Mental Work Demands Protect Against Cognitive Impairment: MAAS Prospective Cohort Study

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Little is known about whether persons with mentally demanding jobs are protected against cognitive impairment and whether this association is independent of intellectual abilities and other confounders. Longitudinal data from the Maastricht Aging Study (MAAS) were used to examine this association. After the 1993–1995 baseline examination, there was a first 3-year follow-up examination (1996–1998) among 630 men and women, aged 50 to 80, who exhibited no cognitive impairment at baseline. Persons with mentally demanding jobs had lower risks of developing cognitive impairment.

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impairment during follow-up (36 cases), compared with persons without such jobs (odds ratio = 0.79; 95% confidence interval: 0.65–0.96). About 1.5% of the persons with high mental work demands developed impairment compared to 4% of the persons with few work demands. The protective effect was independent of intellectual abilities and other confounders. Our findings provide evidence that continued and potentially modifiable mental stimulation during adult life may protect men and women against cognitive impairment.

Mental stimulation has been hypothesized to protect against premature cognitive decline (Ornel & Sahakian, 1995; Swaab, 1991). The “use-it-or-lose-it” perspective postulates that specific mental stimuli and challenges during both childhood and adulthood stimulate the formation of complex neuronal networks and promote cognitive “reserve capacity.”

Cognitive reserve has been described as the full range of cognitive abilities that may fluctuate as a function of external or environmental factors (Satz, 1993). Some researchers have applied the “use-it-or-lose-it” perspective on the cognitive demands needed at work (Dartigues et al., 1992; Frisoni, Rozzini, & Blanchett, 1993; Jorm et al., 1998; Paykel et al., 1994; Schmand, Smit, Geerlings, & Lindeboom, 1997; Schooler, 1990; Stern et al., 1994). Most of these authors reported substantial adverse effects on cognitive function for persons with low psychological work demands (Dartigues et al., 1992; Frisoni et al., 1993; Schmand et al., 1997; Schooler, 1990; Stern et al., 1994). However, most of these studies did not stringently control for potentially confounding variables, such as intellectual abilities, lifestyle, depression, diseases, and family history of dementia. In the current study, data from the longitudinal Maastricht Aging Study (MAAS) were used to examine whether middle-aged and older persons with high mental job demands in their current or last job are protected against cognitive impairment. However, reverse causation could occur, if life-long poor cognitive functioning causes persons to choose jobs with low mental demands. To control for this possibility, individuals who had cognitive impairment at baseline were excluded and new cases of cognitive impairment were examined during follow-up.

METHOD

Participants

MAAS is a study on the determinants and consequences of differences in cognitive aging and successful aging in particular. Between 1993 and 1995, participants were selected from a register of 15 family practices in the south of The Netherlands (Metsemakers, Hoppener, Kooteniers, Kocken, & Limonard, 1992). General practitioners invited 9919 persons to participate in the study that consisted of filling out a questionnaire and (for a smaller group) undergoing a medical and neuropsychological examination. The invited men and women were aged 25 to 82 years and were—according to the practitioners’ register—without medical conditions that interfere with normal cognitive function. Persons with chronic neurological pathology (e.g., dementia, cerebrovascular disease, epilepsy, parkinsonism, and malignancies related to the nervous system), mental retardation, or chronic psychotropic drug use were excluded. Furthermore, the sample was stratified according to age (5-year age groups), sex, and general ability (measured by an index of occupational attainment in the register: low versus high). The response rate was 35%, as 3454 persons eventually filled out the questionnaire.

In this group, 1877 persons decided to further participate in the medical and neuropsychological examination (54%). Twenty-seven individuals with Mini-Mental State Examination scores of 23 or lower (possibly indicative of cognitive disorder) (Folstein, Folstein, & McHugh, 1975) and 27 individuals with unreliable test results were excluded, leaving 1823 individuals. The response rate was likely to have been strongly affected by the policy of the register’s board, which did not allow eligible persons to be reminded, and by persons deciding not to participate because of the prospect of an intensive medical and neuropsychological examination at Maastricht University. More details on the cross-sectional part can be found elsewhere (Jolles, Houx, Van Boxtel, & Ponds, 1995; Van Boxtel et al., 1998).

