Job strain and trajectories of change in episodic memory before and after retirement: results from the Health and Retirement Study

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ABSTRACT

Background We examined indicators of job strain in relation to level and change in episodic memory in the years leading up to as well as following retirement.
Methods Our analyses centre on 3779 individuals from the nationally representative Health and Retirement Study (baseline age 57.3 years) who reported gainful employment in an occupation for 10+ years prior to retirement, and who were assessed for episodic memory performance over up to 20 years (median 8 waves over 16 years). We used ratings from the Occupational Information Network (O*Net) to score occupations for job control and job demands, and to measure job strain (job demands/job control).
Results Controlling for sociodemographic characteristics, depressive symptoms, and cardiovascular disease, less job control and greater job strain were not significantly associated with change in episodic memory in the period leading up to retirement, but were associated with significantly poorer episodic memory at retirement and an accelerated rate of decline in episodic memory following retirement. The results did not vary for men and women or by self-employment status.
Conclusions Job strain expressed mainly as low job control is linked to poorer episodic memory at retirement and more decline after retirement. Job characteristics appear to have implications for cognitive ageing independent of relevant confounds.

Employment is one of the central tenets of adult life in modern society,[1] making work critical to understanding the ageing process. The job strain model,[2 3] especially its measures of job control and psychological job demands, has been established as a useful theoretical framework for investigating work-related stress and health. It has been applied extensively to studies linking work-related stress to cardiovascular problems and mortality.[4] Recently, the job strain model has been with poorer cognition[5 6] and dementia.[7 8] This may be a function of (A) chronic dysregulation of homoeostatic processes and weaken neuronal structures (eg, 'allostatic load'[9–11]) particularly in the hippocampal brain region,[11] or (B) facilitation of cognitive reserve by engaging, low-stress jobs.[12]

A longitudinal study of job strain and cognitive ageing with adequate follow-up time has not yet been published. We utilise data from the Health and Retirement Study (HRS) to investigate the role of job strain in age-related changes in episodic memory. Cognitive assessments in the HRS include a widely used measure of episodic memory,[13 14] which has been found to be a reliable indicator of preclinical signs dementia.[15 16] We hypothesised that higher levels of job strain would be associated with poorer cognitive functioning both during employment and after retirement.

METHODS

Participants

We used data from the nationally representative HRS, an ongoing biennial US panel survey of health, ageing and retirement that began in 1992.[17] Details regarding sampling procedures are described elsewhere.[18] The current study included a subset of HRS participants who were in the 1992 original sample or 1998 refresher sample. For 1992, the response rates were 81.6% for baseline and 84.0–89.1% for reinterviews; for 1998, the rates were 69.9% for baseline and 87.0–90.9% for reinterviews.[19] Additional inclusion criteria were participating in at least one HRS data collection prior to retiring, being 55+ years old at baseline and retiring after baseline (to have at least one assessment pre-retirement). We also excluded those reporting retiring at/after age 71 (>2 SDs above sample mean retirement age). Finally, to minimise bias by measuring work-related strain in temporary and/or odd jobs, or occupations signifying retirement transition,[1] participants were included if they accumulated 10+ years in the current (baseline) occupation on which job strain scores were based. Participants averaged 26.5 (11.0) years in the occupation. A total of 3779 participants met the criteria. These participants averaged 7.4 interviews (SD=2.3, median=8), of which 3.8 (SD=2.0, median=4) occurred prior to retirement and 4.4 (SD=2.3, median=4) occurred after retirement.

Measures

Episodic memory

A unit-weight composite of performances on the immediate and delayed free-recall for a word list learning task was used.[13 14] Cognitive measures for the HRS data collection were described previously.[13] Briefly, participants were asked to recall nouns from a list read to them (immediate recall) and then were asked to recall words from the same list after 5 min (delayed recall). During the first two waves, a 20-noun list was used. Later waves (starting in 1996) employed a 10-noun list. To make scores comparable across waves for analyses, we rescaled each immediate and delayed word recall variable to a percentage score. Episodic memory was scored as a sum of immediate and delayed

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recall items correctly recalled divided by the maximum score and multiplied by 100. Episodic memory was standardised to a T-score, which is a standardised score (similar to z-scores) to improve the interpretability of the results (M=50, SD=10).

