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Successful Aging in the Australian Longitudinal Study of Aging: Applying the MacArthur Model Cross-Nationally

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Wide variation in the experience of aging is increasingly recognized and models for identifying groups based on how "successfully" individuals are aging have taken many forms. This study used the criteria developed in the MacArthur studies on successful aging to identify subgroups with higher, intermediate, or lower levels of function, and to compare them across a range of other domains. Data were drawn from the Australian Longitudinal Study of Aging (ALSA) in Adelaide, Australia, which is a population-based, bio-psycho-social study of a cohort of 1947 adults aged 70 years or more. Six waves have been conducted, between 1992 and 2000. At waves 1 and 3, an extensive personal interview and self-complete questionnaires were administered and objective physical and psychological functioning assessed. Eight-year mortality was also examined. Results showed risk and protective effects of successful aging for physical functioning and performance, lifestyle, cognition, affect, and personality. The findings confirm that people age with differing degrees of success and those aging most successfully not only live longer, but also experience a better quality of life. The MacArthur model proved useful for this cross-national comparison of determinants and outcomes of "successful" aging.

The order of authorship is alphabetical. Correspondence concerning this article should be addressed to Mary Luszcz, School of Psychology, Flinders University, GPO Box 2100, Adelaide, South Australia 5001 Australia [e-mail: mary.luszcz@flinders.edu.au]. An early version of this work was presented at a symposium during the International Association of Gerontology's World Congress of Gerontology, 1997. We gratefully acknowledge the time that participants have freely devoted to this project over the years and the work of other staff members of the Centre for Aging Studies, particularly Lynne Giles, Louise Mawby, and Sabine Schreiber. Lynne Cobiac, CSIRO Division of Human Nutrition, Adelaide, contributed to earlier work. The late George Myers, Center for Demographic Studies, Duke University, provided useful advice and encouragement throughout. Waves 1 to 4 of ALSA were funded in part by a grant from the US National Institutes of Health (NIA grant AG 08523-02), by the Health Commission of South Australia, the Australian Rotary Health Research Fund, the Sandoz Foundation for Gerontological Research, and Flinders University.

Wide variation in the experience of aging has increasingly been recognized and has led to more attention being paid to so-called active, healthy, robust, positive, or successful aging (Rowe & Kahn, 1987, 1998). Several studies have sought to identify subgroups of older people in the population that exhibit minimal functional limitations, using a variety of approaches (Berkman et al., 1993; Garfein & Herzog, 1995; Guralnik & Kaplan, 1989; Harris, Kovar, Suzman, Kleinman, & Feldman, 1989; Jorm et al., 1998; Strawbridge, Cohen, Shema, & Kaplan, 1996; Suzman, Harris, Hadley, Kovar, & Weindruch, 1992). Prominent among these approaches is the MacArthur study of successful aging in the United States, first reported by Berkman et al. (1993). The MacArthur studies aimed to identify, within a population-based 70–79 years of age cohort of men and women, a subgroup with higher levels of physical and cognitive function, and to compare their characteristics in a range of domains with those of subgroups defined as functioning at intermediate and lower levels, respectively.

The MacArthur studies examined data drawn from three community-based populations (East Boston, MA, New Haven, CT, and Durham County, NC) within the Established Populations for the Epidemiologic Studies of the Elderly cohorts (EPESE; Cornoni-Huntley et al., 1993). High, medium, and low functioning subgroups were defined according to predetermined criteria of physical and cognitive function, and significant differences were identified among these three subgroups in biomedical, physiological, psychological, and social functioning (Berkman et al., 1993). Subsequent MacArthur studies have confirmed and substantially extended these findings (e.g., Cook et al., 1995; Glass, Seeman, Herzog, Kahn, & Berkman, 1995; Guralnik, Seeman, Tinetti, Nevitt, & Berkman, 1994; Inouye, Albert, Mohs, Sun, & Berkman, 1993; Seeman et al., 1994, 1995; Seeman, Bruce, & McAvay, 1996; Seeman, Singer, Rowe, Horwitz, & McEwen, 1997; Seeman, Unger, McAvay, & Mendes de Leon, 1999; Wallsten et al., 1995).

