Cognitive function, numeracy and retirement saving trajectories

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Abstract

This paper examines the extent to which cognitive abilities relate to differences in trajectories for key economic outcomes as individuals move into and through their retirement. We use data from the English Longitudinal Study of Ageing which has contained a detailed battery of cognitive functioning tests covering memory, executive function, numeracy and literacy along with comprehensive measurements of all other dimensions of health and socio-economic position for a large sample of adults aged 50 and over in England. In previous research we showed that cross-sectional differences in numeracy are strongly associated with cross-sectional differences in the level and composition of retirement wealth controlling for education and other dimensions of cognitive function, each of which have their own independent effects. In addition, numeracy is related to the probability of holding of risky assets and private pensions as well as to the understanding of pension arrangements and degrees of financial insecurity when we control for the level of financial wealth as well as the other factors. In this research we look at the extent to which differences in baseline numeracy (measured in 2002) and broader cognitive ability predict subsequent trajectories for key economic outcomes such as employment, wealth, retirement income and key dimensions of retirement expectations.

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1. Introduction

The effects of cognitive ability on life-cycle behaviour have become a topic of considerable research interest and policy concern. A subset of the resultant literature has looked at financial outcomes over the life course and examined the extent to which cognitive ability, numeracy and financial literacy are associated with financial saving, portfolio and asset accumulation outcomes as individuals age. The latter two of these dimensions – numeracy and financial literacy – have also become of widespread policy interest in the debate around retirement and pension policy in countries such as the UK where the extent of individual provision in retirement saving institutions has been increasing substantially in recent years.

In this paper we look at the relationship between numeracy and various retirement wealth related trajectories at older ages in England, whilst controlling for many other dimensions of cognitive ability as well as education and other socio-economic covariates. Our measure of numeracy is a very specific measure, focusing on an individual's abilities to carry out simple numerical calculations accurately. We do not have access to broader measures of financial literacy such as those used by Lusardi and Mitchell (2007) that capture other dimensions such as knowledge of financial products, knowledge of different types of risks/returns and use of advice. But, as we discuss briefly in the next section below, our previous analysis has shown this numeracy measure to be strongly correlated with portfolios. Our aim is this paper is to investigate whether these portfolio differences translate into differences in more fundamental outcomes in retirement, such as wealth accumulation and decumulation patterns, replacement rates, and even the degree to which expectations of the future are borne out. This is a somewhat ambitious agenda and with the data we have available, despite being perhaps the best available to date, we are only able to provide a suggestive and predominantly descriptive analysis at present.

1.1 Why might numeracy matter for retirement saving?

One useful starting point is to turn to the evidence from cognitive psychology in which recent papers have used experimental methods to examine the relationship between ability, time preference and willingness to take risks. Such studies typically use experimental designs to reveal preference measures on small groups of subjects in a laboratory environment. Some recent studies have also exploited cognitive load manipulation in the experimental design (essentially distracting subjects whilst they are taking their choices) in order to exploit within-subject variation in “ability”.[1] Within this literature there seems to be wide acceptance that higher ability individuals are more patient (see, e.g. Parker and Fischhoff, 2005; Bettinger and Slonim, 2005; and Kirby, Winston and Santiesteban, 2005). The relationship between risk aversion and cognitive ability is less widely studied, although what evidence there is suggests that higher ability individuals are in fact less risk averse than those of lower ability (e.g. Frederick, 2005; and Benjamin, Brown and Shapiro, 2006).

The reason why higher ability may lead to lower risk aversion or more patience is not fully understood, but it seems that cognitive resources are required to make patient, risk-neutral decisions. Frederick (2005) argues that it is not just the ability to calculate expected returns correctly that leads the more intelligent to take a gamble more often. Again, using experimental data he finds that those with higher cognitive ability were more likely to take a gamble than those with lower ability even when the expected return on the gamble was lower than the safe bet.

Consideration of the issue of the extent of cognitive resources employed in decision making, however, reveals the shortcomings of such empirical evidence for policy purposes since the time, effort and information deployed in making savings decisions in “real life” situations is itself a choice variable. In contrast, such factors are strictly controlled in a laboratory experiment. As an example, individuals with lower cognitive abilities may spend more (or less) time on their

[1] By increasing the cognitive load the “working memory” capacity of the brain is decreased. Since working memory capacity is almost perfectly correlated with general cognitive function, this manipulation is argued effectively to reduce cognitive ability.

saving and pensions decisions than those with higher ability, or be more likely to use various forms of advice or information in their saving and investment decisions.[2]

Conversely, higher ability (and, particularly, more numerate) individuals may be more able to process information and make complex "optimal" decisions in a less costly manner. A series of studies has explored how ability to understand and transform probabilities relates to performance on judgement and decision tasks. Peters et al (2005) summarise their evidence as showing that more numerate individuals were "more likely to retrieve and use appropriate numerical principles, thus making themselves less susceptible to framing effects"[3] and "tended to draw different (generally stronger or more precise) affective meaning from numbers and numerical comparisons, and their affective responses were more precise". Numerical ability appears to matter to complex judgements and decisions in important ways although the extent to which this evidence is relevant depends on the extent to which individuals know their abilities and change their investment planning behaviour accordingly.

Given the complexity of saving and portfolio choices facing individuals in modern financial markets it is not clear that simple preference measures established in somewhat abstract experiments can adequately describe the differences in saving propensities across types that are of interest to economists. Therefore there is still considerable merit in looking at economic data on the distribution of saving and wealth outcomes across abilities, even bearing in mind the empirical difficulties discussed above. Data combining information on economic outcomes and cognitive abilities are now becoming available with which such hypotheses can be investigated. Benjamin, Brown and Shapiro (2006) use the US National Longitudinal Survey of Youth (NLSY) to look at the relationship between cognitive ability and a very crude measure of asset

[2] Lusardi (1999) and Ameriks, Caplin and Leahy (2003) both show an association between financial planning and higher financial wealth but neither study looks at differences by ability.

[3] A framing effect is where the interpretation of a number depends on the way in which it is presented. For example, if meat is presented as being "25% fat" or "75% fat-free".

accumulation and find low cognitive function to be associated with low asset accumulation and financial market participation.

In our previous work on cognitive abilities and components of financial wealth of a large cross-sectional sample of older adults (aged 50–74) in England, we showed significant correlations between the level of financial wealth and both a broad measure of cognitive functioning and a narrow measure of numerical ability based on performance in a series of simple calculations (Banks and Oldfield (2007)). These associations hold when both measures are used simultaneously in a model that also includes measures of education as well as gender and age dummies. Of course, higher cognitive abilities typically result in higher earnings, but what is striking is the role of numeracy over and above other dimensions of cognitive abilities. To the extent that human capital is sufficiently controlled for by general measures of cognitive functioning and memory in these estimates, the role of numeracy may be thought to be indicating a separate mechanism relating to preferences for saving out of lifetime income. Finally, when it comes to portfolio decisions, cognitive ability and numeracy were both associated with a higher likelihood of holding stocks and of having a private pension, even when controlling for the level of financial wealth in addition to the factors mentioned above.[4]

A variety of further evidence is beginning to emerge that relates saving and portfolio choices and outcomes to the psychology of decision making, and much of that research is motivated by the view that simple preference heterogeneity in the context of a standard intertemporal economic model is not sufficient to explain certain features of observed behaviour or other outcomes. Most important, perhaps, is a rapidly expanding literature broadly relating to people's ability to exercise self-control when choosing between present and future options. Variants of this include experimental evidence on the dynamic inconsistency of choices (e.g. Ainslie, 2001), exploration of the economic implications of quasi-hyperbolic discounting models

[4] Lusardi and Mitchell (2007) show similar results for a broader measure of financial literacy using data from the US Health and Retirement Study.