Measurement of job strain

First, we obtained the three-digit Census occupation codes available in the HRS.[20] All occupations were coded with the three-digit codes, including occupation for the 383 participants who were self-employed. Then, we matched these codes with the Occupational Information Network (O*NET; http://www.onetcenter.org). The O*NET is an industry-based coding scheme developed by the Department of Labor. It is the main source of information about job characteristics in the USA.[21] It has been used in research, including cognitive research.[22 23] O*NET values are based on national surveys of job incumbents (at least 20 per category) and ratings by trained job analysts using a priori defined criteria. Therefore, the O*NET combines subjective and objective occupational characteristics. These occupational categories are specific enough to reflect a broad range of occupation-based scores but broad enough to not reassign occupational categories due to minor moves within the same occupation.

We assigned scores for job control and job demands based on worker characteristics in the O*NET. *Job demands* was designed to measure the physical or psychological effort expected on the job (eg, intense, hectic work schedule, extreme work load). *Job control* is a measure of the extent to which one can use personal judgement or decision authority to assert control in the workplace. We adapted a previously used computation method for extracting O*NET occupational characteristics that corresponded to indicators of job demands and job control.[24]

Consistent with prior research,[24] all O*NET items were transformed to 0–100 scales for uniform scaling. Job demands was computed by averaging items *required level of selective attention*, *required ability to shift back and forth between two or more tasks*, *consequence of error*, *importance of being exact or accurate*. Job control subfactors decision authority (average of *independence*, *freedom to make decisions*, *frequency of decision-making*, *impact of decisions on co-workers or company results*) and skill discretion (*achievement)* were summed to create an overall job control factor. The mean (SD) was 79.4 (7.4) for job control and 55.4 (4.4) for job demands. These values were standardised as z-scores (mean=0, SD=1) before analysis. Finally, we measured *job strain* based on the model put forth by Karasek and Theorell[2] as a quotient of demands/control.

Internal consistency (Cronbach's α) of O*NET items linked with participants' occupation measured in the 1992 HRS wave was 0.92 for job control and 0.71 for job demands. Previously, using about 350 workers and 24 occupations,[24] O*NET measurement of job control correlated well with a questionnaire-based measure (intraclass r=0.61 and 0.47 for healthcare/non-healthcare jobs), whereas job demands correlated poorly (intraclass r=0.11 and 0.07), suggesting that the objective element of O*NET-based scheme may affect job demands to a greater extent than job control. Furthermore, we correlated this measure of job control and demands with relevant self-reported items available in the HRS (measured as all the time, most of the time, sometimes and never): "I have a lot of freedom to decide how I do my own work" and "Job requires doing the same things over and over" to correlate with job control (r=0.210, p<0.001 and r=−0.241, p<0.001), and "My job involves a lot of stress" to correlate with job demands (r=0.137, p=0.001). However, these correlations were based on single items in HRS rather than multiple item composites as available in O*NET. Furthermore, prior research has found use of the term 'stress' in a self-report survey item to be ambiguous.[25]

Covariates

Covariates included all available known risk factors for cognitive decline and included baseline age, gender, years of education, marital status (married/not married), race (Caucasian/non-Caucasian), annual income, length of occupation, depressive symptoms, cardiovascular disease and manual/non-manual work. Manual work was measured using the three-digit occupational codes provided by the HRS, as described previously.[20] Depressive symptoms were measured using the eight-item version of the Center for Epidemiological Studies (CES-D) scale.[26 27] Cardiovascular disease was assessed at baseline with the number of self-reported physician-diagnosed medical conditions including heart problems (includes heart attack, coronary heart disease, congestive heart failure) and stroke as 0 (none), 1 (heart problems or stroke), 2 (both).

Statistical method

We used growth curve modelling,[28 29] which retains data regardless attrition. Although most participants (67%) completed at least 7 of the 10 cognitive assessments, there was still a possibility of selective attrition bias. We assessed this possibility by correlating the number of waves completed with scores on job control, job demands and episodic memory. There was essentially no correlation with job control (r=0.01, p=0.375) and weak correlation with job demands (r=−0.05, p=0.002) and episodic memory (r=0.16, p<0.001).

A two-phase growth curve model[30 31] was used with retirement age serving as the pivot (centreing) point. Waves were the within-person level; covariates and predictors were the between-person level in this multilevel model. Two main models were estimated—one testing covariate-adjusted effects for job control and job demands and one testing covariate-adjusted effects for job strain. Each model yielded three estimates for each predictor—a cross-sectional effect of each predictor on episodic memory at the intercept (ie, retirement), and two longitudinal effects expressed as the interaction of predictor with (A) time before retirement and (B) time after retirement. SAS (SAS Institute, Cary, North Carolina, USA) PROC MIXED was used.[32] Time was specified in decades to facilitate interpretation.