Participants in the MacArthur studies have all lived on the eastern seaboard of the United States. We know of only one Australian study (Jorm et al., 1998) that has addressed the issue of the prevalence of successful aging and factors associated with it. Consistent with the MacArthur studies, they used both physical and cognitive criteria to distinguish *successful* from *usual* aging. However, the authors acknowledged that the criteria they applied were arbitrary. This same attribution could be made of the MacArthur criteria; nonetheless, the question of the extent to which these more widely used criteria apply beyond the east coast of the United States remains unanswered. Given the ubiquity of population aging worldwide, cross-national comparisons provide converging evidence for ways of aging well.

The present study is based on data collected across multidimensional domains analogous to that in the EPESE, from the Australian Longitudinal Study of Aging (ALSA). Hence it was not only feasible to attempt to apply the McArthur model, but, also, doing so would afford the opportunity to evaluate its usefulness in a Western nation geographically and culturally removed from the United States.

ALSA is a population-based, bio-psycho-social and behavioral study of a cohort of 1,947 adults aged 70 years or older living in Adelaide, South Australia. We applied the MacArthur criteria (with minor variations in operationalization) at baseline data to identify higher, intermediate, and lower functioning subgroups. We then examined the consequences of these classifications for bio-psycho-social health, lifestyle, activity, and mortality patterns.

The work reported by Berkman et al. (1993), other MacArthur studies and Jorm et al. (1998) was extended in a number of ways. While the MacArthur studies focused specifically on people aged 70 to 79 years, one aim of the present study was to apply the criteria to individuals spanning the entire period from age 70 onwards. Jorm et al.'s work demonstrated substantial declines in the prevalence of successful aging after the age of 79. Our first aim was to determine whether the MacArthur definition of successful aging continued to be appropriate for the oldest old and for a cohort of elderly Australians. Secondly, the Berkman et al. study was essentially descriptive and reported a univariate approach to identify variables that distinguished among differently aging groups. The present study begins with a similar approach, to enable as direct a comparison as possible, but our analysis then extends to incorporate a multivariate dimension. This addresses our further aim of determining variables that might constitute key risk or protective factors for successful aging, not only of basic demographic characteristics, but also of related variables in the same domain. Thirdly, when Jorm et al. adopted such an approach, they found that verbal intelligence was the only variable that constituted a protective factor for successful aging in both men and women. For women, lower neuroticism and not smoking were also associated with successful aging. Our multivariate study looks at a range of additional objective physical and cognitive indicators.

The study includes a focus on psychological well-being, in the cognitive and affective domains (Luszcz, 1992, 1998). By including fluid intelligence measures of memory and processing efficiency and alternative indicators of crystallized intelligence, i.e., abstract reasoning and verbal ability, differential consequences of successful aging for these hallmarks of growing older (Luszcz & Bryan, 1999) and, perhaps, aging successfully, could be identified. Given that crystallized intelligence is known to be more stable with age than is fluid intelligence, we expected cognitive slowing and memory to be among the most sensitive markers of successful aging. Psychological indicators of sense of self (Luszcz, 1998) included markers of psychological well-being (morale and depression) and self-resources (self-esteem and perceived control), all of which were expected to differentiate the groups.

Finally, the present study incorporates a longitudinal dimension by examining mortality in the eight years after collection of the baseline data. Previous ALSA studies on mortality have shown that a range of cognitive, physical and social variables are associated with longevity (Anstey & Luszcz, 2002, in press; Anstey,

Luszcz, Giles, & Andrews, 2001; Finucane et al., 1997; van Doorn & Kasl, 1998). These studies examined mortality over a shorter interval and none attempted the multidimensional scope of this study.

Method

Participants and Procedure

ALSA aims to gain increased understanding of how psychosocial, biomedical, lifestyle and environmental factors are associated with health and well-being in late life. Ethical conventions prescribed by the National Health and Medical Research Council (NH&MRC) for human research were followed and participants could refrain from completing any items at will. Because more complete details of the sample, method, and psychometric properties of scales used in the ALSA are available elsewhere (e.g., Andrews, Cheok, & Carr, 1989; Anstey et al., 2001; Clark & Bond, 1995; Finucane et al., 1997; Luszcz, 1996, 1998; Luszcz, Bryan, & Kent, 1997), coverage here is not exhaustive.