About 3 years later (1996–1998), all persons who were 50 years or older and tested at baseline (n = 1069) were again invited to participate in a reassessment of neuropsychological function. Due to refusal (n = 138), death (n = 50), and loss-to-follow-up (n = 43), 838 persons (response = 78%) were actually tested. Among them were 708 persons (85%) whose information on the mental work demands in the current or last job was available. The remainder of the participants had no occupational experience (e.g., housewives). In the group of 708 persons, we excluded all persons with cognitive impairment at baseline (n = 78) (see ‘Cognitive Impairment’). The analyses were therefore based on the remaining 630 initially cognitively healthy persons (89%).

Cognitive Impairment

Cognitive impairment at baseline was indicated by whether persons scored twice or more often in the poorest 1/10th (decile) of a broad range of cognitive performance tests: the Stroop Color-Word Test (interference subtask) (Houx, Jolles, & Vreeling, 1993; Stroop, 1935), the Verbal Learning Test (immediate and delayed recall sub-tasks) (Brand & Jolles, 1985; Rey, 1964), the Letter Digit Coding Test (Smith, 1986), and the Word Fluency
Test (Luteijn & Van der Ploeg, 1983). The same cut-off scores were applied to the neuropsychological test data at follow-up. Recently, comparable tests were successfully used to determine cognitive dysfunction in a study on the effects of pesticides (Bosma, Van Boxtel, Ponds, Hour, & Jolles, 2000) and in a study on the effects of operation under general anesthesia (Moller et al., 1998). In the group of 630 persons who were without cognitive impairment at baseline, 36 developed cognitive impairment during follow-up (6% cumulative incidence). These included all three persons with incident dementia (excluding them did not affect our findings).

Mental Work Demands

Persons were asked to describe their job or, if not employed, their last job. Jobs were coded according to a job title scheme used at Statistics Netherlands (CBS, Statistics Netherlands, 1985). For each job title code, an independent large-scale survey had previously determined the percent of persons in each job title code that confirmed the following four questions: (1) Is your work mentally demanding? (2) Do you have to concentrate strongly during work? (3) Does your work require great precision? and (4) Do you regularly work under time pressure? (De Zwart, Broersen, Van der Beek, Frings-Dresen, & Van Dijk, 1997). Furthermore, job experts (function analysts) had previously rated each job title according to the degree of mental complexity of the work tasks on a scale from 1 (simple) to 7 (complex) (DGA, 1989). These five measures of mental work demands were rescaled to respective variables ranging from 0 (few demands) to 10 (many demands). A final composite score was computed by standardizing the measures and computing the mean for each job title. Using the job title code as the key, these six indicators were matched to the 630 individual participants.

Confounders

Basic confounders were baseline age (years), sex, educational level, length of follow-up interval, and employment status (currently/previously employed). Attained educational level had eight ordinal categories, ranging from primary education to university education (De Bie, 1987). Baseline intellectual abilities (vocabulary subtask of the Groningen Intelligence Test [Luteijn & Van der Ploeg, 1983]), smoking (never smoked, stopped smoking, 1–9, 10–19, and 20 or more cigarettes per day), alcohol consumption (average number of alcoholic beverages per week), physical activity (average number of hours per week that persons engaged in [physically active] sports), depression (depression subscale [16 items] of the Symptom Checklist; Derogatis, 1977), family history of dementia (father or mother), and relevant diseases (any of the following: cardiovascular diseases, diabetes, and/or hypertension) were potential confounders and were separately examined.