RESULTS

Descriptive statistics

Table 1 shows descriptive statistics. Participants were, on average, 63 years old at retirement, which corresponds to current average retirement age in the USA.[33] Job control and job demands were highly inter-related and positively correlated with education, job length and men.

Indicators of job strain as predictors of episodic memory

Fully adjusted estimates for baseline job control and demands are shown in table 2. Cross-sectionally, low control was associated with poorer episodic memory (estimate=−0.53, p<0.001) whereas the association between job demands and episodic memory performance was non-significant (estimate=−0.02, p=0.823). Longitudinally, neither job control (estimate=0.35, p=0.150) nor job demands (estimate=−0.06, p=0.761) was significantly associated with change in episodic memory before retirement, but lower job control at baseline was associated with greater decline in episodic memory (estimate=−0.70, p=0.031) after retirement. The parallel result for job

Table 1 Baseline characteristics of the analytical sample

	M or %	SD	1	2	3	4	5	6	7	8	9	10	11	12
1. Age at baseline	57.3	2.2	–											
2. Women	49.9%	–	−0.14*	–										
3. Education	12.6	3.0	−0.07*	0.04*	–									
4. Married	75.8%	–	0.04*	−0.26*	−0.01	–								
5. Annual income	10.6	1.1	−0.05*	−0.10*	0.33*	0.28*	–							
6. White	81.2%	–	0.03	−0.12*	0.10*	0.18*	0.12*	–						
7. Manual work	61.3%	–	0.03*	−0.34*	−0.27*	0.11*	−0.01	−0.11*	–					
8. Job length	26.6	10.9	0.05*	−0.22*	0.06*	0.06*	0.09*	0.05*	−0.09*	–				
9. Depressive symptoms	0.7	1.2	−0.04*	0.06*	−0.12*	−0.13*	−0.12*	−0.07*	−0.01	−0.07*	–			
10. Cardiovascular disease	10.1%	–	0.09*	−0.06*	0.02	0.04*	0.04	0.04*	0.01	0.00	0.03	–		
11. Job control	77.8	7.7	0.00	−0.19*	0.43*	0.10*	0.26*	0.16*	−0.06*	0.16*	−0.11*	0.02	–	
12. Job demands	54.6	4.9	0.01	−0.18*	0.15*	0.07*	0.17*	0.09*	0.08*	0.13*	−0.07*	0.03	0.44*	–
13. Episodic memory T score	53.5	9.0	−0.08*	0.19*	0.29*	0.03*	0.14*	0.15*	−0.15*	−0.03	−0.10*	0.02	0.17*	0.05*

N=3779. Job control and job demands were those reflecting the longest held occupation prior to retirement. The score range for job control and job demands was 49.9–98.9 and 34.1–70.5, respectively. Income was log transformed due to skewness.
* p<0.05.

demands was non-significant (estimate=0.01, p=0.981). The results for job control are illustrated in figure 1.

To quantify the magnitude of job control–episodic memory association, we used age and education—common risk factors for cognitive ageing—expressed as z-scores (note that job control/demands were already z-scores). The estimates for age and education were 0.20 (p=0.031) and 2.09 (p<0.001) cross-sectionally and −0.34 (p=0.286) and −0.89 (p=0.004) for change in episodic memory following retirement.

When job strain (the quotient of demands over control) was used, greater job strain was associated with worse episodic memory cross-sectionally (estimate=−0.49, p<0.001), no association with change in episodic memory pre-retirement (estimate=0.39, p=0.181), and significantly greater decline in episodic memory postretirement (estimate=−0.65, p=0.034).

Analyses examining the interactions of indicators of job strain by gender and by self-employed status yielded non-significant results (ps>0.25). Finally, we estimated results where we added all 121 individuals who reported retiring from main occupations at or after age 71 (mean age at retirement=73.5, SD=2.5, range=71–85 years). These participants did not differ from the analytical sample with respect job control, job demands, education or proportion of manual workers (ps>0.05), but they were

Table 2 Job control* and demands in relation to episodic memory at retirement as well as change in episodic memory up until retirement and following retirement

