ATTRITION IN LONGITUDINAL STUDIES USING OLDER ADULTS:

A META-ANALYSIS

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Longitudinal methods have become an improved and essential means of measuring intra-individual change over time. Yet one of the greatest and most hazardous drawbacks studying participants over multiple sessions can be the loss of participants over time. This study attempts to illuminate the problem of attrition in longitudinal research by estimating the mean effect sizes for participant loss across 57 studies published in 13 prestigious journals which regularly use older participants. Results estimate overall attrition to be around 34% of the original sample. The subsequent break down of attrition into its subtypes yield mean effect sizes for attrition due to Refusal (8%), Loss of contact (10%), Illness (6%), and Death (14%) in studies sampling from adults 50 years or older. Analyses were then conducted via meta-analytic one-way ANOVA and weighted regression to identify possible moderators of overall attrition and their four subtypes.

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INTRODUCTION

Longitudinal methods of data collection have arisen as an essential tool for the estimation and analysis of intra-individual change. However, one of the greatest difficulties in conducting studies over long periods of time is the maintenance of subject participation. Often persons are unable to continue in a study do to reasons of death, illness, disinterest, or migratory issues. Within the last three decades it has become well established in the literature that those participants who remain in a study characteristically outperform those who dropout in all areas of biological and cognitive performance; thus effecting both the internal and external validity of the data. Subsequently, this leads to an overrepresentation of the population, and underestimation of age related decline. Also, this issue appears to be particularly relevant for studies which use older adults as participants.

Although attempts have been made by individual researchers to estimate and compensate for the bias due to participant attrition within their individual research, a comprehensive analysis of the appearance and characteristics of longitudinal attrition have yet to be examined.

The goal of this meta-analysis is to provide a comprehensive review of the occurrence and characteristics of attrition in longitudinal studies using older participants in an attempt to illuminate the nature of attrition and provide information that may be used to help address particular factors of methodology, participant characteristics, or general focus of the study where attrition may be more prominent. Also, a comprehensive review may help focus efforts toward over-sampling to compensate for attrition or in the maintenance of subject participation over long periods of time.

STATEMENT OF THE PROBLEM

This study attempts to address the lack of comprehensive knowledge linking various characteristics to the degree of attrition across longitudinal aging studies. While it has become common practice to address attrition effects in individual research, few studies have sought to define the dimensions and characteristics of attrition. Moreover, to this author's knowledge, no one has attempted to identify methodological factors (such as number of test sessions, tests administered, length of test battery, etc.) which could influence the extent of participant attrition.

It was the intention of this study to confirm and extend current findings within individual research studies to a more generalized/global description of attrition and to provide data that would aid researchers by establishing estimates of attrition and recognizing demographic characteristics of the participants, issues of research domain, and methodological factors which may contribute to participant loss.

To solve this problem, a meta-analysis was conducted using longitudinal studies published in thirteen well-established gerontological journals since 1970.

BACKGROUND OF THE STUDY

In longitudinal research studying aging, participant attrition (also termed experimental mortality, or dropout) has become a prime concern not only due to the fact that fewer subjects can weaken statistical power, but because loss of participants in research is anything but random in nature. When the loss of subjects is related to the variables being studied, attrition will often lead to bias in the remaining data. Indeed, researchers have found evidence that data based solely on retest participants is increasingly positively biased and less representative of the original sample or the target population, thus posing an increased threat to internal and external validity of the study (Baltes, Shaie, & Nardi, 1971). For example, Siegler and Botwinick (1997) found that over a twenty-year period, retest participants performed progressively superior in intellectual ability than those who had dropped out over the eleven trials. This led to an overestimation of intellectual ability for the original sample and became a limitation to the generalizability of the findings.

Conversely, there is some evidence which would suggest that while attrition can bias scores when comparing those who dropout to retest participants, the relationships between variables appear to remain stable (Goudy, 1985; Norris, 1987; Streib, 1966). Thus, it would appear that attrition may not be as great a threat when the purpose of the study is correlational in nature (see Weiss (1999) for an analysis of variance test for random attrition).

In the present literature three general areas have been associated with participant loss: (1) characteristics of the participants, (2) issues of research methodology, and (3)

issues of the research domain or general focus. Of these three categories, data comparing characteristics of dropouts to retest participants is the most abundant.

Numerous participant characteristics have been examined in reference to their relationship with experimental mortality. In general, it appears that retest participants outperform dropouts in nearly every area including: health (Hoeymans, Feskens, van Den Bos, & Kromhout, 1998; Markides, Dickson, & Pappas, 1982; Norris, 1985; Powers & Bultena, 1972; Schmidt, Gruman, King, & Wolfson, 2000; Sharma, Tobin, & Brant, 1989; Streib, 1966; Wilson & Webber, 1976), economic resources (Powers & Bultena, 1972; Rabbit, Watson, Donlan, Bent, & McInnis, 1994; van Groenou, Deeg, & Penninx, 2003), and cognitive performance (Cooney, Schaie, & Willis, 1988; Rabbit, Watson, Donlan, Bent, & McInnis, 1994), particularly areas of cognition such as verbal meaning, reasoning, spatial, number, and word fluency (Schaie, Labouvie, & Barrett, 1973). Dropouts tend to be older than retest participants (Markides, Dickson, & Pappas, 1982; Powers & Bultena, 1972; Rabbit, Watson, Donlan, Bent, & McInnis, 1994; Schaie, Labouvie, & Barrett, 1973; Sharma, Tobin, & Brant, 1989; Wilson & Webber, 1976), are more often male (Brayne et al., 1999; Markides, Dickson, & Pappas, 1982; Streib, 1966), are observed to participate less in therapy (Oei & Kazmierczak, 1997) and be less involved with religious institutions (Krause, 1998), to be more likely to express death wishes (Forsell, 2000), exhibit greater behavioral rigidity (Schaie, Labouvie, & Barrett, 1973,) and for older adults especially, tend to be less active and more likely to view themselves as old (Markides, Dickson, & Pappas, 1982). However, retest participants do not appear to differ from dropouts in educational level (Wilson & Webber, 1976), level of depression (Oei & Kazmierczak, 1997), or life satisfaction (Powers & Bultena, 1972).