(e.g. Laibson, 1997), or the modification of the underlying axioms of individuals' economic preferences to allow for temptation (Gul and Pesendorfer, 2004). In each case, important implications for saving, portfolio and consumption behaviour have been demonstrated and ideally such implications would need to be considered in designing a dynamic optimal tax policy. Empirical evidence suggests that levels of self-control vary substantially within the population and are affected by cognitive load (Shiv and Fedorikhin, 1999). Additionally, those demonstrating higher self-control in early childhood (measured by experimental evaluations of young children's ability to delay gratification) have been shown to have better outcomes in a variety of economic and social dimensions in adolescence and early adulthood (see Eistig et al (2006) in particular, or Borghans et al (2008) for a brief overview of the evidence).

2. Data

Our analysis will use the first three waves of the English Longitudinal Study of Ageing (ELSA) which is a survey that provides a representative sample of the English population aged 50 and over on February 29 2002. The study contains a complete picture of financial circumstances (including savings and pension arrangements) as well as detailed information on health and socioeconomic factors (see Marmot et al (2003) for further details and description of the ELSA data). Data from the study have already been used to look at a diverse set of issues ranging from pension and retirement saving outcomes (Banks et al 2005) to physical health and functioning (Banks et al (2006) or Melzer et al (2005) for example) and quality of life (Netuveli et al (2006) and these papers demonstrate the advantages of collecting data on multiple dimensions of circumstances and functioning in later life.

Three waves of data, covering the period 2002 to 2006 are now available for analysis with the fourth wave currently in the field. The study provides data on considerable numbers of older individuals on which to base our analysis – 12,100 adults were interviewed at wave 1 of which 11,392 were 'original sample members' born on or before 28 February 1952. In subsequent waves 9,324 and 7,976 of these were interviewed in 2004 and 2006 respectively. In addition a further 1,795 observations were added to the 2006 sample representing younger cohorts (aged between 50 and 54 in 2006), their partners, and any new partners of original sample members. These latter observations are not used in our analysis since we will be looking at trajectories from 2002 onwards within the original sample only.

The 'core' ELSA questionnaire is delivered in each of the three waves and collects details of all savings, investments, debts held by sample members as well as full details of pension arrangements and housing wealth and various indicators of financial expectations. Our measure of financial wealth is defined at the benefit unit level (i.e. either a couple or single plus any dependent children they have) and our analysis, which is at the individual level, is weighted appropriately and uses standard errors that are clustered at the benefit unit level. The issue of joint decision making and its consequences for our analysis is discussed at the end of this section.

The ELSA core questionnaire instrument also includes a module of questions designed to measure cognitive ability and it is these measures that we will focus on in this paper. These cognitive measures are collected as part of the face to face interview and are designed to partition cognitive functioning into two broad domains, each with sub-components for which blocks of measures have been designed. The first domain relates to memory, with components comprising retrospective memory (recalling things from the past) and prospective memory (remembering to remember things in the future). The second domain, perhaps more relevant for our analysis, relates to executive functioning. In this domain the ELSA instrument comprises specific tasks (relating to verbal fluency, attention, visual search and mental speed) and a set of questions to identify numerical ability and literacy. With respect to the latter, numerical ability questions were delivered in 2002 and a short literacy module was delivered in 2004.[5] Steel et al (2003) describe

[5] At this point in time both numeracy and literacy have only been measured once, so our analysis will not be able to look at changes in these dimensions and how such changes correlate with changes in financial (or any other) circumstances. The 2008 wave of ELSA data currently in the field is recollecting data on numerical ability and the 2010 questionnaire is scheduled to include the literacy items.

the tests in more detail (excluding literacy) and derive a global cognitive index and show that this index covaries with factors in the expected ways. For example global cognitive function is lower in older age groups, and higher for individuals with more education or better health.

2.1 Measurements of numeracy and literacy

As the numeracy measures are a key element of what follows below, we briefly outline the key measures here although the measure used is identical to that described in more detail in Banks and Oldfield (2007). In addition, subsequent to our previous analysis, data on literacy has been collected for ELSA respondents so we will briefly discuss the correlation with numeracy and include literacy in all our subsequent analysis in section 3.

The 2002 ELSA questionnaire asked respondents up to five basic questions involving successively more complex numerical calculations.[6] The six possible questions are presented in Appendix 1. Answers to all questions are entirely unprompted (i.e. respondents are not given a menu of possible answers to choose from). Each respondent initially receives questions q2, q3 and q4. If all of these are answered incorrectly the respondent receives question q1 and that is the end of their numeracy module. Otherwise the respondent receives question q5. If the respondent reports a correct answer to any (or all) of questions q3, q4 and q5, they receive the final and most difficult question q6 that requires an understanding of compound interest. Since more able individuals receive more questions in this design the number of questions answered correctly is a straightforward measure of numerical ability that can be derived simply from this module. This is the measure summarised by Steel et al (2003) in their initial descriptive analysis of the ELSA data.

The numerical ability measure we derive from the ELSA data is instead designed to place individuals into one of four groups according to their broad numerical ability. This has the

[6] A similar study in the US – the Health and Retirement Study – delivered an experimental module of measures of financial numeracy to a subsample of their survey respondents, partly with the aim of comparing to the ELSA measures, in their 2004 wave. Although the questions are not strictly comparable, a descriptive analysis of this US data and how it correlates with retirement saving arrangements is presented in Lusardi and Mitchell (2007)

advantage of allowing us to choose groups that have some prevalence in the population since a simple counting of correct answers does not take into account the relative difficulty of the questions and furthermore may lead to some clusters where there are many observations, with relatively few individuals at the extremes. Hence for our analysis we choose to define numerical ability in four broad groups according to which of the questions were correctly answered. This coding is indicated in Appendix 1. [7]

Figures 1a and 1b show how these four categories of numerical ability co-vary with age, sex and education. We use a simple classification of the population into three education groups - Low education is defined as having no academic qualifications, medium education is defined as having o-levels or equivalent and high education is defined as having a-levels (or equivalent) or higher.

Across all education groups, numerical ability as defined by these measures is greater for men than for women, and greater for younger individuals than for their older counterparts, as with the more aggregated analysis in Steel et al (2003) who simply report the average number of correct answers by group. The association between numerical ability and education is clearly evident in the data -groups with higher education have higher numerical ability as would be expected. Despite this strong correlation, however, there is still a reasonably good distribution of the population across the four numerical abilities within each education group. This is particularly true for the younger sample members who will form the sample of 'retirees' on whom some of the analysis in the latter sections will focus. There are individuals with low numerical ability in the highest education groups and individuals with high cognitive ability in the low and medium education groups. The presence of such variation is important if we are to look at the separate effects of education and numeracy on pension understanding and financial insecurity.

[7] In our previous analysis, we experimented with splitting the largest group (Group II) into two further subgroups, and our conclusions were unaffected. We do not pursue it further here.

Notably, the age pattern in the 'decline' in numerical ability is much stronger for the more educated groups, both for men and women, particularly at the top end. Thus the differences across education groups, whilst still present, are less marked in the oldest members of the ELSA sample in comparison to the 50-59 year olds. It should be repeated, however, that our numeracy data are currently cross-sectional in nature, and the presence of both differential mortality (the rich and cognitively able living longer than their poor and less able counterparts) and the presence of cohort differences in numeracy will mean that these correlations may not be the true age profiles. Whilst the true age profile will only be revealed in longitudinal data, it is possible to speculate on the sign of such biases. Differential mortality would reduce the extent to which we observe a decline with age in our sample and, to the extent that compound and simple interest was more likely to be taught to the older members of our sample, cohort differences in the nature of education would work the same way. In these circumstances the age related decline observed in figures 1a and 1b may even be an underestimate of the true decline with age.[8]

One further comment on cohort effects is warranted - the difference between men and women in the cohorts currently aged 50 and over taken together (i.e. the whole ELSA sample) is unlikely to be indicative of differences between men and women for future cohorts. Current and future generations of working age women have very similar educational and labour market circumstances to their male counterparts and, if such circumstances lead to higher levels of numeracy, one might expect future generations of older women to be more comparable to men.