	Estimate	SE	p Value
Fixed effects			
Intercept	43.94	1.04	<0.001
Job control	−0.53	0.12	<0.001
Job demands	−0.02	0.11	0.823
Pre-retirement change	−5.72	2.01	0.004
Postretirement change	0.92	2.89	0.750
Job control×pre-retirement change	0.35	0.24	0.150
Job demands×pre-retirement change	−0.09	0.21	0.674
Job control×postretirement change	−0.70	0.32	0.031
Job demands×postretirement change	0.01	0.29	0.981
Random effects			
Variance intercept	27.65	1.60	<0.001
Pre-retirement change	14.32	4.68	0.001
Retirement	4.25	1.73	0.007
Postretirement change	13.31	8.37	0.056
Covariance, intercept with pre-retirement change	0.97	2.57	0.707
Covariance, intercept with retirement	−4.44	1.39	0.001
Covariance, intercept with postretirement change	−7.64	2.92	0.009
Covariance, pre-retirement change with retirement	0.58	2.67	0.828
Covariance, pre-retirement with postretirement change	−10.17	5.81	0.080
Covariance, retirement with postretirement change	−0.62	2.53	0.807
Residual	29.99	0.35	<0.001
Goodness of fit, −2 log likelihood	183 984		

*Job control scores were reversed; greater scores indicate greater work-related stress. Results are adjusted for baseline age, sex, education, marital status, race, log of annual income, years at the index occupation, depressive symptoms and cardiovascular disease. The score range for job control and job demands was 49.9–98.9 and 34.1–70.5, respectively. Episodic memory was converted to a T-score (mean=50, SD=10). N=3779. Estimate=unstandardised regression coefficient. Time is expressed as age centred at retirement in decades.

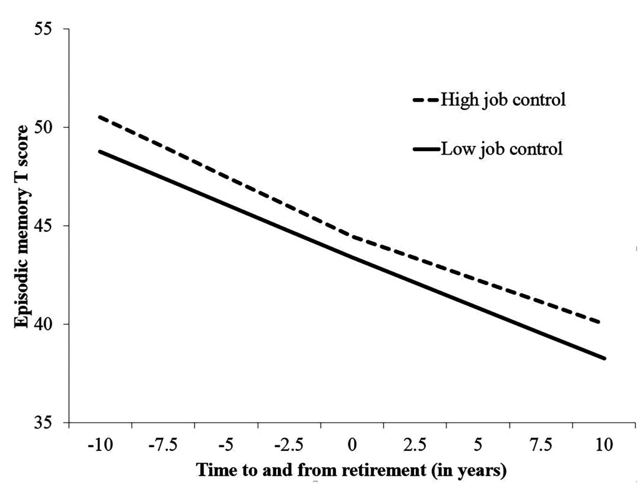

Figure 1 Graphical illustration of the effect of job control on the trajectory of change in episodic memory to and from retirement adjusting for age, sex, education, depressive symptoms, cardiovascular disease, length of occupation and job demands. The solid line represents job control score one SD below the mean; the dashed line represents job control one SD above the mean.

about 2.5 years older at baseline ($p<0.001$). The pattern of results remained unchanged, but the associations between lower job control/greater job strain and greater episodic memory decline after retirement were non-significant (estimate=−0.54, $p=0.115$ and estimate=−0.39, $p=0.185$, respectively).

DISCUSSION

We used a nationally representative sample of the US population to examine the relation between job strain assessed at baseline and episodic memory before/after retirement age. We found that lower job control and greater job strain were associated with poorer episodic memory performance at retirement irrespective of covariates and job demands. The associations between job strain measures and rate of change in episodic memory were not significant pre-retirement. Postretirement, lower job control and greater job strain were associated with steeper episodic memory decline, practically magnifying the disadvantage observed at retirement. Results did not vary by sex, which is in line with prior research,[5 7 8] or by self-employment status. Finally, the magnitude of the associations was comparable to age and education, common factors affecting cognition, except for a greater effect of education on episodic memory cross-sectionally.

Overall, our results highlight the importance of job control in cognitive ageing.[5 34 35] This notion is supported by previous work with self-direction at work, a component of work complexity,[7 36–38] as well as research on general control over life circumstances.[39 40] Job control may also facilitate the development and maintenance of a larger repertoire of behavioural strategies (or changes in neuronal networks) that could subsequently be used to compensate for age-related cognitive decline or neurodegeneration, as expressed in cognitive research hypothesis.[12] The link between job control and accelerated cognitive ageing has important implications for job design, potential interventions and future research, whereby assigning meaningful roles for employees whose jobs involve low control (and allowing opportunities for self-direction) may positively affect cognitive ageing. Also important in this context may be the exploration of interventions specifically designed to ameliorate cognitive decline among older adults retired from jobs with low control.