Moreover, the risk of experimental mortality appears especially high in research sampling from elderly populations (Schaie, Labouvie, & Barrett, 1973).

While the majority of the literature concerning experimental mortality has tended to focus upon comparisons between retest participants and dropouts, there have been a number of studies which have attempted to more fully understand attrition by categorizing participant's reasons for dropping out of the study. Most of the data which exists appear unanimous in their findings. In general participant dropout can be classified either due to refusal, illness, death, or an inability to locate the participant.

Refusers tend to be the most advantaged of all the dropouts (Markides, Dickson, & Pappas, 1982) and to more closely resemble the characteristics and performance of retest participants (Cooney, Schaie, & Willis, 1988; Norris, 1985). Norris (1985) found that older refusers tended to be younger than other dropouts, healthier, and have better quality housing. This has been recently supported by Matthews, Chatfield, Freeman, McCracken, & Brayne (2004) who found higher refusal rates in participants who live in rural centers. Not surprisingly other studies looking at older refusers have found them to be of a higher social class, more socially involved (Markides, Dickson, & Pappas, 1982), less physically frail, more likely to refuse purely due to disinterest (Tennstedt, 1992), and more likely to be female (van Beijsterveldt et al., 2002). Riegel, Riegel, & Meyer (1968) found that refusers had fewer interests, were less active, and more dogmatic than their restest counterparts. Also it has been noted that the largest proportion of attrition due to refusal takes place early in the study, near the second session (Norris, 1985). Deeg, van Tilburg, Smit, & de Leeuw (2002) found evidence in two independent samples of older

adults what suggested requesting participation in a side study increased the risk of refusal at the following follow-up.

Attrition due to loss of contact with the participant may result from any number of reasons. Wilson and Webber (1976) noted that one third of their original sample were unlocatable after nine years. They also found that lost participants were more geographically mobile, more likely to live in trailers or hotels, and to have lower incomes than respondents. Often the most difficult part of keeping track of highly migratory participants involves an increased investment of time and resources from the researchers.

Of all the older participants, those who dropout due to illness or death often perform the lowest (Rabbit, Watson, Donlan, Bent, & Mcinnis, 1994), tend to be older (Norris, 1985; Powers, 1972; Wilson & Webber, 1976), are more often men (Norris, 1985; Wilson & Webber, 1976), and exhibit the lowest levels of health (Norris, 1985; Powers, 1972). Participants dropping out due to illness have reportedly worse health than those dropping out due to death. Also, women in this group tend to be less educated and have fewer social supports (Norris, 1985). Those dropping out due to death before retest have also been found to be less active (Wilson & Webber, 1976), have lower family incomes, are more likely to be widowed, confined to their homes, or unemployed (Powers, 1972), and are most often male (van Beijsterveldt et al., 2002).

Although there appears to be an abundance of work comparing the characteristics of retest participants with dropouts, there remains a dearth of information examining the relationship between research methodology and subsequent attrition. Obviously, such aspects as length of test battery or time between sessions will have some baring on whether or not a participant desires or is able to return for a follow up session. Sharma,

Tobin, and Brant (1989) found that dropouts lived significantly farther from the study center than retest participants and that attrition was much higher if they were recruited into the study by another subject who subsequently dropped out. Also, there is some data to support that attrition in earlier waves may be influenced more by lack of interest (Norris, 1985), while subsequent waves may be influenced more by death and disability (Norris, 1985; Schaie, 1996).

While the above information has been collected by researchers addressing attrition within a particular study, there has yet to be a comprehensive study examining the characteristics of experimental mortality across several longitudinal studies. Consequently, there has not been a comprehensive examination of the effects research domain may have on subject attrition. It would stand to reason that older participants may be more likely to continue to participate in research which matches their interests than research they find boring or tedious. To the author's knowledge, only one article has attempted to address this issue. Cuijpers (1998) conducted a meta-analysis using fourteen studies concerning outreach programs for the depressed elderly. He found that the mean dropout rate for all the studies was 23%, but that cognitive behavioral therapies in particular had significantly higher rates of attrition than other therapies. Cuijpers (1998) also found that group interventions, studies with large samples of female participants, and interventions with several sessions could predict significantly higher degrees of attrition. What's more, these characteristics accounted for 96% of the total variance. However, due to the limited number of studies used and their focus upon interventions with depression, these results may not be generalized to all studies using older participants.

Bias due to experimental mortality has been accepted as a known limitation of longitudinal data. However, some attempts have been made statistically and procedurally in an attempt to compensate for or reduce the influence of attrition. Schaie (1997) notes a number of statistical methods presently used to asses and compensate for experimental mortality. These methods include listwise and pairwise deletions of participants with missing data and the use of algorithms for estimating missing data. Schaie also notes that statistical methods such as means replacement downwardly biases the standard errors and while regression imputation underestimates the variances and standard errors of the data.