Analyses

Using *t*-tests, persons with and without incident cognitive impairment were compared regarding mean scores on basic confounders and indicators of mental workload. Logistic regression was used to compute odds ratios of incident cognitive impairment for the separate indicators of mental workload, controlling for age, sex, educational level, employment status, and length of follow-up interval. This was also done for currently and previously employed persons separately. Intellectual abilities, lifestyle (smoking, alcohol consumption, and physical activity), depression, diseases, and family history of dementia were separately controlled for. Finally, the composite measure of mental workload was divided into thirds (using tertiles). Predicted probabilities of cognitive impairment (expressed in terms of percentages) were computed for the three categories of mental workload. These probabilities were computed—and thus corrected—for mean levels of baseline age, sex, educational level, length of follow-up interval, and employment status.

RESULTS

Table 1 shows that persons who developed cognitive impairment during follow-up were older at baseline, had a lower educational level, and more often were men than persons who remained without cognitive impairment. They did, however, not differ regarding employment status (43% were currently employed). They differed regarding the indicators of mental workload. Although not statistically significant for all six indicators, the incident cases had a lower mental workload than the nonincident persons.

Table 2 shows that persons with a high mental workload had lower risks of developing cognitive impairment than persons with a low mental workload. For example, each unit increase on the composite score (range = 0–10) decreased the odds of incident cognitive impairment by 21% (odds ratio = 0.79). Odds ratios ranged from 0.70 to 0.90 and were (marginally) significant for all measures, except for the complexity measure. Although only one odds ratio was marginally significant among the currently employed persons and four among the previously employed persons, the odds ratios did not significantly differ between both groups (the interaction between mental workload and employment status was never statistically significant). Mental workload did neither interact with the other basic confounders (age, sex, and educational level).

Figure 1 illustrates our findings by showing the adjusted percents of incident cognitive impairment for the separate thirds of the composite measure of mental workload. About 4% of persons with low mental work demands developed cognitive impairment during follow-up compared to 1.5% of their counterparts with high mental demands at work.
### TABLE 1 Means (Standard Errors) of Basic Confounders and Indicators of Mental Workload According to Incident Cognitive Impairment

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 630)</th>
<th>No (n = 594; 94.3%)</th>
<th>Yes (n = 36; 5.7%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic confounders</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>61.8 (8.8)</td>
<td>61.3 (8.6)</td>
<td>70.3 (7.2)**</td>
</tr>
<tr>
<td>Educational level</td>
<td>3.2 (1.7)</td>
<td>3.3 (1.7)</td>
<td>2.3 (1.7)**</td>
</tr>
<tr>
<td>Men (%)</td>
<td>58.4 (5.4)</td>
<td>57.2 (5.4)</td>
<td>77.8**</td>
</tr>
<tr>
<td>Current employment (%)</td>
<td>43.3 (3.1)</td>
<td>43.4 (3.1)</td>
<td>41.7 (3.1)</td>
</tr>
<tr>
<td><strong>Workload indicators</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mental demands</td>
<td>5.2 (2.7)</td>
<td>5.2 (2.7)</td>
<td>4.4 (3.0)</td>
</tr>
<tr>
<td>Strong concentration</td>
<td>5.6 (2.5)</td>
<td>5.6 (2.5)</td>
<td>4.8 (2.7)*</td>
</tr>
<tr>
<td>Great precision</td>
<td>7.0 (2.0)</td>
<td>7.0 (2.0)</td>
<td>6.0 (2.5)**</td>
</tr>
<tr>
<td>Time pressure</td>
<td>5.1 (2.1)</td>
<td>5.1 (2.1)</td>
<td>4.1 (1.7)**</td>
</tr>
<tr>
<td>Task complexity</td>
<td>4.9 (2.8)</td>
<td>4.9 (2.8)</td>
<td>3.8 (2.6)**</td>
</tr>
<tr>
<td>Composite score</td>
<td>5.6 (2.1)</td>
<td>5.6 (2.1)</td>
<td>4.5 (2.1)**</td>
</tr>
</tbody>
</table>

*p < .10; **p < .05; ***p < .01 (differences between persons with and without incident cognitive impairment according to t tests for means and χ² for percentages). Independent sample t tests assuming equal and unequal variances and one-sample t test (using the mean in the nonincident cases as the population estimate with which to compare the mean in the incident cases) gave similar results.

