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Gender Differences in Cognition among Older Adults in China

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Abstract

In this paper, we model gender differences in cognitive ability in China using a new sample of middle-aged and older Chinese respondents. Modeled after the American Health and Retirement Study (HRS), the CHARLS Pilot survey respondents are 45 years and older in two quite distinct provinces—Zhejiang, a high-growth industrialized province on the East Coast, and Gansu, a largely agricultural and poor province in the West—in a sense new and old China. Our cognition measures proxy for two different dimensions of adult cognition—episodic memory and intact mental status. On both measures, Chinese women score much lower than do Chinese men, a gender difference that grows among older Chinese cohorts. We relate both these cognition scores to schooling, urban residence, family and community levels of economic resources, and height. We find that cognition is more closely related to mean community resources than to family resources, especially for women, suggesting that in traditional poor Chinese communities there are strong economic incentives to favor boys at the expense of girls. We also find that these gender differences in cognitive ability have been steadily decreasing across birth cohorts as the economy of China grew rapidly. Among cohorts of young adults in China, there is no longer any gender disparity in cognitive ability. This parallels the situation in the United States where cognition scores of adult women actually exceed those of adult men.

I. Introduction

Cognitive skills are increasingly recognized as key to better decision-making in many domains of life. Cognitive skills may be especially important for the older population in a country such as China where intermediary market institutions are not in place to help make financial decisions related to income security or health care provision. Partly due to their longer life expectancies implying that many of their later life years will be without their husbands, cognitive skills may be even more critical for older Chinese women. Largely due to the absence of relevant data, the importance of cognitive skills for older populations has received little scholarly attention.

In traditional low-income environments such as rural China, families may emphasize development of human capital skills favoring sons at the expense of daughters. This certainly appears to be the case with standard measures of human capital, such as schooling, where large gender gaps in schooling exist in low-income settings (Parish and Willis 1993). As per-capita incomes increase and education expands, this expansion is much stronger for women than for men so that gender disparities begin to dissipate (Becker et al. 2010). In this paper, we investigate whether these gender disparities extend ever deeper to basic cognitive skills and how those gender disparities change as incomes improve over time.

Our data for this inquiry are the recently collected China Health and Retirement Longitudinal Study (CHARLS), the Chinese version of the Health and Retirement Studies (HRS) around the world. Using that data, we examine gender differences in cognitive skills among middle age and older people in the Chinese context. These cognitive skills include *episodic memory* and components of *intact mental status*. We find large raw differences in these cognitive skills in that there is a female deficit in cognitive skills that is smaller among more recent birth cohorts. In addition to personal demographic attributes, we attempt to explain these gender differences by examining the education accomplishments of Chinese men and women in these birth cohorts and the economic resources of the communities in which they live. We find that at low levels of economic resources Chinese communities invest in the cognitive skills of boys at the expense of girls. However, as the economic resources of these communities improve, this gender bias gradually dissipates and eventually disappears or moves actually favoring women.

This paper is divided into five sections. The next describes the CHARLS data and the cognition variables and other constructs used in our analysis. Section III outlines statistical models estimated to uncover the underlying reasons for gender differences in cognition in the Chinese context. Our main empirical findings are in Section IV and the final section highlights conclusions.

II. Data

A. CHARLS Pilot Survey

The 2008 wave of China Health and Retirement Longitudinal Study (CHARLS) was conducted in Zhejiang and Gansu provinces in China (see Zhao et al. 2009). Zhejiang, located in the developed coastal region, is one of the most dynamic provinces given its fast economic growth, small-scale industrialization, and export orientation, while Gansu, located in the less developed western region, is one of the poorest, most rural provinces in China. Among all provinces in 2008, Zhejiang had the highest rural and urban incomes per capita after Shanghai and Beijing, while Gansu had the second lowest rural per capita income and fourth lowest urban per capita income.

The sampling design of the 2008 wave of CHARLS was aimed to be representative of residents 45 and older in these two provinces. The sampling protocol is that one member of the household age 45 and over is sampled and their spouse (no matter what age) is automatically included. In our analysis, the respondent and spouse are both included if they are at least 45 years old. Within each province, CHARLS randomly selected 16 county level units by PPS (Probability Proportional to Size), stratified by region and urban/rural. Within each county, CHARLS randomly selected three village-level units by PPS as primary sampling units (PSUs); within each PSU, CHARLS randomly picked 25–36 from a complete list of dwelling units generated from a map for each PSU.¹ Thus, there were 25–36

¹When more than one age-eligible household lives in a dwelling unit, CHARLS randomly selected one and then determined the number of age-eligible members within a household and then randomly selected one.

households in each community; and 1 or 2 individuals in each household interviewed based on marital status of main respondent. Total sample size was 2,685 people in 1,570 households.