Meanwhile, some researchers have had remarkable success adjusting research procedures to address participant attrition. Coen, Patrick, and Shern (1996), although not using an elderly sample, were able to maintain 95% of an original sample of 785 over a five year period by making specific adjustments to office procedures and location techniques. These included, but were not limited to: (1) a purposeful attempt to develop community relations, (2) keeping a log sheet of interactions with the participant, (3) an explanation of the purpose of the study with an emphasis on the subjects importance, (4) hiring part-time research assistance, (5) collecting names and phone numbers of friends or relatives of the participant to be contacted in case the participant could not be found, (6) flexible scheduling, and (7) persistence with 'soft refusals' whereby refusers were asked if they could be contacted again in a matter of weeks. Tennstedt (1992) found that waiting three months to re-contact dropouts allowed time for those suffering from illness to improve in health. This resulted in the retainment of 43% of participants who had initially refused to continue participation. Similar results were found using advanced

tracking means in developing countries where participants were often mobile, can result in an overall reduction of attrition rates by 45% (Hall, 2004).

Other studies have found promising results by keeping the participants informed of the research progress via a news letter and managing contact and scheduling using electronic databases as well as the use of internet based databases for lost participants (Cotter, Burke, Loeber, Judith, & Navratil, 2002). Currently, nearly every major longitudinal study on aging employs the use of internet websites which include contact information for the foundation and/or experimenters (National Institute on Aging, 2005). Some studies, such as the Seattle Longitudinal Study (2005), make use of their website to help locate participants who have moved or changed their name. Markedly lower attrition rates have been reported through enlisting family members for motivational purposes (Rose, 1976), and by providing added comfort for persons with Alzheimer's disease in an attempt to enhance participant comfort (Sharma, 1984).

The main goal of the present study is to provide a more comprehensive description of attrition in research with the elderly. It is hoped that such information may help pinpoint areas of research which may be apt to experience dropout. Moreover, this information may prove extremely significant in helping researchers who wish to employ oversampling techniques to compensate for attrition. However, it should be noted that while oversampling may help compensate for the number of participants lost to attrition dropout, it does not address the bias introduced by differences between retest participants and refusers.

HYPOTHESIS

While the main purpose of this study was to collect descriptive data of the characteristics of subject attrition, it also tested the following hypotheses:

1. Focus of study, participant characteristics, and issues of design will be adequate predictors of attrition rates.
    1-1. An increase in the length of test battery will be associated with greater rates of participant attrition.
    1-2. Longer times between sessions will be associated with greater rates of participant attrition.
    1-3. Larger numbers of test sessions will be associated with greater rates of participant attrition.
    1-4. Higher mean age at the first session will be associated with greater rates of participant attrition.
    1-5. Greater numbers of male participants will be associated with greater rates of participant attrition.
2. Focus of study, participant characteristics, and issues of design will discriminate between the four groups of dropout categories (death, illness, unlocatable, and refusal).

OPERATIONAL DEFINITIONS

For the purpose of this study the major variables will be operationally defined as follows:

Attrition and experimental mortality. These terms are used synonymously as the differential loss of respondents from one test session to the next as defined by Campbell and Stanley (1963).

Dropouts. Those individuals who, for whatever reason, fail to continue participating in the study after the first session. Dropouts will be further divided into four sub-categories:

1. *Refusers*. Those persons who are located and appear to be healthy but no longer wish to participate in the study.
2. *The unlocatable or lost*. Those participants who cannot be located or contact and subsequently are unable to attend the study.
3. *Ill*. Those persons who give illness as their reason for discontinuing participation in the study.
4. *Dead or deceased*. Those persons who have died since the last session.

Length of test battery. This is defined as the estimated time it takes, in minutes, to complete a single study session.

Incentives will be defined as any compensation offered for participation in the research study; monetary or otherwise.

General focus of the study. This is defined as the general category being studied by the longitudinal study (be it cognitive assessment, medical, etc. in nature).

Method of recruitment will be defined as the means by which the researcher acquired the subject population (be it advertisement in the local newspaper, announcement in an aging institution, through government databases, etc).

Special attempts at maintaining participation. This will be operationally defined as any special attempts noted by the authors to locate or retain participants outside of incentives.

METHOD

Criteria for Inclusion

Computer searches for possible articles for inclusion in this meta-analysis were conducted using online search engines available through EBSCOhost. These included AGELINE, MEDLINE, PSYCarticles, The Psychological and Behavior Science Collection, PSYCINFO, AND PsycLIT. Within each of these databases were entered the key term "longitudinal". Searches were narrowed to thirteen prominent journals which regularly publish studies using older populations. These journals included:

Clinical Gerontologist

Death Studies

Developmental Psychology

The Gerontologist

Gerontology

Human Development

International Journal of Aging and Human Development

Journal of Gerontological Nursing

Journal of Gerontological Social Work

Journals of Gerontology A: Biological Sciences and Medical Sciences

Journals of Gerontology B: Psychological and Social Sciences

Omega

Psychology and Aging

Initial searches yielded 786 articles published since 1970 which met the criteria for possible inclusion in the study.

Articles located in the initial searches were selected for inclusion into the study based upon the following criteria: (a) That the study be longitudinal with two or more sessions taking place at least one month apart, (b) the study must include older adults aged 50 or older as well as provide the number of older adults in the first and final sessions (this was necessary to compute the effect size for the meta-analysis), (c) in order to avoid the upward bias introduced by effect sizes based on small subject samples, as identified by Hedges (1981), each study must have a minimum of 30 participants to be included in the meta-analysis.

Criteria for exclusion from the meta-analysis included: (a) Studies which did not differentiate between elderly and younger cohort dropout rates, (b) studies which selectively exclude some participants from later sessions (for example, using only persons who perform in the upper 50 percent of the initial sample), (c) articles published prior to 1970, (d) studies using matched pairs where the second of the pair was excluded if their match dropped out of the study, and (e) studies employing replacement techniques or other procedures which attempt to control for attrition by including new participants to replace dropouts or used estimates for missing data to include participants who had otherwise dropped out were not included in this statistical analysis.