The indicators of mental workload ranged from 0 (low load) to 10 (high load).

### TABLE 2 Odds Ratios (95% Confidence Intervals) of Incident Cognitive Impairment for the Separate Indicators of Mental Workload

<table>
<thead>
<tr>
<th></th>
<th>Overall (n = 630, 36 cases)</th>
<th>Currently employed (n = 273, 15 cases)</th>
<th>Previously employed (n = 357, 21 cases)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental demands</td>
<td>0.83 (0.68–1.02)*</td>
<td>0.88 (0.62–1.25)</td>
<td>0.82 (0.63–1.05)</td>
</tr>
<tr>
<td>Strong concentration</td>
<td>0.80 (0.64–0.99)**</td>
<td>0.92 (0.63–1.37)</td>
<td>0.75 (0.57–0.99)**</td>
</tr>
<tr>
<td>Great precision</td>
<td>0.78 (0.64–0.95)**</td>
<td>0.78 (0.56–1.10)</td>
<td>0.78 (0.61–1.00)*</td>
</tr>
<tr>
<td>Time pressure</td>
<td>0.70 (0.54–0.90)**</td>
<td>0.68 (0.44–1.04)*</td>
<td>0.70 (0.50–0.97)**</td>
</tr>
<tr>
<td>Task complexity</td>
<td>0.90 (0.76–1.06)</td>
<td>1.00 (0.75–1.36)</td>
<td>0.85 (0.69–1.04)</td>
</tr>
<tr>
<td>Composite score</td>
<td>0.79 (0.65–0.96)**</td>
<td>0.86 (0.60–1.23)</td>
<td>0.76 (0.59–0.98)**</td>
</tr>
</tbody>
</table>

**Note.** Odd ratios were adjusted for age, sex, educational level, employment status, and follow-up interval. Separate analyses were performed for persons with and without a current employment.

*p < .10; **p < .05; ***p < .01.

The indicators of mental workload ranged from 0 (low load) to 10 (high load); the corresponding odds ratios indicate the decrease in the odds of incident cognitive impairment for each unit increase in these measures.
DISCUSSION

Our findings support the hypothesis of mental work demands providing protection against cognitive impairment among Dutch men and women, aged 50 to 80. Findings were similar in persons who were professionally active in the past (many of whom were pensioners) and persons who were still professionally active. The findings were further independent of age, sex, educational level, intellectual abilities, lifestyle, depression, diseases, and family history of dementia. Mental work demands may reflect continued mental stimulation during adult life (Orrel & Sahakian, 1995; Schoeller, 1990; Swaab, 1991). The results are therefore in line with the "use-it-or-lose-it" perspective on cognitive aging (Christensen et al., 1996; Fabrigoule et al., 1995; Hultsch, Hammer, & Small, 1993; Orrel & Sahakian, 1995; Swaab, 1991).

The process through which mental stimulation at work affects cognitive function either involves a direct neuroprotective effect or involves an effect on brain reserve, thereby postponing symptoms of cognitive decline rather than being of significance for underlying pathology (Elias, Elias, & Elias, 1990; Katzman, 1993; Mortimer, 1988; Satz, 1993). In this interpretation, brain reserve is considered subject to further change during adulthood, instead of being fully developed in early life and stable thereafter. Another pathway through which mental stimulation at work affects cognitive decline may be that cognitive aging occurs earlier in the life-course of persons with

TABLE 3 Odds Ratios (95% Confidence Intervals) of Incident Cognitive Impairment for the Separate Indicators of Mental Workload