The CHARLS pilot experience was very positive. The overall response rate was 85 percent; 79 percent in urban areas and 90 percent in rural areas. The response rate was about the same in the two provinces, 83.9 percent in Zhejiang and 85.8 percent in Gansu. These high response rates reflected the detailed procedures put in place to insure a high response to the survey.

B. Measurement in CHARLS—Cognition

Based on similar measures used in the American Health and Retirement Study (HRS), there are two cognition measures in this research. The first is memory *recall* based on a respondent's ability to immediately repeat in any order ten Chinese nouns just read to them (immediate word *recall*) and to recall the same list of words four minutes later (delayed *recall*). Following McArdle et al. (2007), we form an *episodic memory* measure as the average of immediate and delayed recall scores. *Episodic memory* is a necessary component of reasoning in all dimensions. Our second cognitive measure is based on some components of the mental status questions of the Telephone Interview of Cognitive Status (TICS) battery established to capture intactness or *mental status* of individuals. In CHARLS, mental status questions include the following items—serial 7 subtraction from 100 (up to five times) and whether the respondent needed any explanation or used an aid such as paper and pencil, naming today's date (month, day, year, and season), the day of the week, and ability to redraw a picture shown to respondents. Answers to these questions are aggregated into a single *mental status* score that ranges from 0 to 11.

Table 1 presents mean levels of our two measures of cognitive ability separately for Chinese men and women stratified by age using samples of those providing their own responses. Across all ages, Chinese men remember about a quarter of a word more than their female counterparts—a differential in favor of men that exists in all age groups. The male cognitive advantage is even larger for intact mental status where Chinese men achieve a score almost a full point above that of Chinese women.

For both men and women, each cognitive measure declines sharply with age, a decline that is likely a combination of both cohort and aging effects. Prior research has suggested strong normative age declines in most cognitive functions reflecting different aspects of adult cognitive profiles (Levy 1994; McArdle et al. 2002). In a country such as China which has experienced rapid economic development during the last 30 years with impressive increases in schooling for each new generation, one would anticipate significant cohort effects in cognition. We come back to this issue of cohort and aging effects below. There is an indication for both mental intactness and episodic memory of smaller differences among younger cohorts in Table 1.

C. Measurement in CHARLS—SES

Unlike other HRS type surveys, financial dimensions of SES in CHARLS are measured in terms of income, wealth, and consumption expenditures. Because the literature has shown that expenditure provides a better welfare measure than income or wealth in developing countries (Strauss and Thomas 1995), our main measure of economic status is Ln per capita expenditures (Ln PCE). Household expenditures are collected at weekly, monthly and yearly frequencies to minimize recall bias. For example, food expenditure is collected weekly and includes expenditures on dining out, food bought from market and values of home-produced food. Monthly-based expenditures are those usually spent each month, including fees for

utilities, nannies, communications, etc. Yearly-based items record expenditures occurred occasionally in a year, including traveling, expenditures on durables, and education and training fees.

Education

An important dimension of socioeconomic status (SES) used in any cognition analysis is education, which is well known to be directly associated with increased cognitive ability in several dimensions.(McArdle and Woodcock 1998). Education is obtained from the survey question, “What is the highest level of school you have completed?” Twelve possible answers were categorized into five mutually exclusive groups: 1) “illiterate,” those who can neither read nor write; 2) “Sishu/home school or below,” including those who did not finish primary school but were capable of reading or writing, or those who were reported to have been in “Sishu”;² 3) “Finished elementary school,” those who have completed a primary school education; 4) “Middle school,” those who have completed a middle school level education; and 5) “High and above,” those who have completed a high school, vocational school, college, or graduate level education.

Using these categories, Table 2 reports distributions of education by gender and age in CHARLS-Pilot data. The educational level for older Chinese respondents is generally quite low and its distribution is skewed, with about 58 percent having failed to finish elementary school (39 percent are illiterate and 19 percent can read or write), and only a small portion (7 percent for women and 13 percent for men) reaching a high school level education or above. Education declines with age, but men have higher education levels than women in all age groups. Women older than 75 are the most disadvantaged: as many as 77 percent are illiterate, and none of them have reached a middle school level education, compared to 43 percent and 7 percent respectively for their male counterparts. Although both men and women have become more educated over time, a significant gender discrepancy still exists that is becoming smaller in the youngest cohorts compared to the oldest cohorts in Table 2.

D. Cognition and Communities

Especially in rural China, communities are important social and economic entities that have significant impacts on their residents. Strauss et al. (2011) find that for many health outcomes unmeasured community effects are highly important, much more so than one usually finds in other countries. Why communities are so central to understanding China is a key question and answers may depend on the specific life outcome. In terms of sex discrimination, where Chinese rural villages are closeknit communities where residents inherit, preserve, and then pass on the same culture, girls may not be treated similarly relative to boys based on village attributes. These community-based traits may impact cognitive ability of resident girls and boys, and eventually women and men. To obtain an initial look, we divided all communities in the CHARLS survey into ten groups based on the community average Ln PCE where mean community Ln PCE was defined for each CHARLS respondent excluding his/her own family Ln PCE.³

²Sishu is an old, private Chinese education style that before the 20th Century taught young children reading, writing, and other fundamental skills.