Moreover, in the case of several articles based upon the same sample (such as in national studies like the *Seattle Longitudinal Study*), only one article (the original when possible) was included in this analysis.

Of the 786 articles identified in initial searches, 57 met the above criteria (see Table 1). The majority of articles excluded from this analysis were not included due to the use of young and older (multi-cohort) populations, they verified patient status through records or by means which did not include an interview or effortful investment on the part of the participant, or simply failed to provide the necessary data to estimate a proper effect size (see Table 2 for a detailed breakdown of reasons for study exclusion)

Coding

Each of the 57 studies included in this meta-analysis were coded for the following information: number of participants at the first and last sessions, demographic characteristics of the subjects used (e.g. mean age at first session, mean education at first session, number of males and females, etc.), study focus, whether the participants were drawn from an institutionalized or community dwelling sample, nationality, general self-reports of health, as well as various aspects of methodological characteristics of the study (number of sessions, method of recruitment, location of testing, time between sessions, individual or group sessions, etc.). In addition, all studies were coded for the use of monetary or non-monetary incentives as well as any special attempts to maintain subjects over the course of the study (e.g. reminder postcards, or phone databases which included close friends or family who might know the whereabouts of the participant). For 16 articles, data were available to break down the total attrition into the four subcategories of refusal, lost, illness, and death.

Meta-Analytic Procedures

Procedures established by Lipsey and Wilson (2001) on generating and testing effect sizes yielded from proportional data were employed for this meta-analysis. Effect sizes for overall attrition were calculated for each study by dividing the number of total dropouts by the total number of participants at the first session (which provided a percentage of total dropouts). Subsequently, for the 16 studies which included data on subtypes of attrition, effect sizes were calculated by dividing the number of participants in a single subtype (refusal, lost, illness, or death) by the total number of participants in the first session.

The inverse variance weight was then calculated for each effect size using Microsoft Excel and then verified by hand. Inverse variance weights are employed by Lipsey and Wilson (2001) as opposed to the standard error, because sampling error is smaller for effect sizes estimated from large samples while a larger standard error corresponds to a less precise effect size. In this way, studies using larger samples are weighted in order to exude greater influence over statistical results than studies with smaller samples.

Meta-analytic statistics were computed using macros provided by Lipsey and Wilson (2001) for the statistical software SPSS. These macros were used because, although most statistical software programs are able to accurately fit the regression model (i.e., the regression coefficients, betas, R^2, etc.), the standard errors must be adjusted to yield correct assessments of statistical significance. This included estimates for the mean effect size, one-way ANOVA, and modified weighted multiple regression.

RESULTS

Overall Attrition Effect Size

Results from effects sizes in relation to total attrition rate are presented in three sections: (1) descriptive statistics for study characteristics, (2) effect size analysis, and (3) analysis of moderating variables on effect size.

Descriptive Statistics for Study Characteristics

The 57 studies involved a total of 41,876 older adults (minimum = 37; maximum = 12,939). Out of the 13 journals from which potential articles were drawn, 3 did not provide studies which met the criteria for inclusion in the analysis (*Human Development, The Journal of Gerontological Nursing,* and *Death Studies*). Of the remaining 10 journals the average number of studies yielded per journal was 7.5 (SD = 3.8). The range of publication dates for the studies was from 1975 to 2004 with over half of the studies published after 1993 (n = 35, 61.4%). A great majority of the study topics were psychological in focus with only 10.5% having a focus purely on medical or other topics. The number of sessions per study ranged from 2 to 8 with over half comprising two sessions (n = 35, 57.9%).

Effect Size Analysis

A random effects model of analysis was used for the 57 total attrition effect sizes. Initial investigations revealed considerable heterogeneity in the variance of effect sizes ($Q(61) = 8106.26$, $p<.0001$). Use of a random effects model assumes that each effect size differs from the population mean by both subject-level sampling error and a second

component associated with random effects variance. The difficulty, however, is obtaining a good estimate of the random effects variance component. For the purpose of this study, the iterative method based on maximum likelihood was used to estimate random variance, as recommended by Raudenbush (1994) for its ability to provide more accurate estimates. The overall mean effect size for the 57 studies was 34% (d = .332). This effect was estimated to be between .2917 and .3947 at the 95% confidence level, and indicates that the effect size is not equal to zero.

Analysis of Moderating Variables

Categorical moderators. Nine categorical variables were analyzed for possible moderator effects on the overall attrition effect size. Of these 10 variables five were not found to significantly differ among groups (study focus, institutionalized vs. community dwelling samples, nationality, group vs. individual research sessions, and method of recruitment).

Fifteen studies provided clear data rating the health of their sample as either healthy (n = 6) or unhealthy (n = 8). Effects sizes for the two groups were d = .1820 and .3627, respectively. A Chi-square test indicated that the difference between the two effect sizes was significant ($Q(1) = 5.690$, p = .0171). Thus, it would appear based on these 15 studies that attrition rates are significantly lower for studies using healthier older adults. This makes perfect sense in light that two of the four subtypes of attrition (illness and death) are inherently related to participant health.

Number of test session per study was analyzed for moderating effects on overall attrition rate. Initially six groups were coded. However, due to a limited number of cases, the latter three groups were collapsed into a single group which included studies with 5 to

8 sessions. An ANOVA was run using the 4 groups; those with two sessions (n = 33), three sessions (n = 16), four sessions (n = 6) and five or more sessions (n = 2). Effect sizes for the four groups were d = .3192, .4311, .1921, and .4833, respectively. Results of the analysis indicated that the groups did significantly differ ($Q(2) = 10.21$, $p = .0139$). Subsequent analysis combining data from the 4 and 5 or more sessions groups neared statistical difference ($Q(2) = 2.708$, $p = .076$) with the effect size of the combined 4+ sessions group averaging $d = .2651$.

