents divorced (9)	173	204	204	177	204	196	203	204	-	.03	-.08	.02	-.09
number children current marriage(10)	162	185	185	167	185	179	184	185	181	-	-.14*	.05	.11
always had religious preference(11)	175	208	208	180	208	200	207	208	202	183	-	-.07	-.12
rate health (12)	177	210	210	182	210	202	209	210	204	185	208	-	.11
religiosity (13)	144	152	152	151	152	148	151	152	149	141	150	152	-

*p<.05

Table 4c. Correlation Matrix: > 65 Years

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
marital adjustment (1)	-	.11	-.03	.12	-.00	.15	.06	-.12	-.01	-.05	-.07	-.08	.25*

age (2)	93	-	-.24*	.29	-.09	.06	.14	.09	.12	-.22*	-.13*	-.06	-.10
sex (3)	93	125	-	-.13	-.05	-.44*	.03	.04	-.09	.08	.07	-.05	.17
ethnic (b/w) (4)	79	103	103	-	-.12	.15	.05	-.12	.05	-.29*	-.12	.05	-.15
educational background (5)	93	125	125	103	-	.53*	-.09	-.03	-.01	-.07*	.08	.15	-.15
annual income (6)	88	118	118	97	118	-	-.02	-.05	.08	-.07	.08	.05	-.23*
how long married (months) (7)	93	124	124	102	124	117	-	-.75*	-.09	.05	.22*	-.03	.25*
times married (8)	93	124	124	102	124	117	123	-	.07	-.07	-.24*	-.10	-.20*
parents divorced (9)	83	113	113	93	113	109	112	112	-	-.01	-.14	.02	-.21*
number children current marriage(10)	73	97	97	79	93	96	96	90	-	-.11	.09	.09	.04
always had religious preference(11)	90	118	118	99	118	112	117	117	107	.92	-	-.02	.06
rate health (12)	92	122	122	101	122	116	121	121	110	.94	117	-	.17
religiosity(13)	73	85	85	75	85	82	85	84	77	.66	.83	.85	-

*p<.05

Table 5a. Final Results of Stepwise Regression: Antecedents to Marital Adjustment (Overall)

Variable	Beta(B)	Slope(b)	SE(b)
Age	.177	.064**	.024
Annual Income	.167	.570*	.235
Religiosity	.238	.141***	.041

$R^2=.097$ (df=3, 203; F=7.29***)

p<.02; p,.01; ***p<.001

5b. Final Results of Stepwise Regression: Antecedents to Marital Adjustment (<65 years)

Variable	Beta	Slope(b)	SE(b)
Rate Health	.225	1.949	.716

$R^2=.051$ (df=1,139; F= 7.45**)

*p<.007

Table 5c. Final Results of Stepwise Regression: Antecedents to Marital Adjustment (≥65 years)

Variable	Beta	Slope(b)	SE(b)
Religiosity	.249	.172*	.084

$R^2=.062$ (df=1,64; F=4.22*)

*p<.05

Discussion of “Marital Adjustment and Religiosity”

Julie Hall

Laura Wright

North Georgia College & State University

The purpose of the study under discussion, entitled “Religiosity and Family Cohesiveness Among Older Persons,” is to define the relationship between religiosity and marital satisfaction. With the current divorce rate in the United States standing at 50%, it is of interest to examine the dynamics of marriage and elements that may positively or negatively effect marital longevity. Key variables explored in the study include religious affiliation, communication, and religious beliefs. Previous research has considered the relationship between religiosity and marital happiness. In a study conducted by Shehan and Bock (1990) religiosity was shown to have a significant positive correlation with marital happiness in homogeneous Catholics. However, no other denominations demonstrated a significant relationship between these two variables. Heath and Pratt (1990) found that marriages between persons of similar religious affiliation are more likely to have happy marriages. In contrast, Booth and Johnson (1995) did not find a significant correlation between marital happiness and religiosity. With such conflicting results the study under discussion focuses on the further exploration of cohesiveness of religiosity and its possible relationship to marital satisfaction in a community in Alabama.

The authors’ findings may have a potential impact on the role of the church as a mediator in family situations. This research may also influence the types of services the church offers to couples regardless of denomination in order to promote communication skills and potentially improve marital relationships. For example, the Catholic church advocates that couples married in the church participate in a communication workshop prior to marriage. This provides a possible explanation as to why the homogeneous Catholics in the Shehan and Bock (1990) study demonstrated significantly higher levels of marital satisfaction.

Limitations to the design of the study include questions regarding the validity of the responses to the questionnaire received. Participants were asked to complete questionnaires on religiosity and marital satisfaction independently, without consulting with his or her spouse. It could be argued that couples identified as having greater marital happiness may have completed the questionnaires together thereby biasing the results. Another factor that may have confounded the results was that participants were acting on a voluntary basis. Those who responded to the questionnaire may be more religious and therefore inherently different from those who did not respond. An additional limitation is the questionnaires themselves. Many questions are geared toward Judeo-Christian beliefs and primarily assess knowledge regarding the Bible. The measure of cohesiveness is based on comparing the total scores between spouses and not on individual components that comprise the total score. A comparison of the sub-scale scores within the questionnaire may reveal more specific information regarding the similarities between the spouses ideology of religiosity.

An interesting approach to this type of research study would be to conduct it as a longitudinal study starting with newlyweds to track the change in communication patterns as well as any changes in religious beliefs. The definition of religiosity could also be extended to encompass additional components, including church attendance and denomination. These factors may be related and may possibly be influenced by the couple's belief system. This type of information would provide insight into the evolution of the role the church plays in marital harmony.

In conclusion, the ability to identify factors that predict a good prognosis for a successful marriage may allow for society to intervene as part of pre-counseling. For

marriages that are experiencing difficulties, this research may help to define the role of the church as a mediator.