³In the CHARLS sample, 96 percent of women (same for men) live in the same province in which they were born, and 90 percent of men and 87 percent of women live in the same county where they were born. The difference between men and women concerns whether they live in the same village in the same county in which they were born. 75 percent of men compared to 25 percent of women still live in the same village in which they were born, a difference generated by women moving to nearby villages when they marry. Especially in rural areas, these very nearby villages to where women were born have about the same economic status of the village in which they were born. Thus the data in Table 3 should be a good approximation for both Chinese men and women.

Table 3 documents for each of the ten community groups (1 indicates poorest and 10 richest) average mental intactness and episodic memory scores for women and men separately alongside gender difference in scores. Statistical tests are provided to indicate significance of the gender difference. As the average community Ln PCE increases, cognitive scores of its residents increase sharply for both men and women, but this increase is far more dramatic for Chinese women compared to Chinese men. Among Chinese women, average level of mental intactness is more than two-thirds as high in the richest group of communities compared to the poorest. For men, this increase in mean mental intactness score was about 29 percent. The comparable ratio for episodic memory between the poorest and richest communities for women is 2.3 to one. Chinese male cognitive ability also rises as communities become better off economically but nowhere near as much as for women. In the poorest set of Chinese communities, the female deficit in mental intactness is about four units and in episodic memory it is two more remembered words. These female cognitive deficits decline as we move into better off communities although there is actually a female cognitive bonus to Chinese women in the richest set of communities.

The last three set of columns in Table 3 shows fractions of women and men in these ten community groups who are illiterate with the final column tallying female-male difference in illiteracy rates. In the poorest set of communities, over 90 percent of female residents over age 45 are illiterate compared to 39 percent of men. While female rates of illiteracy exceed male rates in all ten groups, the gender difference becomes much smaller as we reach the richest group of communities.

III. Empirical Models

In this section, we present our main empirical analysis aimed at identifying the principal determinants of cognition among CHARLS respondents and at isolating factors that may help to explain gender disparities in cognition. To facilitate interpreting our results, Appendix Table A1 lists relevant descriptive statistics especially for our mental intactness model. We analyze two measures of cognition—episodic memory and intact mental status. Ordinary Least Squares (OLS) models are used as the principal estimation method. Our baseline models in Table 4 control only for a quadratic in age and gender (women = 1) so that estimated coefficients on gender inform us about the age (or cohort) adjusted cognitive disparity for women. Since age distributions do not vary much between men and women, the age-adjusted models reproduce gender cognition differences in Table 1—about a 1.0 higher mental status score for men and a 0.33 higher male episodic memory score. Both gender differences are statistically significant at the one percent level.

In the second set of models, we add variables in domains that could possibly explain the gender differences—education categories, geography (province: Zhejiang = 1; residence: urban = 1), height, and Ln family PCE. These OLS models in Table 4 indicate that cognitively ability increases monotonically with more years of schooling. Compared to those with no education, people who completed middle school scored 2.4 points higher in mental intactness and remembered 1.7 additional words. Since Chinese women have much lower levels of education than Chinese men do, this strong association with education implies that education explains part of the gender difference in cognition. The other three new variables behave as expected—both cognitive scores are higher in urban areas, in the more economically advanced province of Zhejiang, and for those respondents who are taller (mental intactness only) and who live in households with higher per capita expenditures. While the inclusion of these variables eliminates the gender difference in episodic memory, the gender difference in mental intactness remains statistically significant.

Two issues with OLS estimation of these cognitive scores must be addressed—the implicit assumption of equal intervals between scores and the possibility of ceiling effects that could lead to a narrowing of the gender gap as the population mean score approached the ceiling. Ceiling effects are very unlikely for word recall. In our ten-word recall measure, more than 95 percent of respondents score 6 or less (similar for men and women). However, this is potentially a more serious issue for the TICS measure since about 22 percent reached the highest score—19 percent for men and 25 percent for women so it is not that different between the sexes). There-fore, we also estimated an IRT model (Linden and Hambleton 1996) for mental intactness. The estimated coefficients from the Bayesian expected posterior model are listed in the third column of Table 4 next to the corresponding OLS model in Column 2. The two models are substantively identical suggesting that ceiling effects are unlikely to be driving our gender results.