A stratified random sample was initially drawn by the Australian Bureau of Statistics from the South Australian Electoral Roll (Andrews et al., 1989; Hugo, Healy, & Luszcz, 1987). Eligible persons (defined as those individuals aged 70 years and over as of 30 June 1992 and who were at the time resident in the Adelaide Statistical Division) and their spouses (aged 65 years and over) or co-residents (aged 70 years and over) were asked to participate. The sample was stratified to provide estimated equal numbers in five-year age and sex cohorts from 70 to 84 years and over 85 years of age. Males were deliberately oversampled to compensate for their anticipated higher mortality during the study. Patterns of use of Medicare facilities and rates of residential care of this sample correspond well with those seen in the Australian population as a whole, supporting wide generalizability.

Participants were interviewed, for about 1.5 to 2 hours, in their normal place of residence; physical and functional assessments took place at home, approximately two weeks later. Data in this report are drawn primarily from the baseline assessment that occurred in 1992, when 1,947 people over the age of 70 years were initially interviewed. Information on deaths was confirmed by searches of official death certificates conducted by the Epidemiology Branch of Department of Health and Human Services in South Australia, using the South Australian Cancer Registry (see Anstey et al., 2001, for details).

This article discusses data from the 1,403 community dwelling respondents for whom necessary information was available from three modes of data gathering (see next section). Loss of data was primarily attributable to participants who did not take part in the optional components of the study (Anstey et al., 2001, provides a detailed examination of attrition within and across waves, and six-year mortality; see also Anstey & Luszcz, 2002, in press).

Modes of Data Collection

Face-to-face interviews covered a comprehensive set of domains, including demography, health, depression, morbid conditions, hospitalization, cognition, gross mobility and physical performance, activities of daily living and instrumental activities of daily living, lifestyle activities, exercise, education, and income. At the conclusion of the interview, participants were left with self-complete questionnaires and invited to also participate in a follow-up functional assessment.

Self-complete questionnaires comprised paper and pencil questionnaires including additional psychological measures of self-esteem, morale and perceived control. They were either mailed back in pre-paid envelopes or collected at the time of the functional assessment.

Functional assessments objectively assessed both physical and cognitive functioning. The physical examination included blood pressure, anthropometry, visual acuity, audiometry and spirometry. The cognitive assessment included measures of memory, information processing efficiency, and verbal ability.

Measures

In the *face-to-face interview*, health was assessed using the standard format described by Idler and Benyamini (1997), on a 5-point scale (excellent = 1, poor = 5); sleep quality was evaluated, and medical conditions from which they had ever suffered were endorsed from a comprehensive list. Activities of daily living (ADL) and instrumental ADL (IADL) were those used in the Older American Resources and Services program (Fillenbaum, 1988) and gross mobility and physical performance were gauged using items developed by Nagi (1976) and Rosow and Breslau (1966). The Adelaide Activities Profile (Clark & Bond, 1995) provided measures on four scales: domestic chores, household maintenance, service to others, and social activities. Reports on physical exercise (Finucane et al., 1997) were used to classify exercise intensity as none, moderate, or vigorous. Lifestyle characteristics asked about co-resident status, driving a car, smoking habits, and the importance of religion.

Depression was measured using the CES-D (Radloff, 1977) and items from the Mini Mental State Examination (MMSE; Folstein, Folstein & McHugh, 1975) assessing orientation, registration, attention, calculation, and recall (see Teng, Chui, Schneider, & Metzger, 1987) gauged current global cognitive status and impairment. Abstract reasoning was indexed by Wechsler Adult Intelligence Scale (WAIS) similarities items.

During the *functional assessment*, blood pressure was measured in a seated position; isolated systolic hypertension was defined as systolic blood pressure of 160 mm Hg or more, with diastolic pressure less than 95 mm Hg. Full tandem

and semi-tandem stands, repeated chair stands, time to walk a distance of eight feet, and grip strength were assessed following the procedures used in the EPESE (Cornoni-Huntley et al., 1993). Cognitive assessment comprised an abbreviated version of the Boston Naming Test (Mack et al., 1992), an extended version of the Digit Symbol Substitution Test (Luszcz, 1992; Luszcz et al., 1997; Wechsler, 1981), and the National Adult Reading Test (NART; Nelson, 1977). After Boston Naming and Digit Symbol tasks, incidental memory of the pictures and symbols was measured (see Luszcz et al., 1997).