The use of incentives (monetary or otherwise) was analyzed for moderating effects on overall attrition rate. Analysis revealed that studies which include incentives (n = 8) had a lower level of overall attrition ($d = .1893$) than those which did not (n = 48, $d = .3648$). These differences were also found to be statistically significant ($Q(1) = 6.5101$, $p = .0107$).

Next, special attempts to maintain individual participation in a study were analyzed for possible moderating effects. Analysis revealed that those studies which did not implement attempts to maintain study participants (n = 51, $\underline{d}$ =.359) neared significantly different effect sizes ($Q(1) = 2.8209$, $p = .0681$) than those who did (n = 6, $d = .2171$). These results suggest there may be reason to more closely examine maintenance attempts and their moderating effect on overall attrition rates.

Continuous moderators. Seven continuous variables were examined by means of statistical regression for their possible moderating effects on overall attrition effect sizes. Of these, the mean age of participants, the mean education level, the number of males at the first session, number of females at the first session, the length of the test battery, and initial response rate all failed as significant predictors of the overall rate of attrition.

Fifty-four studies provided information on the time between sessions. During coding in cases where times were inconsistent between three or more sessions, an average was taken across times. Weighted regression revealed that time between sessions was a significant predictor of overall attrition effect size ($Q(1) = 18.9597$, $p < .0001$), accounting for 26% of the variance. This variable was then converted into a categorical variable in order to analyze possible directional trends in the effect size. Within this new variable the three groups were: (a) studies with 2 to 12 months between sessions (n = 21 $d = .2839$), (b) studies with 13 to 24 months between sessions (n = 12, $d = .2796$), and (c) studies with 25 or more months between sessions (n = 21, $d = .4382$). A Chi-square test revealed the three groups to be significantly different ($Q(2) = 10.2104$, $p = .0061$). However, no clear trend is evident, although the results suggest that studies with more than 2 years between sessions have an increased risk of participant attrition.

Attrition Subtype Effect Sizes

Of the 57 articles included in this study, 16 broke down the overall attrition into the four subcategories of refusal, lost, illness, and death. Effect sizes and inverse variance weights based upon the total number of participants at the first session were calculated for each of these subtypes as well as tests for possible moderators. It should be noted however that the results from these few studies may not generalize well to the 57 studies included in the overall attrition effect size estimates. However, for the sake of shedding some light on the relation of demographic and methodological factors with attrition subtypes, meta-analytic procedures were conducted on the select 16. Crosstabulations and

Chi-square test of independence were used in comparing the 41 studies which did not break down attrition into subtypes to the 16 that did. The results suggest that the two groups did not differ significantly on characteristics such as rate of overall attrition ($X^2(37) = 39.0$, $p = .801$) study focus ($X^2(4) = 4.644$, $p = .326$), number of subjects at the first session ($X^2(38) = .390$, $p = .425$), Mean age ($X^2(6) = 5.867$, $p = .974$), mean level of education (X^2 (6) = 7, p = .90), institutionalized vs. community dwelling samples (X^2 (2) = 3.19, $p = .204$), number of test session ($X^2(3) = .919$, $p = .821$), or time between sessions ($X^2(16) = 15.963$, $p = .456$).

Effect Size Analysis

Refusal. A mean effect size was calculated for the proportion of dropouts lost due to refusal. Initial tests revealed the variance of the effect sizes to be considerably heterogeneous ($Q(14) = 136.40$, $p < .0001$) and subsequent analysis were conducted using a random effects model. The overall effect size for participants who dropped out due to refusal was 8% ($d = .0857$). This effect was estimated to be between .0655 and .1059 at the 95% confidence interval.

Lost. Of the 12 studies which broke down attrition into the four subtypes, 14 reported the number of dropouts due to participants who could no longer be contacted. For these thirteen a mean effect size of 10% ($d = .0990$) was calculated for the proportion of participants overall lost during the course of a longitudinal study. This effect size was estimated to be between .0668 and .1312 at the 95% confidence level. The variance of the effects sizes appeared heterogeneous ($Q(11) = 197.0778$, $p < .0001$).

Illness. A mean effect size was calculated for the proportion of dropouts due to illness but not death. Only seven studies provided data on this attrition subtype. The

results, therefore, must be viewed with caution as they may not generalize to even the 16 studies which broke down attrition into subtypes. The mean effect size for participant attrition due to illness was estimated to be 6% (d = .0612), with effects sizes falling between .0265 and .0960 at the 95% confidence level. The mean effect size variance was found to be heterogeneous ($Q(6) = 123.3101$, $p < .0001$).

Dead. Of the subtypes reported but not included in this analysis, the proportion dead was noted most often by the author during coding. Data on the number of participants was available for all 16 studies. Analysis yielded an overall mean effect size of 14% (d = .1417) of the participants at the first session dropping out due to death. This effect was estimated to be between .0994 and .1840 at the 95% confidence level. The mean effect size was found to be heterogeneous ($Q(15) = 1750.5834$, $p <.0001$) and a random effects model was used in all subsequent analysis based upon this effect size.

Analysis of Moderating Variables

Nine categorical variables (study focus, institutional or community sample type, number of sessions, group or individual sessions, use of incentives, location, and attempts to maintain participants) were examined by means of a one-way ANOVA to test for possible moderating effects on each of the attrition subtype effect sizes. Within the analysis each of the categorical variables were used as the independent variable and tested for their moderating effects on the dependent variable (effect sizes for the four attrition subtypes). Thus, thirty-six individual one-way ANOVAs were tested for significance.