Seemingly counterintuitive to the concept of job strain are the null results for job demands,[2 3] although results with cardiovascular outcomes do not always link job demands to increased risk.[41] Job demands appear to represent not solely stress, but a combination of work-related stress and intellectual engagement/challenge at work, which has potentially favourable effects on cognitive health,[5 12 35] In previous research, the results for job demands were either null[5 7 8] or not presented.[6]

At least two explanations for the role of low job control in poor performance cross-sectionally (when entering retirement) and accelerated cognitive ageing postretirement are possible. First, long-term exposure to low job control likely contributes to dysregulation of the stress response, thereby increasing allostatic load.[11] Ample evidence exists to support the notion that exposure to stress interferes with proper storage, consolidation and retrieval of information.[42] Furthermore, there is a reduction in hippocampal activity in response to excess release of cortisol during exposure to stress.[42] Of note here is that the physiological stress response has been found to occur independent of the subjective perception of work-related stress.[43] Hence, low job control may not ‘feel’ particularly stressful, especially if combined with low job demands, but the effects may still emerge with ageing.

Alternatively, individuals in jobs with greater control enter retirement prepared to engage themselves intellectually, thus boosting or maintaining their cognitive advantage, a concept presented as cognitive reserve.[12] Our findings suggesting a more favourable trajectory of cognitive change postretirement as a function of higher job control seems to support this notion.

The null findings for work strain and memory change in the pre-retirement period also deserve mention. The follow-up period pre-retirement may have been too short, especially relative to the accumulated years in index occupation (mean=26 years), much longer than the average of 6 years of pre-retirement follow-up. Alternatively, the effects of chronic stress in cognitive ageing may not emerge until older adulthood.

Limitations

Cognition is a multidimensional construct and we only focused on episodic memory, albeit episodic memory appears to be a crucial cognitive domain with respect to cognitive ageing.[15] A more refined cognitive assessment may provide a more detailed picture of the assessed associations. Second, our measures of job strain were not validated and correlated only weakly with available self-report measures. Also, although the measures combine self-reported with objective information, job strain may be better assessed subjectively. This point is particularly pertinent given the low correlation between our measure and self-reported measure of job demands reported previously.[24] Unfortunately, baseline self-report data implying work stress available in the HRS are limited and lacked face validity. There is some evidence suggesting that objective measurement of job strain may have good predictive validity,[5 7 8] and that individuals present with consistent physiological stress responses regardless of subjective perception of work stress.[43] Still, future research should investigate the role of self-reported job strain in cognitive outcomes more thoroughly.

Third, it is possible that non-work stressors (home environment, interpersonal stress) may affect the findings. Although some potential influences (eg, age, gender, education and depressive symptoms) were controlled, further research with other stressors is needed. Fourth, despite long follow-up, we cannot exclude the possibility of reverse causation in our data, whereby cognition preselects participants into occupations. Therefore, the results need to be interpreted with caution. Finally, there are many pathways to retirement and participation in part-time positions and/or volunteering may affect cognitive outcomes. One evidence of this phenomenon may be that our results were weakened when those reporting retiring after age 71 were added. Although retirement age may have not been estimated correctly in at least a portion of these individuals, the question of the effect of different pathways to retirement on cognitive ageing is worthy of further empirical pursuit.

In conclusion, we found job control, whether in combination with job demands or alone, to be associated with worse performance and a greater decline in episodic memory following retirement. These findings support the possibility of long-term effects of work environment on cognitive ageing. Therefore, job strain, and low job control in particular, may be an important target for intervention.

What is already known on this subject

Work-related stress as measured by the job strain model is associated with poor health outcomes, with recent evidence suggesting this effect may extend to cognitive ageing and dementia.

What this study adds

- This study presents the first longitudinal analysis of the association between job strain and cognitive ageing that includes more than two cognitive assessments.
- This study is the first to consider retirement as a pivot point in the association between job strain and cognitive ageing.
- This study uses a large sample representative of the US population.

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Contributors RA conducted data analysis and prepared the manuscript. FJI prepared the data set, advised on data analysis and contributed to the manuscript by revising it critically for important intellectual content. EAHR assisted in data analyses and contributed to the manuscript by revising it critically for important intellectual content. MC assisted in conceptualisation of the study and contributed to the manuscript by revising it critically for important intellectual content. LM and GGF helped prepare the data set and contributed to the manuscript by revising it critically for important intellectual content.

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