Self-complete questionnaires assessed self-esteem (Bachman, O'Malley, & Johnson, 1978; Rosenberg, 1965), morale (items from Philadelphia Geriatric Center Morale Scale; Lawton, 1975) and perceived control (items from Reid and Ziegler's (1981) Expectancy of Control scale; for details, see Luszcz, 1998).

Functional Classification of Successful Aging

Participants were classified as higher, intermediate, or lower functioning based on criteria from the MacArthur studies of successful aging (Berkman et al., 1993). Apart from the screening of cognitive function using items from the MMSE, rather than the Short Portable Mental Status Questionnaire (Pfeiffer, 1975), and the testing of delayed recall with an address, rather than a short story, criteria were identical to those of Berkman et al.

Individuals were classified as higher functioning ($N = 503$ or 36%) if they met all of the following six criteria:

1. no cognitive impairment using the Mini-Mental State Examination;
2. delayed recall of at least 3 out of 5 elements of an address (*John Brown, 42 West Street, Kensington*);
3. no disability in 7 activities of daily living (bathing, grooming, dressing, eating, toileting, indoor mobility, transfer in and out of bed);
4. no more than 1 disability in 8 activities reflecting physical performance (pushing or pulling heavy objects, stooping or kneeling, lifting a ten pound weight, reaching above shoulder level, handling a small object) and gross mobility (climbing stairs, walking half a mile, doing light housework);
5. able to hold a semi-tandem balance for 10 seconds; and
6. able to stand from a seated position 5 times in 20 seconds.

Individuals were classified as lower functioning ($N = 522$ or 37%) if they fulfilled any of the following four criteria: cognitive impairment, 1 or more disabilities in ADLs, 2 or more disabilities in gross mobility, 3 or more disabilities in physical performance. The remaining individuals were classified as intermediate functioning ($N = 378$ or 27%).

Table 1. Control Variables by Level of Function

Variable	High		Intermediate		Low		χ^2	df
	no.	%[a]	*no.*	%[a]	*no.*	%[a]		
Age								
70–74	232	46.1	104	27.5	127	24.3	105.43***	6
75–79	153	30.4	121	32.0	135	25.9		
80–84	85	16.9	85	22.5	131	25.1		
85+	33	6.6	68	18.0	129	24.7		
Sex								
Male	302	60.0	223	59.0	253	48.5	16.51***	2
Female	201	40.0	155	41.0	269	51.5		
Age left school								
Less than 15 years	244	48.6	211	56.0	285	55.0	6.07*	2
15 years or more	258	51.4	166	44.0	233	45.0		
Total assets								
Less than $10,000	121	25.1	115	32.5	219	45.4	53.59***	6
$10,000–19,999	99	20.5	81	22.9	94	19.5		
$20,000–49,999	118	24.5	79	22.3	90	18.7		
$50,000+	144	29.9	79	22.3	79	16.4		

[a]column percentages indicate the distribution within each level of function.
*$p < .05$. ***$p < .001$.

Analytic Approach

Data analysis evaluated the relative importance of a large number of potential risk or protective factors for successful aging in two stages. First, univariate analyses were conducted. In the MacArthur studies, age and sex were controlled by design, by restricting the age range to 70–79, and matching for sex. Given evidence that age, household assets, and education are associated with successful aging (Berkman et al., 1993; Jorm et al., 1998; Strawbridge et al., 1996), the second stage of analysis used a logistic regression model that controlled for these effects. Groups of conceptually related predictors were entered as a block, to correct for mutual associations. In all analyses of successful aging, the higher functioning group was designated as the reference category, to which the intermediate and lower groups were compared in separate analyses. Table 1 summarizes categories, reference category, and descriptive statistics.

Results

Control Variables

Univariate analyses showed that each of the control variables distinguished among members of the three functional categories. Successful aging was associated with lower age, being male, and more education and assets.