Because statistically significant gender differences only remain for mental intactness, we explore further this cognitive outcome in Table 5. The first model adds measures of average economic well-being of communities where respondents reside (community Ln PCE), an interaction of urban residence with being female, and a set of Prefecture dummies to control for any other unobserved geographic factors. Prefectures are administrative units that govern a combination of counties in China. There are 19 prefectures in our two Provinces.⁴ This female cognitive deficit is much larger in rural areas, and this cognitive ability increases strongly with Ln PCE at both the family and community level. The estimated association of community Ln PCE on cognitive ability is much larger than effects estimated for family Ln PCE. To some extent, this could reflect a greater role for measurement error at the individual family level compared with the community level. It also could reflect the fact that community-level measures capture in part elements of permanent income. Since we have about a four-times-larger effect at the community level compared to the family level for mental intactness, this is unlikely to be a complete explanation. We should be better able to disentangle this possibility when panel data of the CHARLS data become available in a few years.

The second model in Table 5 adds a variable that interacts being female with community Ln PCE. The association of community Ln PCE with cognitive ability is much higher for Chinese women compared to Chinese men, even after we include education of respondents. The significant urban-female interaction goes away in this model indicating that this effect is better proxied by community Ln PCE. In sharp contrast to the much stronger female association with Ln PCE at the community level, we did not find any statistically significant difference of Ln family PCE between Chinese women and Chinese men (not shown). These results suggest that the favoritism of men in low-income settings appears to be mainly a community rather than individual level effect. Once again the final column in Table 5 presents the IRT variant of this model and once again these results are substantively the same as in the OLS model.

What is it about poor and rural communities in China and elsewhere that produces such large differences in cognitive outcomes? One reason is the restriction in educational opportunities for girls in poor communities. In traditional China, sons are preferred over daughters because sons carry family lineage and take care of older parents while the daughter's responsibility lies with her husband's family. The education opportunity was mainly given to boys when community resources are constrained while girls work on the farm and around the house. In poor communities, when many families treat their daughters this way, this practice becomes culture and more tolerated. This we believe is why community income level has an effect independent of family income.

⁴Once we control for Prefectures, we have to drop the Zhejiang province dummy.

While education is not specifically sex-segregated in China, girls were much less likely to go to school and this difference is larger in poor communities. In addition, women are less likely to take public roles in rural villages. Not until recently did women have the right to be elected as village leaders in remote areas. This lack of experience in public roles also may have reduced the opportunity to promote their cognitive functioning. Due to the extremely low level of women's roles in village affairs, the Organic Law of Village Committees of the People's Republic of China suggested that "there should be certain number of women in a village committee" (National People's Congress of China 1998), but this suggestion was not followed well. Until 2008, women only amounted to 21.7 percent in the village committees even though more than 60 percent of the rural labor were women; less than 1 percent of the principal positions in the village committees were taken by women and the fraction of women representatives was still very low (Women Watch, February 2, 2010, <http://www.womenwatch-china.org/newsdetail.aspx?id=474>). Then in 2010, the Amendments to the Organic Law of Village Committees further specified that "there should be women in a village committee, and women should take up at least one-third of the village representatives." This long-term lack of experience in public roles also may have reduced the opportunity to promote their women's cognitive functioning. In sharp contrast, Beaman et al. (2009, 2012) show that assigning gender quotas on political leadership positions in India narrowed gender gaps in aspirations of young people in affected villages.

Another way poor communities may impact cognition of girls favoring boys is through nutrition. While we have no direct measure of nutrition intake of the CHARLS respondents when they were children, we do measure one of the later life markers of differential nutrition during the childhood years—their adult height. Mean adult height, particularly in the twentieth century, rose in many countries, especially developing countries, as economic development proceeded (see Strauss and Thomas 1995 and Steckel 1995). Adult height is determined both by childhood height and the adolescent growth spurt. Childhood height is thought to be largely determined in pre-school ages, particularly before age three (Martorell and Habicht 1986). Childhood height reflects health generally, not only nutritional intakes and expenditures, but some illnesses, particularly from infectious diseases, and appears to be related to adult cognitive ability (Case and Paxson 2008).

Table 6 displays mean adult heights of women and men (in centimeters) alongside female-male difference in heights in our ten groups that rank communities by their average Ln PCE. To avoid confounding cohort differences in height and shrinkage at old age, we use a subsample comprised of people aged 55–70.⁵ Among Chinese women, there is a steady rise in their adult heights as we move from the poorest set of communities to the richest. The difference in female stature from the poorest to richest set of communities is over five centimeters. In sharp contrast, there is little change for men across these community groups so the male excess height is 12.3 centimeters in the poorest places and shrinks to 7.9 centimeters in the richest set of communities.