Of course, to argue that such differences in numeracy across individuals are the relevant ones for analysis of retirement saving and retirement saving trajectories, we need to believe that these differences, collected in 2002, are appropriate indicators of the previous lifetime differences across individuals, or at least the differences that have been present across the portion of life where individuals have been working in the labour market and making their own consumption

[8] Of course, cohort effects in the proportion of individuals with higher levels of education (if this extra education led to higher levels of numeracy) would affect the composition of individuals across age bands and might affect the bias in any measure of the unconditional age decline in numeracy.

and saving decisions. Obviously our study provides no data on numeracy levels prior to 2002, and therefore prior to age 50 for the youngest sample members, and nothing prior to even older ages for the others. Evidence from other studies, however, such as that presented in Figure 2, suggests that it is only from the late forties that any age decline begins to set in. Hence we are reasonably confident that the differences between individuals captured here are genuinely reflective of differences across earlier parts of the life-course when key intertemporal consumption and labour supply decisions were being taken.

Turning to the 2004 measure of literacy, once again there is substantial covariation in cognitive abilities along this dimension with both the other measures of cognitive abilities and with education.[9] To summarise the key issue for our purposes, Table 1 shows the correlation of numeracy and literacy scores by presenting the proportions within each numeracy group that fall into each of the three literacy groups. A number of features are worthy of comment. Firstly, the literacy test was a relatively low level test – around two thirds of the sample were in the highest group (receiving a perfect score in the test) and only around one in seven were in the bottom category. These fractions showed systematic variation with age and education along the same lines as the numerical data described above, but this analysis is not presented here. A second feature of Table 1 is the strong correlation between the literacy and the numeracy scores. Indeed it is only really within the bottom two numeracy groups that there are substantial proportions of individuals receiving less than perfect scores in the literacy tests.

One final issue warrants discussion before we turn to our key empirical analysis, and this is the issue of individual versus household decision making. Many of the outcomes on which our analysis will focus in the following section are defined most meaningfully at the household (or at

[9] The literacy test is a simple set of three questions relating to a short paragraph of text about a hypothetical medicine and the circumstances under which it should be taken. The paragraph is printed on a card and respondents are allowed to refer to the card whilst answering the questions. The test is just scored categorically from 1 to 3 according to how many of the answers given were correct (with those giving no correct answers grouped together with those giving one correct answer).

least the benefit unit) level.[10] Indeed, for some measures such as wealth, they are only available at this level due to the way that they were collected in the ELSA survey instrument. Given that our cognitive ability measures are at the individual level, some control needs to be made for within-household differences in numeracy and literacy to the extent these exist. After all, one may not need to be numerate if one is married to someone who is numerate and they are taking an active role in the management of household saving and consumption decisions. Our strategy in dealing with this will be to allocate each member of the couple the highest numeracy and literacy scores within that couple when we are analysing benefit level outcomes such as income and wealth, effectively assuming they benefit from full sharing of the abilities and knowledge of their partner.

Of course, to the extent that there is a perfect correlation between the abilities of each member of a couple this would be an inconsequential assumption. But Table 2 shows the correlation in numeracy scores between men and women in couples in our data and the correlation is far from perfect. Looking at the third row of this table as an example, of the one third of men that are in numeracy group 3, only 9.24 percentage points are married to someone who is also in that numeracy group. Instead roughly half of the spouses (17.79 percentage points) are in numeracy group 2, with substantial fractions in both the lowest and the highest numeracy groups as well. Similar patterns exist for each of the levels of numeracy, whether one chooses to look along the rows (i.e. indexed by the males numeracy level) or down the rows (i.e. indexed by females numeracy level). Of course the fact that numeracy scores are higher for men than for women mean that there is, on average, more sample above the diagonal than below.

The effect of this 'household' assumption on the correlation between numeracy and literacy is in fact to increase the correlation between the two dimensions even further. Table 3 replicates the analysis of Table 1 but instead using the maximum household levels for numeracy and literacy as opposed to the individual scores. Over ninety per cent of the top numeracy group

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[10] The terms household and benefit unit will be used interchangeably in what follows for simplicity of exposition, however, all analysis is at the benefit unit, not the household level.

defined this way are also in the top literacy group, and the proportion of the lowest numeracy group falling into the lowest literacy group rises from 36% (at the individual level) to over 40% when defined at the household level.

3. Cognitive function and retirement saving trajectories

In what follows we focus on three key elements of retirement saving trajectories and consider whether, and if so how, their subsequent evolution differs across groups defined by their numeracy status as measured at the initial 'baseline' of 2002. At this point the analysis is somewhat descriptive, focusing simply on the evolution of wealth, retirement income, food consumption and expectations over the following four years to 2006. Multivariate analysis is presented simply as a way of controlling for other potentially confounding baseline factors and additionally any effect of imputation (particularly for wealth) on the observed profiles. Nevertheless, the simple analyses do serve to illustrate whether the somewhat marked differences in baseline portfolios across numeracy groups that were observed in Banks and Oldfield (2007) led to (short-run) consequences for more fundamental retirement savings outcomes.

3.1. Changes in financial wealth

We begin our analysis by looking at trajectories for real net financial wealth defined as the value of all financial assets (i.e. excluding private and state pensions and housing) less the value of any outstanding non-mortgage debts. With the longitudinal dimension of our data being relatively short (three observations over the period 2002 to 2006) we have no hope of using the now-standard approaches to attempt to distinguish age effects from time or cohort effects. So instead we just confine ourselves to some descriptive analysis of unconditional wealth profiles by date of birth cohort and some multivariate models of changes in wealth for broad age groups.

Figure 3 presents average real net financial wealth profiles by age for cohorts defined by 5 year date of birth intervals, with each date of birth cohort split into two groups according to the baseline numeracy score. The high numeracy group comprises those falling into groups 3 and 4 of our classification, as identified in Box 2 of Appendix 1, with the low numeracy group being the remainder. The use of five-year date of birth cohorts prohibits a finer numeracy classification since the number of observations in the two extreme high and low numeracy groups would be insufficient at the two ends of our date of birth sample.

Figure 4 presents the 25th, 50th and 75th percentiles of the net financial wealth distribution at each age for each date-of-birth/numeracy cohort.[11] The strong correlation between numeracy and the level of financial wealth is immediately apparent in each of these figures, with the wealth levels for the higher numeracy group substantially above those for the low numeracy group for all date of birth cohorts. More interestingly from our perspective here, there is some albeit weak evidence of a more pronounced hump-shape in wealth profiles for the high numeracy group than for their low numeracy counterparts, particularly at the median and 75th percentile in Figure 4. But the differences in the hump shape seem to come more from differences in the 'cohort effects' (i.e. the vertical shifts between the lines for each date of birth at similar ages) rather than from markedly different slopes of the age changes within each cohort.

In order to investigate these wealth changes in more detail we need of course to control for the many other factors that are correlated with numeracy, not least education and other dimensions of cognitive function. Tables 4a and 4b present a simple multivariate analysis in the form of a set of quantile regressions – for the 25th, 50th and 75th percentile of the change in real net financial wealth between 2002 and 2006 – with the sample split loosely into those in 'pre-retirement' and 'post-retirement' years.[12] In each of the models it is the most advantaged groups

[11] Of course, to interpret these as true age-profiles for date of birth cohorts we would need numeracy to be constant for each date-of-birth cohort over the period in question, which is one of the reasons we choose two numeracy groups rather than four for this analysis. In addition, the profiles in Figure 4 cannot be necessarily interpreted as cohort profiles since, unlike the means presented in Figure 3, the quantiles do not necessarily refer to the same households in each year and hence composition is not necessarily constant over time.

[12] Individuals immediately around the time of retirement, i.e. aged 60-64 in 2002, who would be 64-68 by the end of the sample, are omitted from the analysis due to the potentially complex wealth transitions associated with receipt of lump sumps from pensions that may be occurring around this time. In addition, since retirement ages vary widely within this window it is not clear whether this age sample would or should be, on average, accumulating or decumulating wealth.

that are defined as the reference group, i.e. those with the highest numeracy, literacy and education. Table 4a shows that, prior to retirement, asset accumulation is somewhat lower for the lower numeracy groups, whether one chooses to control for initial wealth levels or not. This is true across all quantiles of the distribution of changes in wealth. After retirement, the evidence is more mixed, although the upper quantiles of the distribution of changes in wealth are lower amongst lower numeracy groups. Once again, these differences exist over and above the effects of education differences, literacy and other dimensions of cognitive function, and indeed baseline levels of net financial wealth.