Health and Medical Conditions

Eleven medical conditions were of sufficient prevalence to permit meaningful statistical analyses. Results of univariate analyses (Table 2) indicate that nine of these conditions discriminated among functional categories. In all cases, endorsing a medical condition was associated with poorer functioning. In logistic regressions (Table 3), morbid conditions were entered as a block and adjusted for the control variables. Only diabetes and arthritis emerged as significant risk factors for being in the intermediate, relative to the higher functioning, group. Isolated systolic hypertension provided an apparently protective effect, which was observed

Table 2. Medical Conditions by Level of Function

	High		Intermediate		Low		
Condition	*no.*	%[a]	*no.*	%[a]	*no.*	%[a]	$\chi^2_{(2)}$
Stroke	6	1.2	6	1.6	34	6.5	27.53***
Diabetes	32	6.4	37	9.8	49	9.4	4.35
Heart condition	92	18.3	59	15.6	133	25.5	15.08***
Myocardial infarction	51	10.1	46	12.2	83	15.9	7.80*
Systolic hypertension	139	27.7	85	22.5	117	22.5	4.81
Arthritis	237	47.1	212	56.1	341	65.3	34.53***
Slipped/ruptured disc	34	6.8	31	8.2	64	12.3	9.89**
Fractured hip	5	1.0	11	2.9	27	5.2	15.10***
Osteoporosis	14	2.8	14	3.7	38	7.3	12.71**
Asthma	24	4.8	28	7.4	55	10.5	12.12**
Chronic bronchitis	39	7.8	41	10.8	80	15.3	14.70***

[a]column percentages indicate the prevalence of medical conditions within each level of function.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3. Logistic Regression Summary: Level of Function by Medical Conditions Entered as a Block

	Higher vs. Intermediate		Higher vs. Low	
	AOR[a]	95% CI[b]	AOR[a]	95% CI[b]
Stroke	1.33	0.33–5.26	9.09***	3.23–24.98
Diabetes	1.95*	1.12–3.33	1.75*	1.02–3.03
Heart condition	0.72	0.48–1.08	1.41*	1.01–2.04
Myocardial infarction	1.26	0.78–2.04	1.16	0.72–1.85
Systolic hypertension	0.64*	0.45–0.92	0.61*	0.43–0.87
Arthritis	1.57**	1.16–2.13	1.96***	1.45–2.63
Slipped/ruptured disc	1.05	0.59–1.85	2.03**	1.22–3.45
Fractured hip	2.07	0.94–8.33	5.05**	1.72–14.29
Osteoporosis	1.35	0.57–3.13	2.50*	1.20–5.26
Asthma	1.78	0.95–3.33	2.57**	1.41–4.76
Chronic bronchitis	1.45	0.87–2.44	1.83*	1.14–2.94

[a]Adjusted Odds Ratio, where odds ratios are adjusted for age, gender, education and assets.
[b]95% confidence interval.
*$p < .05$. **$p < .01$. ***$p < .001$.

in contrasting the higher and lower functioning groups. Apart from myocardial infarction, all conditions were associated with increased risk of lower function; the risk was particularly high for stroke and fractured hip, while arthritis, slipped disc, or asthma at least doubled the risk.

Activity, Physical Performance and Health Indicators

Univariate analysis showed that a range of activity, physical performance, and health indicators discriminated among groups (Table 4). Lower levels of activity, physical performance, and health were consistently associated with lower levels of functioning. As demonstrated by the results in Table 5, this was confirmed in the multivariate analyses, especially if self-rated health was poor, IADLs proved more difficult and walking was slowed.

Psychological Functioning

Univariate analyses of variance (ANOVAs) showed that each of the cognitive variables distinguished among the three functioning groups (Table 6). Differences were observed for confrontation naming and immediate recall of the BNT pictures, number of digit-symbol pairs completed (speed), and similarities (abstract reasoning). The highest functioning group was superior to the other two, which did not differ from each other, for delayed picture recall, immediate recall of symbols, and verbal ability (NART errors). All groups differed on depression, morale, and self-esteem; the highest functioning group had the strongest expectancy of control.

Logistic regressions entering the sense of self variables as a block showed that absence of depressive symptoms provided a protective effect against membership in the lower and intermediate groups, and morale also provided protection against membership in the lower group (see Table 7). Analysis for the cognitive block (see Table 8) showed that processing speed and recall of symbols were the key variables distinguishing the groups, providing a protective effect against membership in the intermediate or lower, compared to the higher, functioning group. Furthermore, picture memory protected against membership in the lower functioning group.