The difference in heights between sexes across communities is not surprising given how traditional Chinese parents treat sons and daughters differently in educational opportunities. Because sons are more important to parents, their health and nutrition are given priority over girls. While not so dramatic as schooling, traditional Chinese parents tilt the dinner plate toward their sons when food takes a large chunk of the family resource. When the hen lays an egg, it is given to the boy; when a few slides of meat are cooked with vegetables, the meat is picked out to place in the boy's bowl. Daughters are taught from the beginning that their brothers are more valuable and they must not compete for food. This practice is contagious in the community. When brothers and sisters grow up witnessing this, when they

⁵The results are not sensitive to the choice of exact cutoff point.

marry and have children, they practice it too. Hence we see an impact of community income level independent of household incomes.

IV. Secular Trends in Gender Differences in Cognition in China

Our analysis shows that there are large gender differences in cognition in China that are smaller among younger people in the CHARLS survey among those 45 years and older. The question we now ask is whether this narrowing of gender differences extends to even younger age groups as economic development in China proceeded rapidly across the last 20 years.

Gender and age patterns of education are plotted in Figure 1, as obtained from the latest Chinese One Percent Population Survey in 2005. The top part in this Figure shows the fraction of people who have not completed primary school by gender and age, while the bottom part depicts the fraction of those with college and above. Within the 45 and over age groups represented in CHARLS, the 2005 Survey shows the same large female deficit in schooling except that this deficit characterizes all provinces in China. Among those 65 years old and over the fraction of women who had less than elementary schooling is more than twice that of men, and among those 75 + the fraction of women with less than a primary school education was 41 percentage points higher than that of men. There has been a steady erosion of the female deficit in schooling across younger birth cohorts as gender education disparities steadily decline over time until the gender differences for both primary and college or above almost converges in the youngest generation.

The strong role education plays in cognitive ability predicts that these female education advances should carry with them improvements in cognitive ability of women compared to men. To test this, we utilize another recent survey in China—the WHO SAGE survey fielded between 2007 and 2009. SAGE has the advantage of covering the complete age distribution with its cognition measures.⁶ SAGE obtained a representative cohort of persons aged 50 years and older, with a smaller cohort of persons aged 18 to 49 for comparison purposes.

While the main emphasis in SAGE was health, a cognitive battery also was included. Cognition measures in SAGE are somewhat different than those in CHARLS either conceptually or in implementation. While SAGE measure of episodic memory is also based on an average of immediate and delayed recall, these ten words are repeated to the respondent three times before the respondent has to repeat them. As one would expect, memory is much improved with the three repetitions and it is improved more among those whose memory is not as good. The second SAGE cognition measure is digit span, which asks respondents to repeat a series of numbers either as heard or backward. These tests measured concentration, attention, and immediate memory.

Table 7a shows gender specific means of these SAGE cognitive measures alongside the female-male difference in cognitive scores. In both older age groups in common with the CHARLS survey, Chinese women have lower cognitive scores than men do of the same age. But these gender deficits decline systematically with age so that there is little difference in either word recall or digit span among those in the youngest age group, 25–34 years old.

Table 7b displays American differences in memory recall (the same immediate and delayed recall ten word test as CHARLS), and TICS cognitive battery, meant to capture intactness or mental status of individuals.⁷ The HRS can be used to establish as a point of contrast what

⁶See <http://www.who.int/healthinfo/systems/sage/en/index.html>.

gender contrasts exist in cognition in a mature developed economy. Within age groups, American women score somewhat better in terms of memory and the TICS score does not differ significantly between genders.

Like all research, our study has limitations. In addition to aging and cohort effects, another factor that could impact gender differences in cognitive ability is mortality selection effects. If cognitive ability is protective on mortality (Batty et al. 2007), the least cognitively able will die first, imparting an upward bias to the age gradient among survivors. Because Chinese men die at a younger age than Chinese women do, mortality selection in cognition could contribute to a cognitive differential favoring men. Unfortunately, we are unable to find any credible estimates of cohort survival curves for these Chinese birth cohorts in part due to the quality of data in those days and a weaker Population Science. In addition, one would have to know the size of mortality selection by cognition (by sex), which is not possible in Chinese data. Finally, direct measurement of many of the factors we think are important such as gender differences in nutrition and social and political roles are not available especially during the period when these older adults were young.

V. Conclusions

In this paper, we examined the size and determinants of gender differences in cognition among those 45 and over in two provinces in China. We relied on a recent data source—CHARLS—that is part of the international network of Health and Retirement Surveys around the world. We found large cognitive differences to the detriment of women that were mitigated but not fully explained by large gender differences in education among these generations of Chinese people.

These gender differences in cognition are concentrated within and related to the poorer communities in China with the gender differences being more sensitive to community-level attributes than to family-level attributes, with economic resources (measured by per capita expenditures) being the primary illustration of that point. In traditional poor Chinese communities, there are strong economic incentives to favor boys at the expense of girls not only in their education outcomes, but in their nutrition and eventually their adult height. We also find that these gender differences in cognitive ability have been steadily decreasing across birth cohorts as the economy of China grew rapidly. Among younger cohorts of young adults in China, there is no longer any gender disparity in cognitive ability, perhaps suggesting that with continued economic development, China will move toward the American case where cognitive skills of women are at least equal to those of men.