<table>
<thead>
<tr>
<th>Mental demands</th>
<th>Strong concentration</th>
<th>Great precision</th>
<th>Time pressure</th>
<th>Task complexity</th>
<th>Composite score</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.83 (0.68-1.02)*</td>
<td>0.80 (0.62-1.05)*</td>
<td>0.78 (0.64-0.98)*</td>
<td>0.70 (0.54-0.95)*</td>
<td>0.70 (0.54-0.95)*</td>
<td>0.79 (0.63-0.96)*</td>
</tr>
</tbody>
</table>

Note: Odds ratios were adjusted for age, sex, educational level, employment status, and family history of dementia (α = 0.05, 36 cases). The indicators of mental workload ranged from 0 (low load) to 10 (high load); the corresponding odds ratios indicate the decrease in the odds of incident cognitive impairment for each unit increase in these measures.

Table 3 shows that the protective effects of mental workload remain, when intellectual abilities, lifestyle, depression, diseases, and family history of dementia were additionally controlled for. Odds ratios hardly changed.
low mental work demands, because of a higher vulnerability to more proximate medical, biological, behavioral, or psychosocial stressors (e.g., Jolles et al., 1995; Elias et al., 1990; Houx & Jolles, 1994).

Our findings suggest the relevance of a potentially modifiable determinant of cognitive impairment. Monotonous jobs requiring few mental efforts could be enriched as to increase mental challenges in these jobs. Sufficient care should be taken not to overload employees and to increase job control accordingly, as high job demands–low control conditions are related to poor physical and psychological well being and elevated risks of cardiovascular diseases (De Jonge, Bosma, Peter, & Siegrist, 2000; Bosma et al., 1997; Karasek & Theorell, 1990). It may be worthwhile in further studies to examine the likely beneficial effects of active jobs (high demands–high control) on successful cognitive aging, because it has been hypothesized that active jobs increase both productivity and learning (Karasek & Theorell, 1990).

Methodological Considerations

Some methodological issues should be discussed. Firstly, nonresponse was large at baseline and related to old age and low educational level (Jolles et al., 1995; level; Van Beijsterveldt et al., 2002; Van Boxtel et al., 1998). Further selection, also according to low mental work demands, occurred when persons were invited for neuropsychological testing and the follow-up 3 years later. For example, 73% of the persons in the lowest third of the composite workload measure participated at the follow-up wave compared to 85% of persons in the highest third. Assuming similar associations between mental work demands and cognitive change in participants and nonparticipants at follow-up, this is likely to have resulted in underestimated associations between mental work demands and incident cognitive impairment.

Secondly, the associations that we found should be examined further in longer follow-up periods. Only small cognitive changes occurred in our 3-year follow-up interval. Moreover, the indicator of cognitive impairment should be further examined with respect to its conceptual and empirical validity (Bosma et al., 2000; Moller et al., 1998; Ritchie & Touchon, 2000). The strength of the present findings is that mental work demands already predict cognitive impairment in a 3-year follow-up of initially cognitively healthy persons. The consistency across indicators of mental work demands supports the relevance of mental work demands for cognitive aging.

Thirdly, our indicators of mental work demands may have some drawbacks. Information was based on data from an external source. While reducing any reporting bias, actual differences in mental work demands within job title codes are lost using this information. This may have resulted in underestimated effects of mental work demands. Further research should preferably use information on the complete job history of persons and take into account the secular changes in mental work demands.

Finally, as mental work demands are generally higher in higher socioeconomic groups (Marmot et al., 1991), socioeconomic status may have been a neglected confounder in our analyses (Berkman, 1986; Mortimer & Graves, 1993). We, however, think that controlling for educational level excluded most of its potential confounding influence on our findings.

CONCLUSIONS

High mental demands at work protect adult men and women against the development of cognitive dysfunction. This indicates potential benefits of continued and potentially modifiable mental stimulation during adult life for successful cognitive aging.

REFERENCES