Lifestyle Variables

Examination of selected lifestyle variables by level of function revealed a significant association only with driving a car, in both univariate ($\chi^2_{(2)} = 13.25$, $p < .0001$) and multivariate analysis. The latter showed that not driving was a risk for membership of the lower versus higher category of function. Relative to the higher functioning group, not driving was strongly associated with membership of

Table 4. Activity, Physical Performance and Health Indicators by Level of Function

	High			Intermediate			Low				
Variable	*M*/%[d]	*SD*	*n*	*M*/%[d]	*SD*	*N*	*M*/%[d]	*SD*	*n*	F^a/χ^2	df
No. IADL problems	0.1	0.4	503	0.6	1.3	377	1.7	2.1	521	153.06	2,1398
Adelaide Activities Profile[e]											
Domestic chores	55.7	16.8	502	51.2	19.3	377	45.2	21.2	518	38.83	2,1394
Household maintenance	60.9	14.9	503	52.8	17.8	375	40.3	19.5	501	176.59	2,1376
Service to others	54.4	20.6	503	51.8	21.0	376	47.2	18.3	516	17.16[b]	2,1392
Social activities	53.4	22.8	498	49.9	20.1	374	48.6	16.9	515	7.60[c]	2,1384
Intensity of exercise											
None	23.9	–	503	34.2	–	377	50.3	–	521	90.22	4
Moderate	68.3	–	503	63.1	–	377	47.2	–	521		
Vigorous	7.8	–	503	2.7	–	377	2.5	–	521		
Able to do tandem stand	84.3	–	503	60.3	–	378	45.4	–	522	168.98	2
Time to walk 8 ft. (sec)	2.8	0.7	495	3.4	1.0	358	4.3	2.7	463	87.58	2,1313
Grip strength (1 kg)	28.4	8.2	501	25.6	8.4	373	21.9	8.6	502	77.31	2,1373
Self-rated health											
Excellent/good	87.7	–	441	74.1	–	280	50.2	–	262	175.55	2
Fair/poor	12.3	–	62	25.9	–	98	49.8	–	260		
Gets sufficient sleep	91.7	–	461	87.5	–	330	80.8	–	422	26.25	2
Snores	64.1	–	320	56.1	–	208	54.6	–	281	10.69	2

[a]all $p < .0001$; unless marked *b* or *c* each mean difference is significant.
[b]higher functioning group differs from other two.
[c]low functioning group differs from other two.
[d]column percentages indicate the distribution within each level of function.
[e]all scales standardized to population mean 50, standard deviation 20; higher scores indicate greater activity.

Table 5. Logistic Regression Summary: Level of Function with Activity, Physical Performance and Health Indicators Entered as a Block

	Higher vs. Intermediate		Higher vs. Low	
	AOR[a]	95% CI[b]	AOR[a]	95% CI[b]
No. IADL problems	1.79**	1.34–2.40	3.02***	2.29–4.07
Adelaide Activities Profile				
Domestic chores	0.98*	0.97–1.00	0.97**	0.96–0.98
Household maintenance	0.98*	0.97–0.99	0.97***	0.96–0.98
Service to others	1.00	0.99–1.01	0.99**	0.98–1.00
Social activities	1.00	0.99–1.01	1.00	0.99–1.01
Intensity of exercise				
None	1.00		1.00	
Moderate	0.83	0.58–1.11	0.69*	0.48–0.98
Vigorous	0.47*	0.21–0.96	0.81	0.33–1.46
Able to do tandem stand	0.55**	0.38–0.77	0.52**	0.36–0.70
Time to walk 8 ft.	1.67***	1.32–2.10	1.98***	1.49–2.74
Grip strength	0.98	0.92–1.05	0.92***	0.87–0.99
Fair/poor self-rated health	2.20***	1.47–3.31	6.21***	4.27–9.03
Gets sufficient sleep	.74	.45–1.20	0.47**	.29–.78
Snores	.81	.59–1.12	0.98	.70–1.37

[a]Adjusted Odds Ratio, where odds ratios are adjusted for age, gender, education and assets.
[b]95% confidence interval.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 6. Cognitive and Sense of Self Variables by Level of Function: Means and Standard Deviations