Acknowledgments

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⁷HRS TICS questions consist of the following items—serial 7 subtraction from 100 (up to five times), backward counting (from 20 to 1), naming today's date (month, day, year), and naming President and Vice President of the United States. Answers are aggregated into a single mental status score that ranges from 0 to 10 (McArdle et al. 2011).

Appendix

Appendix Table A1a
Means and Standard Deviations of Attributes by
Gender and Province of Residence

Variable	All	Female	Male	Zhejiang	Gansu
Cognition					
Mental status	8.621 (2.144)	8.167 (2.301)	9.046 (1.891)	9.144 (1.919)	7.979 (2.231)
Episodic memory	3.413 (1.793)	3.294 (1.852)	3.524 (1.730)	3.539 (1.820)	3.263 (1.749)
Demographics					
Age	58.571 (9.514)	57.686 (9.585)	59.399 (9.376)	59.320 (9.929)	57.653 (8.898)
Female	0.483 (0.500)	NA NA	NA NA	0.494 (0.500)	0.470 (0.499)
Zhejiang	0.551 (0.498)	0.564 (0.496)	0.539 (0.499)	NA NA	NA NA
Gansu	0.449 (0.498)	0.437 (0.496)	0.461 (0.499)	NA NA	NA NA
Urban	0.475 (0.500)	0.515 (0.500)	0.437 (0.496)	0.582 (0.493)	0.342 (0.475)
Rural	0.525 (0.500)	0.485 (0.500)	0.563 (0.496)	0.418 (0.493)	0.658 (0.475)
Zhejiang	159.070 (9.189)	153.483 (7.119)	164.298 (7.715)	158.784 (8.154)	159.424 (10.329)
Log household PCE	8.471 (1.131)	8.462 (1.225)	8.479 (1.036)	8.725 (1.059)	8.158 (1.138)
Observations	1,873	905	968	1,032	841

Appendix

Appendix Table A1b
Cognition (Mental Intactness)

	All		Female		Male	
	Mean	Standard	Mean	Standard	Mean	Standard
Urban	9.153	(1.931)	8.863	(2.051)	9.473	(1.737)
Rural	8.140	(2.213)	7.428	(2.324)	8.714	(1.940)
Height (0–1/3)	7.880	(2.274)	7.703	(2.256)	8.441	(2.065)
Height (1/3–2/3)	8.903	(2.023)	8.315	(2.297)	9.250	(1.784)
Height (2/3–1)	9.106	(1.939)	8.523	(2.286)	9.317	(1.760)
Community log PCE (0–1/3)	7.681	(2.242)	6.702	(2.217)	8.275	(2.045)
Community log PCE (1/3–2/3)	9.109	(1.918)	8.711	(2.085)	9.402	(1.703)
Community log PCE (2/3–1)	9.461	(1.785)	9.236	(1.862)	9.687	(1.626)
Observations	1,873		905		968	

Note: Bottom third (0–1/3), Middle third (1/3–2/3) and Top third (2/3–1) are the Bottom, Middle, and Top thirds of Communities ranked by their Mean Ln PCE.

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Figure 1.
Secular Trends in Education by Gender

Table 1

Gender Difference in Cognitive Function: by Age

Cohort	Number of Observations	Mental Intactness			Episodic Memory		
		Overall	Female	Male	Overall	Female	Male
45-49	339	9.068	8.746	9.514	-0.768***	3.858	3.961
50-54	402	9.003	8.543	9.453	-0.910***	3.730	3.913
55-59	356	8.635	8.054	9.142	-1.088***	3.117	3.636
60-64	292	8.541	7.920	9.090	-1.171***	3.057	3.573
65-74	353	8.156	7.687	8.490	-0.803**	2.839	3.006
75 +	131	7.687	7.051	8.208	-1.158**	1.663	2.348
All	1,873	8.621	8.167	9.046	-0.879***	3.294	3.524

Source: CHARLS 2008. Gender Difference is Female-Male. Mental Intactness is based on components of the TTCS battery scaled from 0-11 that are meant to capture intact mental status. Episodic Memory is an average of the immediate and delayed ten word recall.