Nine continuous variables were also examined (number of subjects at the first session, mean age at first session, mean education at first session, number of males at the

first session, number of females at the first session, the length of the test battery in minutes, the time between test sessions, number of test sessions, and the percentage of initial response). In most every case, across all four subtypes of attrition, the majority of demographic and methodological variables were non-significant. What follows are those moderating variables which reached statistical significance.

Attrition due to refusal. Based upon fifteen studies which reported the proportion of attrition lost to participant refusal, data suggested that the use of incentives could have a possible moderating effect on refusal effect size ($Q(1) = 4.6948$, $p = .0303$), with those studies implementing incentives having greater attrition due to refusal (n = 3, $d = .1324$) than those studies which did not (n = 12, $d = 0740$).

After the variable for study focus was condensed into three categories (general psychological, cognitive psychological, and medical oriented), significant differences were discovered between the newly coded three groups ($Q(7) = 3.6655$, $p = .0316$) with general psychological focus (n = 8, $d = .0711$) and medical (n = 2, $d = .0590$) having significantly lower rates of attrition due to refusal than those with a cognitive psychological focus (n = 5, $d = .1240$).

Due to a limited number of cases per each group, test location was recoded into a dichotomous variable. The new groups were: (a) those participants who were assessed in their homes (n = 4, $d = .0787$), and (b) those participants who were assessed in places other than their homes (n = 3, $d = .1328$). A Chi-square test for independence resulted in a significant result suggesting that these two groups were significantly different ($Q(1) = 6.1684$, $p = .0130$).

Lost and ill attrition subtypes. Based upon 12 studies, possible moderating effects on participant dropout due to loss of contact or illness were examined. None of these variables yielding significant results. Such moderating variables may well exist, however they were not coded within this study.

Attrition due to death. Analysis were run on the 16 studies which included the proportion of participants lost to death. The only variable to yield significant results was the time between studies ($Q(1) = 13.9761$, $p < .0005$). A weighted regression revealed that 46% of the total variance in attrition due to death could be accounted for by the number of months between the initial and latest session. This variable was then recoded into a categorical variable for direction and trend analysis. Within the categorical variable were three groups: (1) studies with 2 to 12 months between sessions (n = 3, $d = .0227$), (2) studies with 13 to 24 months between sessions (n = 3, $d = .2103$), and (3) studies with 25 or more months between sessions (n = 10, $d = .1605$). A Chi-square test revealed the three groups to be significantly different ($Q(2) = 4.0588$, $p = .0131$), however no clear trend or could be ascertained from these results.

DISCUSSION

What can be concluded from this meta-analysis is that attrition is indeed a sizable drawback to the study of older aged participants over time. Estimates based upon the 57 longitudinal studies included in this analysis suggest that on average 34% of the initial sample will be lost by the time of the studies conclusion. This average is somewhat larger than that found by Cuijpers (1998). However it should be noted that Cuijpers' meta-analysis was conducted using 14 studies, whereas my mean effect size has been based on 57 studies published over the past thirty-five years.

Moreover, attrition rates appear to vary considerably from study to study. My analysis suggests that this variability is non-random. In order to illuminate those factors which could possibly moderate participant dropout this study examined several demographic and methodological variables for their possible influence on overall attrition rates.

Results from this meta-analysis support results found by previous researchers. This study found the level of participant education to be a non-significant predictor of the overall attrition rate; results previously observed by Wislon and Webber (1976). Sharma, Tobin, and Brant (1989) note that distance from test location is significantly related to participant dropout, while this study also suggests that research conducted in the participants home, where distance is not an issue for the participant, has markedly lower levels of overall attrition.

Conclusions can also be made from this study which contradict findings found by other researchers. Results from this analysis suggest that age is not a significant factor for attrition rates while several studies have shown that dropouts are often older than participants who remain in the study (Rabbit et al., 1994; Schaie, Labouvie, & Barrett, 1973).

Norris (1985) and Schaie (1996) report that death and illness become increasing influential on rate of dropout as a longitudinal study moves into subsequent waves. In support of these findings this study found the number of sessions to be a significant moderator of overall attrition, though a clear trend was not established. However, an earlier meta-analysis conducted by Cuijpers (1998) has established this trend. Also, in support of the role illness and death play as two of the four subtypes of attrition, this analysis found that studies using older participants rated as healthy showed significantly less overall attrition.

This analysis also has found evidence to support those researchers whose individual studies appear to have retained more older adults due to special attempts to maintain participation (Coen, Patrick & Shern, 1996; Rose, 1976; Tennstedt, 1992). Maintenance techniques such as reminder postcards and phone calls neared significance at having a moderating effect on overall attrition. Evidence that detailed contact information, incentives for participation, and postcard/telephone reminders help to reduce participant dropout have been found with adolescent samples (Boys, Mardsden, Stillwell, Hatchings, Griffiths, & Farrell, 2003). Future research should more closely examine the influence maintenance procedures may have in retaining older participants who would otherwise dropout from the study, nullifying their contribution.

Moreover, the inclusion of incentives for older participants appears to lesson the overall proportion of participants lost due to dropout. The author suggests that though monetary incentives for amounts of $10 or $20 may not have a motivating influence on older adults already retired or economically secure, the symbol of appreciation from the researcher may be incentives greatest contribution.

Additionally, results from this meta-analysis suggest that the interval of months between sessions has a significant moderating effect on rate of attrition. In particular, sessions between which two or more years have passed are likely to experience markedly greater overall attrition than those which meet once a year or every few months. Researchers planning longitudinal studies may want to take into consideration that a larger sample is necessary if research sessions intervals are greater than one year apart.