	High			Intermediate			Low				
Variable	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	F^{abc}	df
Boston Naming (0–15)[d]											
Picture Naming	14.11	1.31	425	13.45	1.75	308	13.00	2.09	408	42.1	2,1140
Immediate Recall	6.31	2.05	425	5.29	2.38	308	4.68	2.46	405	53.2	2,1137
Delayed Recall	5.12	2.40	424	4.02	2.35	306	3.60	2.45	402	44.0[b]	2,1131
Digit Symbol Task											
Substitution	34.33	10.03	418	28.35	10.34	304	24.67	10.42	382	90.5	2,1103
Symbol Recall (0–9)	6.82	1.53	416	6.05	1.94	300	5.69	2.41	373	33.3[b]	2,1086
National Adult Reading											
Errors (0–50)	20.91	7.75	423	22.84	8.25	294	23.81	9.09	387	12.6[b]	2,1103
Similarities (0–3)	2.66	.67	488	2.51	.80	350	2.33	.92	489	19.4	2,1326
Depression (0–60)	5.21	5.00	502	7.99	7.17	372	10.66	7.78	516	83.4	2,1389
Morale (15–30)	26.01	2.91	412	24.87	3.42	274	23.58	3.50	366	53.7	2,1051
Self-Esteem (10–50)	42.43	5.13	409	41.06	5.50	274	39.95	5.92	362	19.5	2,1044
Control (12–60)	25.58	4.83	414	26.37	4.80	279	27.99	5.53	363	22.5[c]	2,1055

[a]all $p < .0001$; unless marked *b* or *c*, each mean difference is significant.
[b]higher functioning group differs from other two.
[c]low functioning group differs from other two.
[d]values in parentheses indicate possible range of scores; with the exception of NART-Errors, Depression and Control, higher scores indicate better functioning.

both the intermediate function group ($OR = 0.68$, 95% $CI = 0.49$–0.99, $p < .05$) and the lower function group ($OR = 0.38$, 95% $CI = .25$–56, $p < .001$). Being a past smoker, living alone or reporting that religion is not important constituted neither risks nor protection (statistics available by request).

Table 7. Logistic Regression Summary: Level of Function with Sense of Self Variables Entered as a Block

	Higher vs. Intermediate		Higher vs. Low	
	AOR[a]	95% CI[b]	AOR[a]	95% CI[b]
Depression	1.05***	1.02–1.09	1.10***	1.06–1.13
Morale	.95	.89–1.02	.90***	.84–.96
Self-esteem	.98	.95–1.02	.99	.95–1.03
Control	.99	.96–1.03	1.04	.99–1.08

[a]Adjusted Odds Ratio, where odds ratios are adjusted for age, gender, education and assets.
[b]95% confidence interval.
***$p < .001$.

Table 8. Logistic Regression Summary: Level of Function with Cognitive Variables Entered as a Block

	Higher vs. Intermediate		Higher vs. Low	
	AOR[a]	95% CI[b]	AOR[a]	95% CI[b]
Memory				
Picture Immed.	.93	.83–1.05	.80	.75–.86
Picture Delay	1.00	.88–1.14	.75	.70–.81
Symbol	.89***	.79–.99	.78***	.71–.85
Speed	.96***	.94–.99	.92***	.91–.94
Naming	.91	.79–1.06	.73	.66–.81
NART errors	1.05	.98–1.04	1.03	1.01–1.05
Similarities	1.06	.82–1.37	.69	.57–.84

[a]Adjusted Odds Ratio, where odds ratios are adjusted for age, gender, education and assets.
[b]95% confidence interval.
***$p < .001$.

Mortality

By February 2000 a total of 527 (37.6%) participants had died. There were 116 deaths (23%) in the higher, 144 (38%) in the intermediate, and 267 (51%) in the lower function group. Death during the eight-year period since baseline data were collected was strongly related to functional classification ($\chi^2_{(2)} = 86.23$, $p < .001$). This pattern was confirmed in the adjusted logistic regression analysis. Relative to the higher functioning group, subsequent death was strongly associated with initial membership of both the intermediate ($OR = 1.66$, 95% $CI = 1.19$–2.33, $p < .001$) and the lower ($OR = 3.03$, 95% $CI = 2.22$–4.17, $p < .001$) functioning groups.