3.2. Replacement rates

Financial wealth is only one element of retirement resources, and what is more, it is an element that is of differing relative importance across the socio-economic groups. A broader measure of 'smoothing' across pre and post-retirement states might be thought to be some measure of replacement rates for net income, or consumption changes. Net incomes are completely measured in the ELSA survey so replacement rates are straightforward to analyse. When it comes to consumption changes, the only item of non-housing consumption measured consistently across the three waves we use here is food consumption. Other non-food items were collected in 2004 and 2006, but we do not observe enough retirements in that pair of years alone to be able to facilitate a detailed analysis.

Our analysis of replacement rates simply compares levels of income and food consumption before and after households are observed to retire, regardless of how old they were when they retired. As such, our sample is limited to the 800 or so individuals that are observed retiring in the four year window and have full information on all the financial and cognitive variables required for our model. Figure 3 presents unconditional summary statistics for the distribution of net income replacement rates for retirees between 2002 and 2006 across the four numeracy groups and Figure 4 provides a corresponding analysis for the distribution of changes in food consumption. There are relatively few apparent differences across the groups. The distribution of income replacement rates is somewhat more compressed for the lowest numeracy group but other than that there are no differences across groups. On the spending side, median food spending seems to fall on retirement for the lower numeracy groups but not for the most numerate, and indeed other percentiles of the distribution appear positively correlated with numerical ability.

The multivariate models of the same changes, presented as both OLS and quantile (median) regressions in Tables 5 and 6 show that these apparent effects are consequences of other confounding variables rather than of numeracy itself. Income replacement rates are lower for those that retire in their early fifties, and are naturally heavily dependent on whether the spouse is in or out of work in each of the two years (since our measure of income is at the household level). Other than that, however, there is no role for either numeracy or any of the other cognitive function variables. This is true whether or not we control for initial wealth, although for brevity, the models without initial wealth controls are not presented here. The analysis of changes in real food expenditures before and after retirement is even less enlightening, with very few variables having statistically significant effects in either the OLS or the quantile specifications. It is worth noting, however, that the signs and magnitudes of the parameters are certainly consistent with the basic patterns observed at the median in Figure 4.

3.3. Expectations

Our final evidence on longitudinal trajectories relates to expectations of retirement and the information individuals may have about their future circumstances. In common with a number of ageing studies, ELSA collects quantitative information on subjective expectations of a number of future events using the 'per cent chance' methodology. Individuals are asked to assess the chances of future events on a scale of 0 to 100, where 0 means there is no chance and 100 means the individual is certain the event will occur. Whilst ELSA collects expectations data on mortality probabilities, housing values, future health outcomes and inheritances/bequests, we focus here on two particular dimensions of expectations. First we look at the expectations of future work for those currently in work. For the large majority of those working at our baseline sample, these expectations can be assessed directly against the subsequent outcomes over the period that the expectations were referring to. Second, we look at individuals subjective chances that their financial resources will, at some point in the future, prove inadequate to meet their needs.

Taking employment probabilities first, we simply divide up the sample that were employed at wave 1 into groups according to their self-reported chances of employment at future ages. For those that crossed the 'reference ages' we calculate the fraction that actually were in work, split by the two broad numeracy groups representing the bottom two and top two numeracy categories respectively.[13] In Figure 7 these employment outcomes are plotted against the employment expectations for each of the two groups.[14] Once again, whilst there are differences between the groups, and these differences go the way that one might suspect – the relationship for the higher numeracy group is steeper representing a stronger correlation between expectation and outcomes – the differences between groups are not particularly striking.

When it comes to expectations of the adequacy of future retirement incomes there is no concrete benchmark or outcome against which we can assess the expectations of different groups of the population. Instead, we therefore look at the stability and the correlation of these expectations over time within individuals. Table 5 provides an analysis of the correlations between expectations in 2006 and those collected in 2002, with the correlation allowed to depend on numeracy and a substantial set of controls for other factors. In addition we split our analysis into three age groups to capture the fact that future financial insecurity may change as individuals move into, and through, retirement. Table 5 shows that, for all age groups, the correlation over time in expected financial security is strongest for the most numerate group, even controlling for

[13] A strong correlation of low numeracy with labour market status, coupled with low prevalence of low numeracy amongst the youngest (working-age) groups means that there is insufficient sample size to do this analysis broken down by a four-way numeracy split.

[14] In this sectionwe work with individual level numeracy, literacy and cognitive function measures since expectations are characterized at the individual level in contrast to the benefit level outcomes and cognitive measures of the rest of our analysis.

other cognitive and socioeconomic variables. But this correlation is relatively weak for all individuals and particularly so at the oldest ages. The table also shows that, amongst those approaching retirement, those with low numeracy have systematically higher self-reported chances of future inadequacy of financial resources, even when we control for the level of wealth and education. The same is true for literacy. To quantify these effects, a low numeracy, low literacy individual in the bottom wealth quintile reports on average a chance of future resouce inadequacy that is 29 percentage points higher than that for the reference individual. And the correlation in these expectations over time for individuals of this type would be 0.25 as opposed to almost 0.4.

4. Conclusions

As the UK has moved more towards a system of individual provision for retirement income, the importance of an individual or household's abilities to take the right choices when it comes to providing for their retirement – either in terms of the decision to accumulate financial wealth, the form in which such wealth should be accumulated, or the decision of when to retire and how that might affect ones retirement income – has increased. In addition to preferences, key components to individual's choices are the information the individual has about the relevant options available and their ability to process this information. Indeed the British government's 'informed choice' agenda has explicitly targeted improvements in these latter two dimensions, along with simplification of the private savings environment, as a goal for government policy (Sandler (2002), Pickering (2002)).

This paper has looked at broad retirement wealth and retirement-related trajectories by groups defined by cognitive function, numeracy, literacy, education and wealth. Whilst our previous analysis identified marked differences in portfolios, asset-holding behaviour and knowledge of pension arrangements across numeracy groups, the analysis in this paper has demonstrated that it is much harder to find substantial effects on subsequent trajectories for the broader retirement outcomes we have studied here. In particular, whilst there may be some weak evidence for a more ‘hump shaped’ profile of wealth amongst more numerate households this does not systematically translate into differences in replacement rates, either defined as ratios of post-retirement to pre-retirement incomes or ratios of post-retirement to pre-retirement consumption. And whilst there is some evidence for less informed expectations of the future amongst lower numeracy older individuals it is hard to separate this from any effects of differential reporting behaviour across numeracy groups or from genuine differences in the shocks and variability of economic circumstances that these groups might face.

There are a number of possible explanations for these findings. One is simply that predicting individual level changes in panel data from permanent ‘baseline’ differences across individuals is always going to be a challenge, particularly when outcome variables (such as wealth) are measured with error and the available time-series of longitudinal information is short. Another important contributory factor, however, may well be that the vast majority of retirement resources for low numeracy households does not come from privately saved (non-pension) financial assets and hence portfolio differences have little consequences for differences in broader retirement outcomes. Put simply, the fact that the less numerate hold systematically different portfolios may well be only of second or third order importance for determining retirement outcomes since the latter are driven much more strongly by state pensions, other components of the welfare system, informal insurance mechanisms, and perhaps housing.

Perhaps this is not surprising. As Browning and Lusardi (1996) discuss in their survey article on the life-cycle consumption model, non-life-cycle behaviours (such as those hypothesised in behavioural-type models) are much more likely to be evident in portfolio choices than at the more aggregate consumption-savings margin, since ‘behavioural’ consumers will still smooth their consumption one way or the other. A similar phenomenon could well be at play with regard to lower numeracy or less financially literate individuals. This is not to say that numeracy and financial literacy do not matter, nor that they may not become more important over time as the degree of individual provision and the complexity of financial institutions and portfolio options increases.