Attempts were also made to break down and establish mean rates of attrition for subject loss due to *Refusal* (8%), *Loss of contact* (10%), *Illness* (6%) and *Death* (14%). To the author's knowledge, no prior research has attempted to make these estimates at a meta-analytic level. While the apparent greatest source of attrition (death) lies well out of the hands of researchers, the second most contributing cause of dropout (loss of contact) is much more within their control. Further focus should be given to procedures which effectively encourage the maintenance of participants over time.

Data from this meta-analysis also suggest that the use of incentives may, in fact, be counter productive in maintaining participants who lean toward dropping out of the study due to refusal. These findings are in direct contrast to the overall attrition results which suggest that incentives may help to reduce overall attrition. Perhaps the moderating effect incentives exert is unique to the refusal subtype who is known to be

more financially stable and more active to their dropout counterparts. It is also possible that, for participants who are already leaning toward refusal, the offering of monetary or other incentives may be interpreted as coercion on the part of the researcher.

Moreover, it is suggested that such methodological factors as the use of incentives, and the administration of assessments in the participants homes could help to reduce participant loss after the initial session. Also, these findings may help in alerting those researchers conducting studies with a cognitive psychological focus to prepare for greater refusal rates than that of general psychological or medical studies. This was more clearly identified by Cuijpers (1998); as his meta-analysis noted that cognitive assessments tend to increase the overall participant dropout rate.

This analysis did not find, however, any significantly moderators for the dropout rates related to lost to ill participants. However, due to the considerable variability of scores within these two groups, it is suggested by the author that moderators do exist but were not assessed within this analysis. Further research should be conducted in order to account for some of this within-group heterogeneity.

ASSUMPTIONS AND LIMITATIONS

Within this study, it is possible that some participants may have given illness as their reason for dropping out when, in fact, they did not wish to continue for other reasons, such as disinterest. It was therefore assumed that all participants, when giving reasons for dropout, where sincere with their explanations.

While attempts have been made to be relatively inclusive in the breadth of aging related journals used for the meta-analysis, the researcher has limited himself to journals which are more easily found in the University of North Texas campus library. Therefore, a possible limitation of this study lies in the selectivity of these journals and their generalizability to all longitudinal studies conducted in the last thirty years. Also, these are generally considered prestigious journals and perhaps underestimate the overall effect size for all journals.

Moreover, since the articles included in this study were selected based on their use of older adults, the results may not generalize well to all age groups. Indeed, Schaie, Labouvie, and Barrett (1973) found that older adults had a significantly greater degree of attrition than younger participants. One should take caution when attempting to generalize these results onto other age cohorts.

One of the possible drawbacks for a Meta-analytical study is significance testing (The File Drawer Problem) (Anderson, 1999; Gliner & Morgan, 2000). It has been well documented that if only studies yielding significant results get published, then the data collected using these articles may be biased. Although the outcomes of the research articles included in this meta-analysis are inconsequential when looking at attrition rates,

it is possible that studies which experienced an extreme amount of attrition may have failed to render significant results or get published due to a small sample size. Consequently, one possible limitation of a meta-analysis on attrition could be an underestimation of participant loss.

Table 1

Meta-Analysis Studies

Authors	Title	Effect Size	*n*
Adams (1987)	Patterns of network change: A longitudinal study of friendships of elderly women.	.400	70
Agren (1998)	Life at 85 and 92: A qualitative longitudinal study of how the oldest old experience and adjust to the increasing uncertainty of existence.	.682	129
Arbuckle, Nohara-LeClair & Pushkar (2000)	Effect of off-target verbosity on communication efficiency in a referential communication task.	.411	336
Baarsen, van Duijin, Smit, Snijders, & Knipscheer (2001-2002)	Patterns of adjustment to partner loss in old age: The widowhood adaptation & longitudinal study.	.586	239
Baur & Okun (1983)	Stability of life satisfaction in late life.	.171	105
Benyamini, Idler, Leventhal, & Leventhal	Positive affect and function as influences on self-assessments of health: Expanding our view beyond illness and disability.	.383	851
Binjnen, Feskens, Caspersen, Mosterd & Kromhout (1998)	Age, period, and cohort effects on physical activity among elderly men during 10 years of follow up: The Zutphen elderly study.	.674	939
Bultena & Powers (1978)	Denial of aging: Age identification and reference group orientations.	.615	611
Chapman, Han & Pearlman (1996)	Longitudinal assessment of the nutritional status of elderly veterans.	.303	300
Cheung & Ngan (2000)	Contributions of volunteer networking to isolated seniors in Hong Kong.	.101	139
Chou & Chi (2000)	Stressful events and depressive symptoms among old women and men: A longitudinal study.	.531	554

(table continues)

Table 1 *(continued).*

Authors	Title	Effect Size	*n*
Cohen, Teresi & Holmes (1985)	Social networks and adaptation.	.174	161
Cutler (1975)	Transportation and changes in life satisfaction.	.388	170
Desrosiers, Hebert, Bravo & Rochette (1998)	Comparison of cross-sectional and longitudinal designs in the study of aging of upper extremity performance.	.267	360
Falvo & Norman (2004)	Never too old to learn: The impact of an HIV/AIDS education program on older adults' knowledge.	.150	40
Fernandez, Mutran, Reitzer & Sudha (1998)	Ethnicity, gender, and depressive symptoms in older workers.	.082	826
Ferraro (2003)	Psychological resilience in older adults following the 1997 flood.	.030	37
Fine & Tangeman (1993)	Adaptive behavior scale predictive validity with elderly male veterans.	.442	120
Gall, Evans & Howard (1997)	The retirement adjustment process: Changes in the well-being of male retirees across time.	.478	224
Gill, Williams, Richardson & Tinetti (1996)	Impairments in physical performance and cognitive status as predisposing factors for functional dependence among nondisabled older persons.	.180	945
Gold & Arbuckle (1995)	A longitudinal study of off-target verbosity.	.146	205
Graney (1975)	Happiness and social participation in aging.	.233	60
Holahan & Holahan (1987)	Self-efficacy, social support, and depression in aging: A longitudinal analysis.	.187	64