Discussion

Our key objectives were to: (a) examine the applicability of the MacArthur model for the study of successful aging in a setting removed geographically and culturally from the United States, (b) determine whether functionally defined

subgroups differed from each other across a range of domains, and (c) signal key markers of successful aging. Discrete groups of individuals aged 70 or more and showing higher, intermediate, or lower degrees of successful aging were identified. More importantly, they could be distinguished from each other on additional measures of physical functioning and health, lifestyle, and psychological status and the key indicators remained after controlling for the effects of age, gender, education, and income.

Mortality data showed that death in the intervening eight years was more likely in those originally classified as aging less successfully. These findings confirm that people age with differing degrees of success. Further, those defined as aging most successfully, on the basis of simple physical and cognitive activities, are likely not only to live longer, but also to experience a better quality of life across a wide range of indicators.

While univariate analyses of basic demographic groupings showed that aging most successfully was more likely in the young old than the old old individuals and in men rather than women, differences in education and assets were more evident in the intermediate and lower functioning groups. After controlling for these characteristics, striking effects were seen in all domains.

The interconnections among physical, psychological, and social functioning and successful aging are strong. The patterns of morbidity are best summarized in the six-fold increased risk for unsuccessful aging associated with rating one's health as fair or poor, which points to the complex co-morbid effects of a range of chronic conditions. Lower functioning is especially demonstrable following the major disabling effects of stoke and fractured hip. The latter, coupled with not driving, slowed walking, and increasing difficulties with daily tasks, support the assertion that compromised mobility can have widespread effects which reduce one's capacity to age well.

Psychologically, better fluid abilities and stronger sense of self were key concurrent markers of successful aging. There is a clear pattern showing faster processing, better verbal and abstract reasoning ability, and more proficient memory for those in the higher functioning group. Analysis of relative risk of membership in the intermediate and lower functioning group showed that processing efficiency and good memory (both markers of fluid ability) and absence of depressive symptoms were dimensions most defining of group membership, independent of differences in age, education, gender, and income. Also, analyses of change over two years (Luszcz, 2000) have shown more resilience in the higher functioning subgroup, best reflected by increases in processing accuracy, perceived control, and self-esteem. The latter effects contrast with the cross sectional results in that it appears that, over time, psychological resources (reflecting control and self-esteem) are more fundamental to successful aging than affect (depression and morale). To the extent that psychological resources are malleable, the findings are important in pointing to possible interventions that might increase quality of life.

Regardless of the domain assessed, the distinctions were more marked for the extreme groups, i.e., higher compared to lower groups, rather than the intermediate and the other two groups. The negative manifold seen in both objective and subjective measures suggests that erosion of basic cognitive and physical functions, as captured by the application of the MacArthur criteria to the ALSA data, is consequential for other areas of functioning. These relationships require more intensive study, particularly when taken in conjunction with the mortality effects and consequences for change in psychological functioning. Initial longitudinal work in the psychological domain (Luszcz, 1998) will be augmented with analysis of additional psychological and the biosocial dimensions in order to provide further insights into the dynamics of aging well. Data from a recent sixth wave (8-year comprehensive follow-up) of the ALSA (Anstey, Hofer, & Luszcz, 2002; Luszcz & Anstey, 2002) will provide the basis for further longitudinal work.

In conclusion, the application of the MacArthur Model to the Australian Longitudinal Study of Aging proved useful and pointed to the need to undertake further prospective work along these lines using more culturally diverse samples. The multidimensionality of the notion of *successful* aging is apparent, as is the substantial heterogeneity exhibited within an aging cohort across these various dimensions (Baltes & Baltes, 1990; Baltes & Smith, 1999). The results are encouraging from the perspective of the utility of the MacArthur model for cross-national comparative work.

While this work and the extant MacArthur studies have examined successful aging in Western samples, work currently underway suggests the relevance of these criteria for identifying varying degrees of successful aging in a Chinese sample. Because the criteria for distinguishing groups are simply, easily, and objectively measured and amenable to slight variations in operationalization, they portend an approach that could prove fruitful in identifying some of the more universal patterns of aging well and the variations that may arise from a complex of culturally distinct circumstances and experiences. Regardless of culture, basic indices of thinking and physical capacities are included in most epidemiological studies of aging enabling further comparisons that may reveal culturally distinct patterns or trajectories of aging well across a variety of domains.

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