At this stage, our findings are therefore somewhat preliminary. Since the English Longitudinal Study of Ageing is a continuing longitudinal study, new insights will become available as we get the ability to follow the wealth trajectories of individuals for longer periods pre and post retirement, to control for age-related changes in cognitive function and numeracy, and to observe a greater number of individuals and households retiring. The analysis of such data, possibly combined with a behavioural model of individual financial decision making and its consequences for wealth accumulation and financial insecurity will continue to be a priority for future research.

In addition, the development of cognitive and numerical tests that can, with relatively few questions, distinguish in a more graded way between individuals at the extremes of the cognitive functioning distribution would be useful, and such activities are underway in a number of ageing studies. This will be particularly important for studying working age individuals and those at or approaching retirement whose choices may be the most complex. Combining such data with individual level data on financial literacy, the information individuals have for planning purposes, and the use of advice would offer a particularly promising avenue for future research.

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APPENDIX 1
Derivation of numeracy classification variables

Box 1a. Numeracy items in ELSA questionnaire

q1) If you buy a drink for 85 pence and pay with a one pound coin, how much change should you get?

q2) In a sale, a shop is selling all items at half price. Before the sale a sofa costs £300. How much will it cost in the sale?

q3) If the chance of getting a disease is 10 per cent, how many people out of 1,000 would be expect to get the disease?

q4) A second hand car dealer is selling a car for £6,000. This is two-thirds of what it cost new. How much did the car cost new?

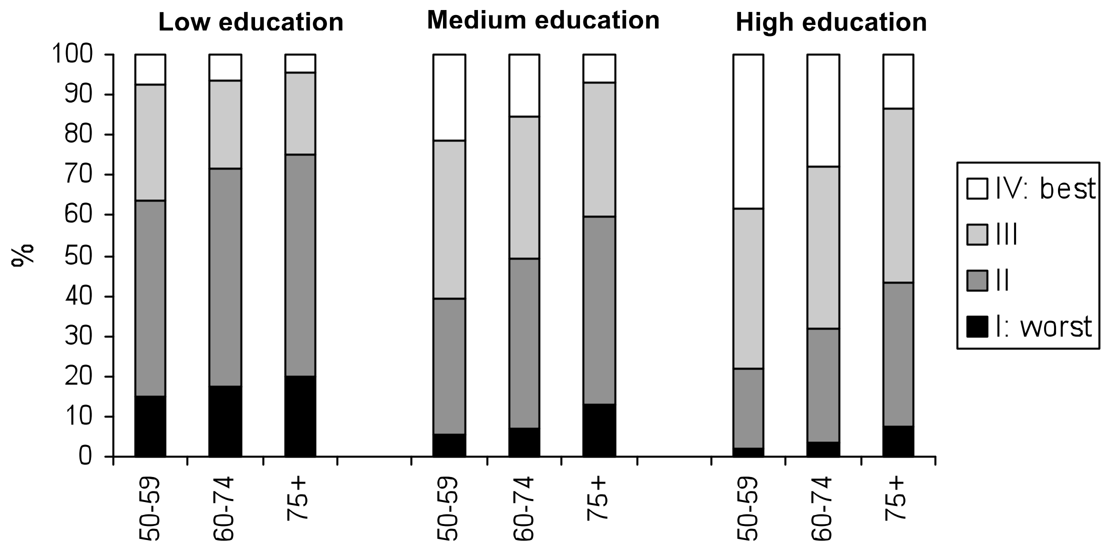
q5) If 5 people all have the winning numbers in the lottery and the prize is £2 million, how much will each of them get?

q6) Let's say you have £200 in a savings account. The account earns ten per cent interest per year. How much will you have in the account at the end of two years?

Box 1b. Construction of broad cognitive function categories

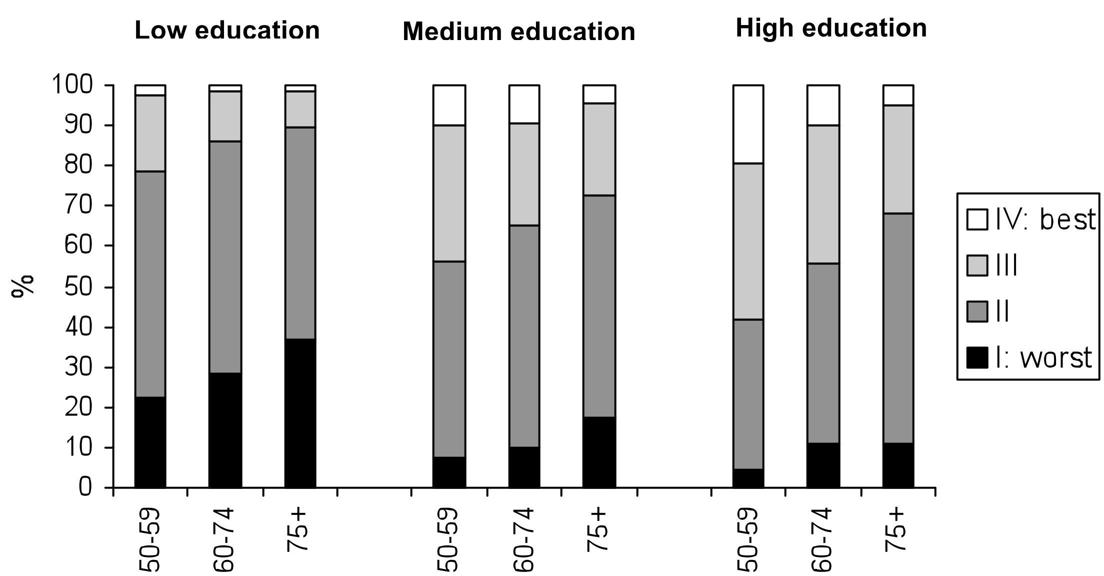
Classification	Response to questions	Proportion of sample
Group I	Either: q2, q3, q4 all incorrect Or: q2 correct; q3, q4, q5 all incorrect	16.24%
Group II	At least one of q2, q3, q4, q5 incorrect; q6 incorrect	46.46%
Group III	q2, q3, q4, q5 correct; q6 incorrect	26.08%
Group IV	q2, q3, q4, q5, q6 correct	11.22%

Figure 1a: **Broad numeracy score, by age and education: Men**



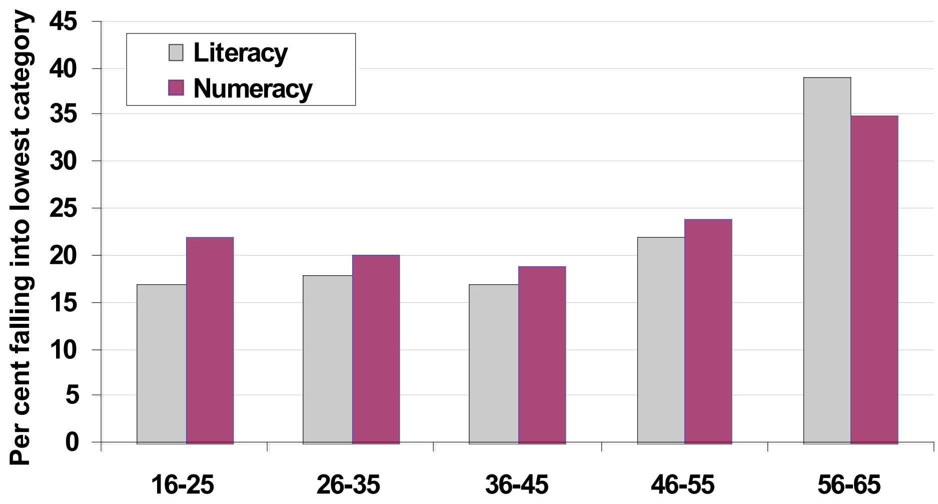
Source: Banks and Oldfield (2007)

Figure 1b: **Broad numeracy score, by age and education: Women**



Source: Banks and Oldfield (2007)

Figure 2. No evidence of cognitive decline before age 50



Source: Adult literacy in Britain, ONS, 1997

Figure 3: Mean real net financial wealth profiles by date of birth and broad numeracy cohort