Table 2

Education: Percent Distribution by Gender and Age Groups

Education Participation Rate	Female						Male					
	All	All	45-55	55-65	65-75	75 and above	All	45-55	55-65	65-75	75 and above	
Illiterate	0.386	0.549	0.465	0.567	0.640	0.769	0.232	0.134	0.209	0.356	0.430	
Sishu/home school and below	0.192	0.163	0.121	0.207	0.183	0.154	0.220	0.150	0.286	0.219	0.244	
Elementary school	0.183	0.128	0.137	0.140	0.098	0.077	0.236	0.221	0.291	0.196	0.163	
Middle school	0.136	0.093	0.161	0.046	0.049	0.000	0.177	0.254	0.140	0.146	0.081	
High school and above	0.102	0.068	0.116	0.040	0.031	0.000	0.133	0.240	0.074	0.078	0.070	
Observations	2,007	972	415	328	164	65	1,035	366	364	219	86	

Source: CHARLS 2008.

Table 3

Cognition by Mean Ln PCE in Community

Mean Ln PCE in Community	Mental Intactness (0–10)			Episodic Memory			Fraction Illiterate		
	Female	Male	Female-Male	Female	Male	Female-Male	Female	Male	Female-Male
1	5.917	7.637	-1.721***	1.913	2.994	-1.081***	0.906	0.390	0.516***
2	6.975	8.529	-1.554***	2.836	3.651	-0.815**	0.741	0.299	0.441***
3	7.013	8.784	-1.770***	2.571	3.273	-0.702*	0.814	0.331	0.483***
4	7.704	8.812	-1.108***	2.982	3.228	-0.247	0.690	0.323	0.368***
5	8.231	9.392	-1.161***	3.143	3.462	-0.319	0.590	0.263	0.327***
6	8.371	9.240	-0.868**	3.137	3.000	0.137	0.591	0.175	0.416***
7	8.588	9.549	-0.961***	3.285	3.418	-0.133	0.561	0.259	0.302***
8	9.239	9.589	-0.350	3.571	3.840	-0.268	0.318	0.131	0.187***
9	9.420	9.854	-0.433	3.781	3.615	0.166	0.292	0.126	0.166**
10	9.949	9.865	0.084	4.109	4.253	-0.144	0.365	0.125	0.240**
All	8.167	9.045	-0.879***	3.294	3.524	-0.230**	0.605	0.258	0.347***

Note: Communities are placed into ten groups from lowest to highest based on the mean Ln household per capita expenditures (PCE) of all residents of those communities minus the respondent. Mental Intactness is based on components of the TICS battery scaled from 0–11 that are meant to capture intact mental status. Episodic Memory is an average of the immediate and delayed ten word recall. Fraction Illiterate represents the fraction who can neither read nor write. Statistically significant at 1 percent (***) 5 percent (**) and 105 (*) level.

Table 4
Baseline OLS and IRT Analysis of Age, Gender and Education on Cognition

Independent Variables	Mental Intactness (0–11)			Episodic Memory (0–10)		
	OLS	OLS	IRT	OLS	OLS	OLS
Demographics						
Age (+45)	0.033 (0.056)	0.126*** (0.047)	0.058*** (0.019)	–0.002 (0.052)	0.112*** (0.049)	
Age square/100	–0.067 (0.045)	–0.125*** (0.038)	–0.055*** (0.015)	–0.043 (0.043)	–0.121*** (0.040)	
Female	–0.955*** (0.095)	–0.286*** (0.096)	–0.115*** (0.038)	–0.323*** (0.085)	0.095 (0.095)	
Urban		0.438*** (0.085)	0.166*** (0.034)		0.377*** (0.083)	
Zhejiang		0.958*** (0.086)	0.398*** (0.034)		0.179** (0.085)	
Height		0.112** (0.005)	0.005** (0.002)		0.007 (0.005)	
SES						
Education (illiterates omitted)						
Sishu/home school and below		1.391*** (0.114)	0.584*** (0.045)		0.598*** (0.114)	
Elementary school		1.582*** (0.118)	0.656*** (0.046)		0.804*** (0.116)	
Middle school		1.941*** (0.133)	0.766*** (0.052)		1.464*** (0.129)	
High school and above		2.399*** (0.152)	1.000*** (0.060)		1.671*** (0.147)	
Log household PCE		0.183*** (0.038)	0.097*** (0.017)		0.136*** (0.038)	
Observations	1,873	1,873	1,873	1,663	1,663	
R-squared	0.092	0.375	0.403	0.081	0.231	

Note: Standard errors in parentheses.

Columns 1–3 are models with Mental Intactness (on a scale of 0–11) as the dependent variable, while Columns 4 and 5 model Episodic Memory (the average of the ten word memory recalls (immediate and delayed)). Models 1, 2, 4, and 5 are based on Ordinary Least Squares (OLS) while Model 3 uses Item Response Theory (IRT). IRT models the response of a respondent of a given item in the test. The estimated coefficients from the Bayesian expected posterior model are listed.