(table continues)

Table 1 *(continued).*

Authors	Title	Effect Size	*n*
Hultsch, Hertzog, Small & Dixon (1999)	Use it or lose it: Engaged lifestyle as a buffer of cognitive decline in aging?	.487	487
Hultsch, Hertzog, Small, McDonald-Miszczak & Dixon (1992)	Short-term longitudinal change in cognitive performance in later life.	.386	484
Hyduk (1996)	The dynamic relationship between social support and health in older adults: Assessment implications.	.595	1598
Janevic, Janz, Dodge, Wang, Lin & Clark (2004)	Longitudinal effects of social support on the health and functioning of older women with heart disease.	.163	570
Krause (1987)	Chronic strain, locus of control, and distress in older adults.	.245	351
Krause (1990)	Perceived health problems, formal/informal support, and life satisfaction among older adults.	.380	1831
Lachman (1983)	Perceptions of intellectual aging: Antecedent or consequence of intellectual functioning?	.208	96
Lachman & Leff (1989)	Perceived control and intellectual functioning in the elderly: A 5-year longitudinal study.	.594	106
Lee & Markides (1990)	Activity and mortality among aged persons over an eight-year period.	.500	508
Liu, Liang, Muramatsu & Sugisawa (1995)	Transitions in functional status and active life expectancy among older people in Japan.	.171	2200
Markides, Levin & Ray (1987)	Religion, aging, and life satisfaction: An eight-year, three-wave longitudinal study.	.503	511

(table continues)

Table 1 (continued).

Authors	Title	Effect Size	*n*
McAvay, Seeman & Rodin(1996)	A longitudinal study of change in domain-specific self-efficacy among older adults.	.114	264
McCulloch (1991)	A longitudinal investigation of the factor structure of subjective well-being: The case Of the Philadelphia geriatric center morale scale.	.533	418
Meeks, Murrell, & Mehl (2000)	Longitudinal relationships between depressive symptoms and health in normal older and middle-aged adults.	.495	2931
Mossey, Knott & Craik (1990)	The effects of persistent depressive symptoms on hip fracture recovery.	.105	219
Newsom, Nishishiba, Morgan & Rook (2003)	The relative importance of three domains of positive and negative social exchanges: A Longitudinal model with comparable measures.	.230	200
Nuttman-Shwartz (2004)	Like a high wave: Adjustment to retirement.	.071	56
Ostir, Ottenbacker & Markides (2004)	Onset of frailty in older adults and the protective role of positive affect.	.448	3050
Parmelee, Katz & Lawton (1992)	Incidence of depression in long-term care settings.	.484	868
Parmelee, Kleban, Lawton & Katz (1991)	Depression and cognitive change among institutionalized aged.	.798	995
Reinhardt, Boerner & Benn (2003)	Predicting individual change in support over time among chronically impaired older adults.	.451	570
Richardson & Kilty (1991)	Adjustment to retirement: Continuity vs. discontinuity.	.112	250

(table continues)

Table 1 *(continued).*

Authors	Title	Effect Size	*n*
Roberson & Lichtenberg (2003)	Depression, social support, and functional abilities: Longitudinal findings.	.319	47
Russell & Cutrona (1991)	Social support, stress, and depressive symptoms among the elderly: Test of a process model.	.056	301
Schofield & Mishra	Validity of self-report screening scale for elder abuse: Women's health Australia study.	.195	12939
Shaw & Krause (2002)	The impact of salient role stress on trajectories of health in late life among survivors of a seven-year panel study.	.519	1103
Smider, Essex & Ryff (1996)	Adaptation to community relocation: The interactive influence of psychological resources and contextual factors.	.019	104
Smith, Petersen, Ivnik Malek & Tangalos (1996)	Subjective memory complaints, psychological distress, and longitudinal change in objective memory performance.	.292	397
Taylor, Miller, & Tinklenberg (1992)	Correlates of memory decline: A 4-year longitudinal study of older adults with memory complaints.	.250	43
Tesch, Nehrke & Whitbourne (1989)	Social relationships, psychosocial adaptation, and intrainstitutional relocation of elderly men.	.556	54
Thompson, Gallagher-Thompson, Futterman, Gilewski & Peterson (1991)	The effects of late-life spousal bereavement over a 30-month interval.	.401	374
Troll & Skaff (1997)	Perceived continuity of self in very old age.	.375	144

(table continues)

Table 1 *(continued).*

Authors	Title	Effect Size	*n*
Williamson & Schulz (1995)	Activity restriction mediates the association between pain and depressed affect: A Study of younger and older adult cancer patients.	.417	132
Zarit, Griffiths & Berg (2004)	Pain perceptions of the oldest old: A longitudinal study.	.480	190

Table 2

Reasons for Study Exclusion

Category	%	*n*
Participants under age 50 /Multi-cohort study	34.6	272
No attrition data provided /Review or commentary /Non-longitudinal data	17.1	134
Used replacement techniques	12.7	99
Data provided by caregiver, family /By proxy /Census data or death certificates	12.1	95
Paired/Twin study	4.8	38
Earlier article existed /Multiple articles from 1 sample	4.4	35
Other/ unique reasons	3.2	25
Dementia sample	2.9	23
Non-human sample	2.3	18
Small sample (n < 30)	2.1	16
Attrition data appeared in error	1.7	13
Treatment Study	1.4	11
Article unattainable	1.1	7

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