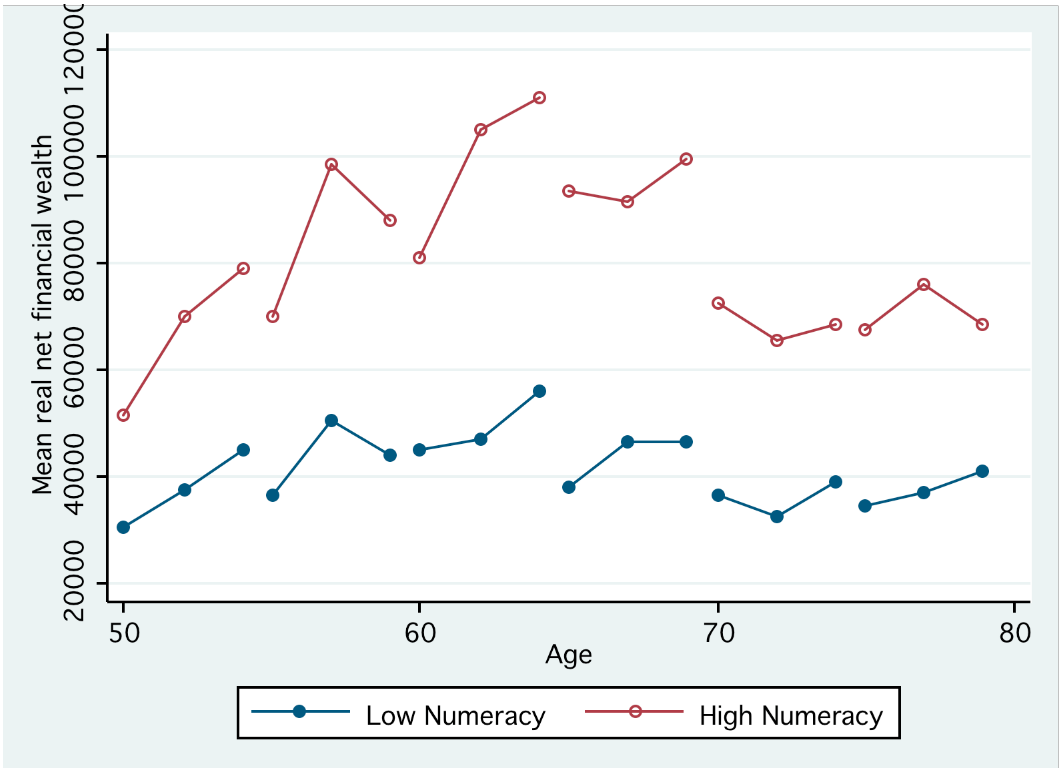


Figure 4: Quantiles of real net financial wealth over age,
by date of birth and broad numeracy cohort