100) > p
***
 $p < 0.05$
**
 $p < 0.1$
*

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Table 5

OLS and IRT Analysis of Mental Intactness

Independent Variables	OLS		IRT	
	(1)	(2)	(3)	(3)
Demographics				
Age (+45)	0.119** (0.047)	0.120** (0.047)	0.055*** (0.018)	0.055*** (0.018)
Age square / 100	-0.122*** (0.038)	-0.123*** (0.038)	-0.055*** (0.015)	-0.055*** (0.015)
Female	-0.516*** (0.127)	-0.409*** (0.132)	-0.158*** (0.052)	-0.158*** (0.052)
Urban	0.121 (0.131)	0.266* (0.139)	0.084 (0.055)	0.084 (0.055)
Urban *female	0.358** (0.160)	0.067 (0.187)	0.028 (0.073)	0.028 (0.073)
Height	0.012** (0.005)	0.011** (0.005)	0.004** (0.002)	0.004** (0.002)
SES				
Education (illiterate omitted)				
Sishu/home school and below	1312*** (0.115)	1.298*** (0.115)	0.543*** (0.045)	0.543*** (0.045)
Elementary school	1.511*** (0.120)	1.486*** (0.120)	0.603*** (0.047)	0.603*** (0.047)
Middle school	1.808*** (0.135)	1.781*** (0.135)	0.695*** (0.053)	0.695*** (0.053)
High school and above	2.256*** (0.184)	2.254*** (0.184)	0.939*** (0.072)	0.939*** (0.072)
Female *high school and above	-0.120 (0.278)	-0.184 (0.278)	-0.093 (0.109)	-0.093 (0.109)
Log household PCE	0.112** (0.046)	0.114** (0.046)	0.061*** (0.018)	0.061*** (0.018)
Community log PCE	0.485*** (0.144)	0.218 (0.169)	0.083 (0.066)	0.083 (0.066)
Community log PCE *female		0.558*** (0.186)	0.286*** (0.073)	0.286*** (0.073)
Prefecture dummies	Yes	Yes	Yes	Yes
Observation	1,873	1,873	1,873	1,873
R-squared	0.398	0.401	0.430	0.430

Note: Standard errors in parentheses.

Mental Intactness is based on components of the TICS battery scaled from 0–11 that are meant to capture intact mental status. Models 1 and 2 are based on Ordinary Least Squares (OLS) while Model 3 uses Item Response Theory (IRT). IRT models the response of a respondent of a given ability to each item in the test. The estimated coefficients from the Bayesian expected posterior model are listed. Prefectures are administrative units that govern a combination of counties in China.

***
p < 0.01

$p < 0.05$
**
 $p < 0.1$
*

Table 6
Height by Mean Log PCE of Community

Group	Height (cm)			
	Overall	Female	Male	Female-male
1	157.18	150.50	162.76	-12.26***
2	158.22	152.65	162.86	-10.21***
3	156.13	149.65	162.22	-12.57**
4	157.78	152.21	163.55	-11.35***
5	159.82	154.59	165.05	-10.46***
6	158.69	152.74	163.95	-11.21***
7	157.50	151.95	162.44	-10.49***
8	159.84	155.28	165.59	-10.31***
9	159.84	154.59	165.08	-10.50***
10	159.65	155.41	163.29	-7.89***
Overall	158.25	152.68	163.55	-10.87***

Note: Log PCE of community is the mean of the log of household PCE in the communities. Communities are separated into ten groups and are then ranked from lowest (1) to highest (10) based on mean community PCE. Height is measured in centimeters.

Table 7
Gender Differences in Cognition

a. Gender Differences in Cognition by Age in WHO Chinese SAGE Survey								
Age	Word Recall Mean				Digit Span Mean			
	Male	Female	F-M diff	N	Male	Female	F-M diff	N
25–34	7.447	7.494	0.047	134	6.761	6.744	– 0.017	134
35–44	6.612	6.671	0.059	321	6.387	6.094	– 0.293	321
45–54	6.013	6.020	0.007	1,540	5.923	5.561	– 0.362	1,540
55–64	5.609	5.539	– 0.069	2,396	5.643	5.275	– 0.368	2,396
65–74	5.033	4.801	– 0.232	1,644	5.364	4.854	– 0.510	1,644
75 +	4.165	3.900	– 0.265	909	4.962	4.261	– 0.702	909
b. Gender Differences in Cognition by Age in HRS 2006								
Age	Average of Immediate and Delayed Recall				TICS Score Count			
	Male	Female	F-M diff	N	Male	Female	F-M diff	N
50–54	5.408	5.794	0.387	1,574	NA	NA	NA	NA
55–59	5.258	5.752	0.495	2,387	NA	NA	NA	NA
60–64	5.127	5.610	0.483	2,272	NA	NA	NA	NA
65–69	4.750	5.249	0.500	3,206	9.384	9.330	– 0.054	3,232
70–74	4.430	4.851	0.421	2,630	9.291	9.317	0.026	2,662
75 +	3.619	3.903	0.283	4,454	8.945	8.809	– 0.136	4,568