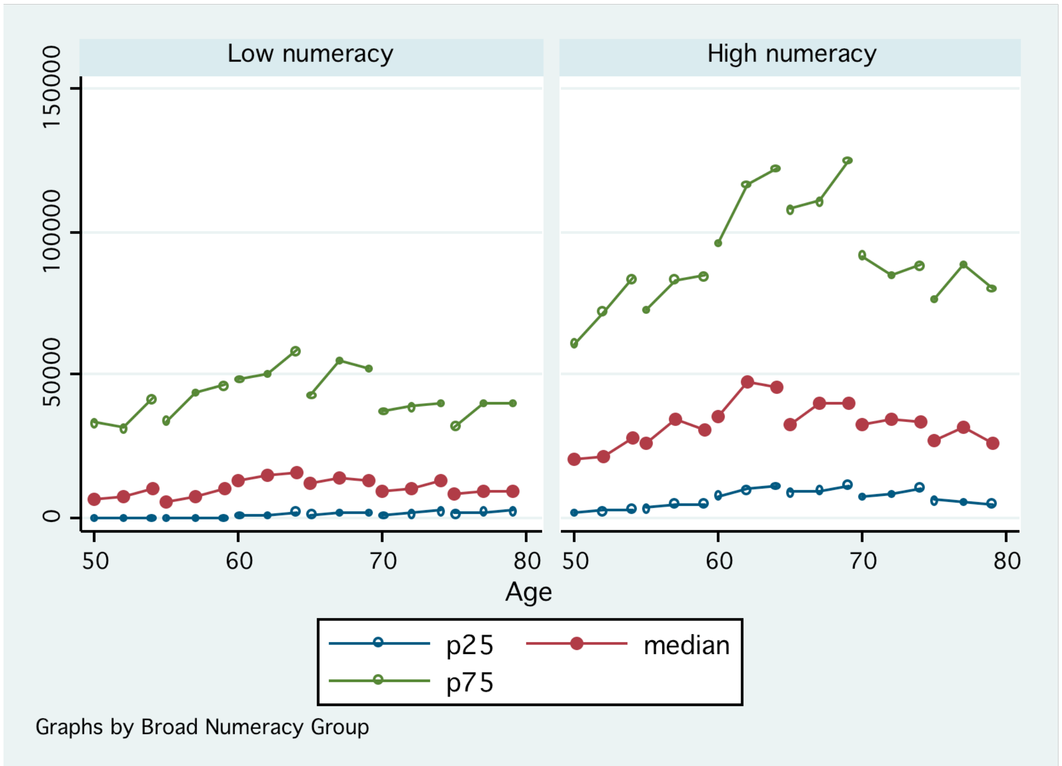


Figure 5: Distribution of net income replacement rates, by numeracy type

Households with at least one member retiring between 2002 and 2006

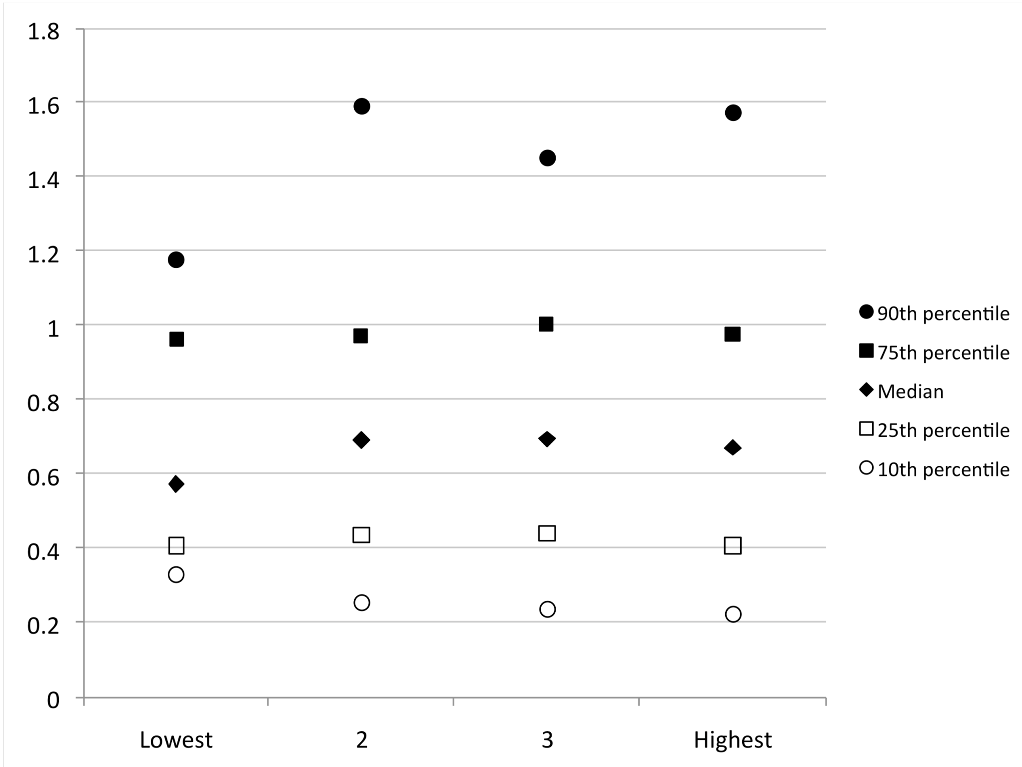


Figure 6: Distribution of food consumption replacement rates, by numeracy type

Households with at least one member retiring between 2002 and 2006

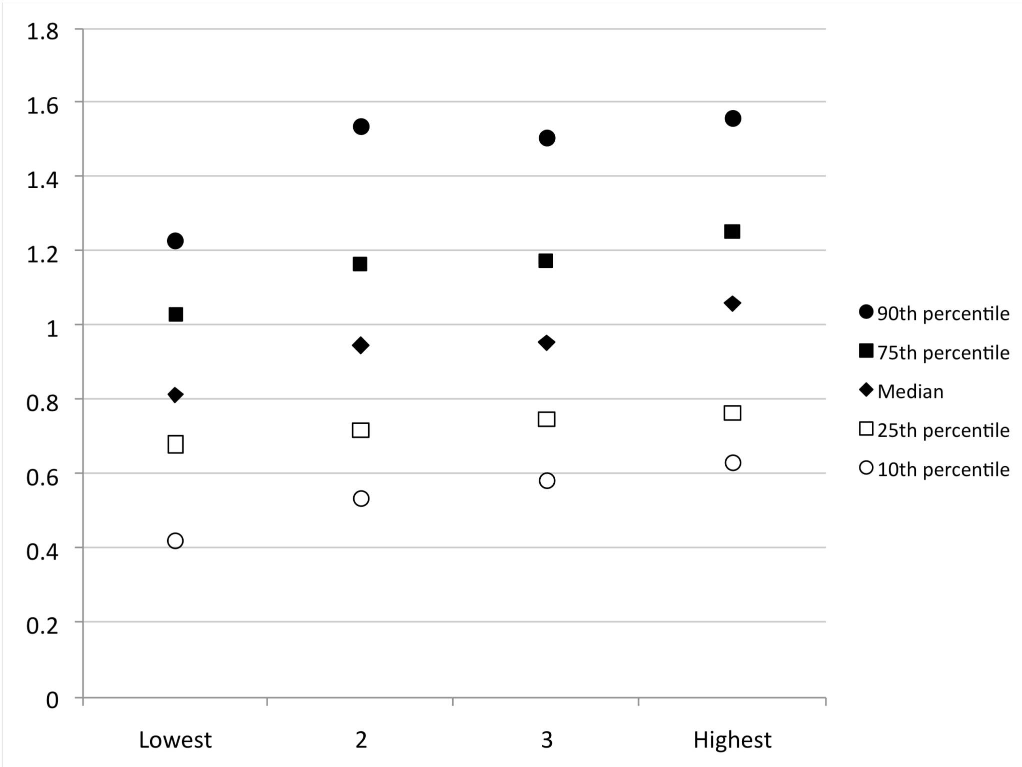
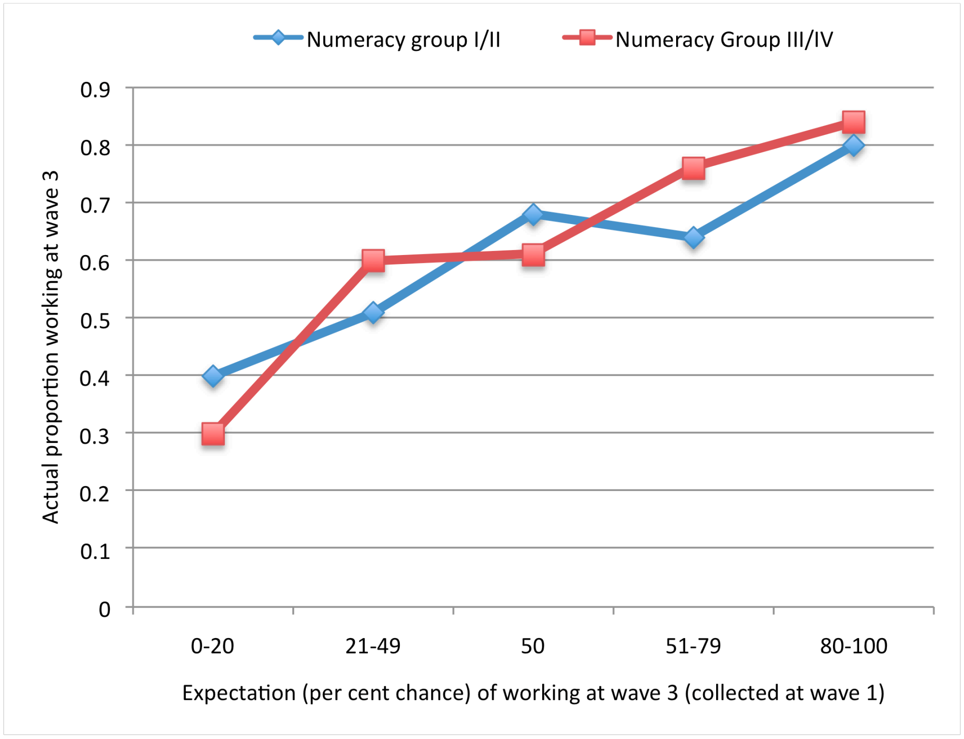


Figure 7: Accuracy of future work expectations



Note: Sample is all those working at wave 1 who crossed the reference age for the expectations question (Women 50-54: Reference age = 55; Women 55-59: Reference age = 60; Men 50-59: Reference age = 60; Men 60-64: Reference age = 65).

Table 1: Correlation of numeracy and literacy scores

% distribution	Lowest literacy	Medium literacy	Highest literacy
Lowest numeracy	36.90	25.51	37.59
2	14.64	23.88	61.48
3	7.48	17.33	75.19
Highest numeracy	5.54	10.87	83.58
All	13.58	20.30	66.12

Table 2: Correlation of numeracy scores within couples

Percentage of total sample of couples in each combination

2:Female 1:Male	Worst	2	3	Best	All
Worst	2.85	4.26	1.13	0.47	8.71
2	8.30	22.30	8.27	2.38	41.25
3	3.88	17.79	9.24	2.76	33.67
Best	1.69	7.70	5.07	1.91	16.38
All	16.72	52.05	23.71	7.52	100.00

Table 3: Correlation of household maximum numeracy and literacy scores

% distribution	Lowest literacy	Medium literacy	Highest literacy
Lowest numeracy	40.67	23.21	36.12
2	12.62	20.34	67.04
3	5.27	11.04	83.69
Highest numeracy	3.46	5.29	91.25
All	9.67	13.92	76.41

Table 4a: Quantile regressions for change in real net financial wealth, 2002-2006
Ages 50-61 in 2002

	Not controlling for initial wealth			Controlling for initial wealth		
	25th percentile	Median	75th percentile	25th percentile	Median	75th percentile
Numeracy group I	8814.32*	-2695.97*	-19823.50**	-891.65	-5524.69**	-18498.50**
Numeracy II	7595.14**	-2949.94**	-20425.81**	-2981.35**	-6694.64**	-18651.54**
Numeracy III	5005.89**	-2167.93**	-13504.22**	-2123.17**	-4807.83**	-11628.80**
Low Ed	5325.15**	-2404.01**	-19474.14**	-2585.47**	-7299.53**	-16165.91**
Med Ed	3950.52**	-2139.22**	-14231.12**	-2177.03**	-6021.40**	-11309.18**
Age 50-54	5356.93**	532.74	-5795.79**	-2044.85**	-1622.72	-4586.09*
Age 55-59	3390.10	279.20	-5105.46**	-530.42	-560.31	-4320.84*
ExecFunc	1490.32*	657.94**	689.97	925.60**	615.64	753.23
ExecFunc^2	-68.81**	-20.54*	-0.98	-35.95**	-18.03	-6.65
Memory	268.96	-290.45	-360.38	7.82	-181.39	-264.60
Memory^2	-12.86	5.21	4.71	1.42	4.38	0.53
Low literacy	625.12	-672.12	-2671.83	-1742.94	-2535.82	-1043.09
Medium literacy	2224.76	122.39	-1862.97	-307.74	-1029.62	-1595.16
Initial wealth				-0.62**	-0.27**	0.10**
_Cons	-27445.24**	3338.70	42497.98**	-1324.58	12451.36**	36027.56**

Table 4b: Quantile regressions for change in real net financial wealth, 2002-2006
Ages 65 and over in 2002

	Not controlling for initial wealth			Controlling for initial wealth		
	25th percentile	Median	75th percentile	25th percentile	Median	75th percentile
Numeracy group I	12761.52**	1629.14*	-8157.87**	-3065.98**	-1245.83	-11440.12**
Numeracy II	12222.20**	1642.19**	-7419.13**	-3317.68**	-913.94	-10534.05**
Numeracy III	11256.64**	1936.52**	-5114.54**	-2324.17**	1047.29	-7085.85**
Low Ed	11038.56**	544.52	-12409.54**	-3469.19**	-7906.59**	-14655.39**
Med Ed	4761.41**	65.84	-9110.13**	-1766.14**	-4394.48**	-9868.07**
Age 50-54	-913.11	-254.94	-1061.38	-86.59	-1247.03*	-1592.23*
Age 55-59	1567.16	298.12	-805.76	-45.01	-658.66	-1181.07
ExecFunc	-574.43	-314.58*	-449.26	-28.7	-631.49**	-561.41
ExecFunc^2	13.71	11.63	21.43	3.99	32.19**	30.95*
Memory	788.45*	41.03	-771.25*	271.52	216.71	-472.32
Memory^2	-36.92**	-1.71	30.99**	-8.75	-4.94	19.48
Low literacy	1336.72	261.02	-833.8	-192.38	-533.5	-1182.56
Medium literacy	2801.95**	45.16	-773.85	-853.08*	-1217.01*	-891.34
Initial wealth				-0.73**	-0.42**	-0.08**
_Cons	-26143.50**	-487.53	30011.07**	4579.36**	11581.78**	34446.95**

Notes: All models also include dummies for sex, marital status and imputed wealth data
** $p<0.05$, ** $p<0.01$*

Table 5: Quantile regressions for percent change in real net income, All those retiring between 2002-2006

	OLS			Median Regression		
	(1)	(2)	(3)	(1)	(2)	(3)
Numeracy group I	-0.053	-0.057	-0.051	-0.024	-0.033	-0.062
Numeracy group II	0.012	0.010	0.010	0.006	-0.008	0.002
Numeracy group III	-0.021	-0.019	-0.018	0.013	0.027	0.037
Age5054	-0.123*	-0.125*	-0.123*	-0.184*	-0.205**	-0.184*
Age5559	0.003	0.005	0.008	-0.050	-0.049	-0.032
Age6064	-0.003	-0.003	-0.001	-0.007	-0.002	0.004
Wealth q1	-0.030	-0.028	-0.020	-0.089	-0.102	-0.061
Wealth q2	-0.078	-0.077	-0.079	-0.103	-0.104	-0.112
Wealth q3	-0.056	-0.053	-0.051	-0.084	-0.085	-0.061
Wealth q4	-0.078	-0.076	-0.072	-0.043	-0.061	-0.054
Spouse work 2002	-0.117**	-0.116**	-0.115**	-0.140*	-0.141**	-0.160**
Spouse work 2006	0.170**	0.171**	0.171**	0.203**	0.224**	0.198**
Low_Ed		-0.011	-0.003		0.009	0.044
Med_Ed		-0.040	-0.034		-0.067	-0.041
ExecFunc			-0.001			-0.002
ExecFunc^2			0.000			0.000
Memory			-0.029			-0.039
Memory^2			0.001			0.001
Low literacy			-0.025			-0.039
Medium literacy			0.039			-0.006
_cons	0.812**	0.828**	1.037**	0.739**	0.774**	1.024**

Notes: All models also include dummies for sex, marital status and imputed wealth data
** p<0.05, ** p<0.01*

Table 6: Quantile regressions for percent change in real food expenditure, All those retiring between 2002-2006

	OLS			Median regression		
	(1)	(2)	(3)	(1)	(2)	(3)
Numeracy group I	-0.186	-0.171	-0.156	-0.173*	-0.146	-0.110
Numeracy group II	-0.046	-0.035	-0.029	-0.087*	-0.048	-0.037
Numeracy group III	-0.043	-0.038	-0.036	-0.100**	-0.059	-0.055
Age5054	-0.051	-0.058	-0.058	-0.019	-0.016	-0.003
Age5559	-0.030	-0.031	-0.031	-0.020	-0.014	0.014
Age6064	-0.055	-0.057	-0.057	-0.043	-0.050	-0.026
Wealth q1	-0.030	-0.010	-0.010	0.014	0.034	-0.013
Wealth q2	-0.117*	-0.103*	-0.104*	-0.132**	-0.112*	-0.146**
Wealth q3	-0.058	-0.048	-0.047	-0.030	-0.027	-0.056
Wealth q4	-0.035	-0.027	-0.026	-0.011	-0.002	-0.039
Spouse work 2002	-0.011	-0.008	-0.007	-0.002	-0.011	-0.001
Spouse work 2006	0.063	0.061	0.054	-0.003	0.006	0.001
Low_Ed		-0.068	-0.063		-0.065	-0.080*
Med_Ed		-0.064	-0.060		-0.049	-0.051
ExecFunc			0.013			0.008
$ExecFunc^2$			-0.000			-0.000
Memory			0.002			0.032
$Memory^2$			-0.000			-0.001*
Low literacy			-0.012			0.019
Medium literacy			-0.042			-0.007
_cons	1.155**	1.186**	1.080**	1.074**	1.095**	0.842**

Notes: All models also include dummies for sex, marital status and imputed wealth data
** p<0.05, ** p<0.01*

Table 7: OLS regressions for percent chance of inadequate resources at some time in the future, reported in 2006

Dependent variable: Expectations_2006	Age 50-59 in 2002 b	se	Age 60-69 in 2002 b	se	Age 70+ in 2002 b	Se
Expectations_2002	0.396**	*0.041*	0.376**	*0.065*	0.257**	*0.088*
Expectations_2002*Gp I	-0.141*	*0.071*	-0.191*	*0.081*	-0.160	*0.104*
Expectations_2002*Gp II	-0.127**	*0.048*	-0.133	*0.070*	-0.063	*0.093*
Expectations_2002*Gp III	-0.010	*0.050*	-0.068	*0.075*	0.057	*0.099*
Numeracy Group I	8.827*	*3.733*	8.607*	*3.595*	1.991	*4.224*
Numeracy Group II	6.846**	*2.107*	5.879*	*2.667*	0.826	*3.535*
Numeracy Group III	1.472	*2.063*	0.627	*2.699*	-3.485	*3.665*
Low_Ed	-0.346	*1.314*	2.763	*1.523*	4.411*	*1.952*
Med_Ed	0.993	*1.194*	2.575	*1.614*	2.466	*2.359*
Female	2.613**	*1.004*	0.263	*1.203*	-0.279	*1.462*
Couple	-0.738	*1.208*	0.707	*1.275*	3.184*	*1.409*
2006 wealth quintile 1	12.753**	*1.571*	10.400**	*2.083*	7.052**	*2.666*
2006 wealth quintile 2	8.710**	*1.629*	9.314**	*1.863*	4.798*	*2.225*
2006 wealth quintile 3	7.368**	*1.490*	7.694**	*1.714*	4.702*	*2.210*
2006 wealth quintile 4	3.420*	*1.408*	2.135	*1.675*	-1.643	*2.233*
ExecFunc	0.047	*0.473*	0.808	*0.600*	0.224	*0.615*
ExecFunc^2	-0.002	*0.020*	-0.033	*0.026*	0.001	*0.030*
Memory	1.507*	*0.633*	-0.058	*0.670*	0.347	*0.752*
Memory^2	-0.046**	*0.017*	0.002	*0.020*	-0.010	*0.025*
Low literacy	7.568**	*1.679*	2.233	*1.761*	-1.189	*1.869*
Medium literacy	3.053*	*1.289*	2.324	*1.434*	-1.484	*1.639*
_cons	-0.147	*6.397*	8.583	*6.471*	7.860	*7.107*

Notes: All models also include dummies for imputed wealth data
** p<0.05, ** p<0.01*