Repetitive Thinking as a Psychological Cognitive Style in Midlife Is Associated with Lower Risk for Dementia Three Decades Later

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Key Words

Repetitive thinking · Stress · Dementia, risk · Epidemiology

Abstract

Aims: To examine the association of a reported tendency toward repetitive thinking (RT) in midlife when confronting difficulties in family and work settings with dementia many years later. **Methods:** A tendency toward RT was assessed in approximately 9,000 male participants in the Israeli Ischemic Heart Disease study in 1965. The subjects were categorized according to their tendency toward RT in familial and work settings as: 1 = always forget; 2 = tend to forget; 3 = tend to think repetitively, and 4 = usually think repetitively. Dementia was assessed over 3 decades later in 1,889 participants among 2,604 survivors of the original cohort. **Results:** The prevalence rates of dementia were 24, 19, 15 and 14% in the 4 groups of tendency toward RT in stressful work situations with superiors (p for trend < 0.0002), respectively. The prevalence rates of dementia were 21, 18, 14 and 14% in the 4 groups of tendency toward RT in familial situations (p for trend < 0.004), respectively. These associations held after multivariate analysis. **Conclusions:** The tendency toward RT when confronting distress is associated with a lower risk for dementia. Future studies should assess possible mechanisms and potentials for intervention and modification.

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Introduction

Cognitive activity has, relatively constantly, been associated with a reduced risk for dementia [1–4]. Yet, cognitive activity, most commonly measured as engagement in some form of activity requiring cognitive effort [5, 6], is also associated with internal, psychological/mental processes such as social cognition, emotion, motivation, self-regulation, psychopathology and reaction to stress [7]. It is therefore reasonable to assume that internally derived cognitive activity is also associated with a risk for dementia. The relationships of these forms of cognitive activity in midlife and the risk for dementia in late life have rarely been investigated.

Repetitive thinking (RT) about one's experiences, thoughts and concerns is a mental process commonly engaged in by all people [7]. It is defined as a process of thinking attentively, repetitively or frequently about one's self and one's world [8]. Some forms of RT are considered to be adaptive by contributing to effective problem solving and to the recuperation from traumatic and upsetting events [7]. Other forms of RT, however, such as rumination, have been demonstrated to be associated with the onset and duration of depression and anxiety and with poor physical outcome [7]. Rumination involves an unintentional process of repetitively focusing the attention on one's depressed mood and its potential causes and impli-

cations, and is considered a characteristic of neuroticism [9]. According to some studies, neuroticism [10] and depression [11] are, in turn, associated with an increased risk for dementia.

The aim of the present study was to examine the association of a reported tendency toward RT in midlife when confronting difficulties in family and work settings with dementia many years later. A tendency toward RT in response to interpersonal stress in family and work settings with peers and superiors was assessed in men aged 40–65 years, 36–37 years prior to the dementia diagnosis. Under the assumption that RT in this stressful context might be a negative cognitive style, we hypothesized that a tendency toward RT would be associated with an increased risk for dementia.

Methods

The Israeli Ischemic Heart Disease Project

In 1963, the sample of the Israeli Ischemic Heart Disease (IIHD) Project was chosen by stratified sampling of civil servants and municipal employees based on: (1) tenured men aged 40 years and above at the time of inclusion; (2) place of work limited to the 3 largest urban areas in Israel (Tel Aviv, Jerusalem and Haifa), and (3) sampling fractions aimed at obtaining numbers of study subjects from 6 geographical areas of origin (Central Europe, Eastern Europe, the Balkan countries, the Middle East, Northern Africa and Israel) approximately proportional to the Israeli male population at these ages. Of 11,876 men approached, 10,232 (86.2%) agreed to participate. The subjects were seen upon enrollment (1963) and the survivors were seen at 2 follow-up visits (1965 and 1968). Subsequent analyses excluded 173 men who were born outside the 6 predefined geographical areas. Only 9,138 subjects reported to the interview that investigated their psychological and cognitive coping styles. Further details of the study (sampling procedures, mortality, follow-up and analysis) have been described elsewhere [12].

Assessment of Tendency toward RT

The tendency toward RT measured the tendency of participants to keep thinking and worrying about situations in which they had been hurt or disappointed by their wife or children, or by their peers or superiors at work, as opposed to a tendency to forget these situations. The tendency toward RT in stressful situations within domestic (wife and children) and work (peers and superiors) settings was assessed using the following questions: when your wife or children, peers or superiors at work hurt or disappoint you, do you forget this or do you tend to keep worrying and thinking about it? To all questions, 4 answers were possible, the higher score reflecting a higher tendency toward RT: 1 = always forget; 2 = tend to forget; 3 = tend to think repetitively, and 4 = usually think repetitively.

The total score for RT (composite RT score) ranging from 3 to 12 was assembled from the sum of the individual scores reflecting the tendency toward RT when hurt by wife or children, peer at

work and superior at work. Based on this score, the subjects were divided into 4 groups: group Rt 1 having the least tendency toward RT at baseline, group Rt 2 tending to forget, group Rt 3 tending to think repetitively, and group Rt 4 usually thinking repetitively. The composite RT scores defining these groups were 3–5, 6–8, 9–10 and 11–12, respectively.

Assessment of Tendency toward Retaliation

The tendency toward retaliation in domestic (wife and children) and work (peers and superiors) settings was assessed using the following questions: when your wife or children, peers or superiors at work hurt you, do you feel the need to retaliate? To all questions, 4 answers were possible, the higher score reflecting a lower tendency toward retaliation: 1 = very often; 2 = sometimes; 3 = seldom, and 4 = never. A composite score for retaliation was assembled reflecting the tendency toward retaliation in all settings (domestic and work). This score was coded '0' if the answers 'sometimes' or 'very often' were given in all 3 settings, '2' if the answers 'never' or 'seldom' were given in all 3 settings, and '1' for all other combinations in between, i.e. neither 'often tend to retaliate' nor 'never tend to retaliate' in all 3 settings.

Assessment of Anxiety

The subjects were assessed regarding the existence of anxiety symptoms by the following questions: (1) do you consider yourself a tense person; (2) do you suffer from anxiety (fear) for no evident reason, and (3) do you suffer from sleep problems? Each question could be answered 'yes' or 'no'. The total score for anxiety was 0, 1, 2 or 3, reflecting the number of questions answered positively.

Assessment of Number of Problems

The subjects were questioned regarding past and present financial, family and work problems. For every probe, there were 4 possible answers: 1 = very serious; 2 = serious; 3 = not serious, and 4 = none.

Socioeconomic Status Index

The Socioeconomic Status Index (SES) was based on formal education and the type of employment. Formal education included 9 levels ranging from 'no formal education' to 'completed university education'. Employment was the current one at the time of examination (1963) and included 5 levels ranging from 'laborer' to 'professional'. The SES scale ranged from 1 ('very low SES'; 3 lowest education levels and lowest employment level) to 5 ('very high SES'; 3 highest education and 2 highest employment levels) [13].

Diagnosis of Dementia

The dementia assessment was performed in 1999 and 2000 in survivors of the original cohort, 36–37 years after the assessment of their tendency toward RT. Cases of dementia were identified using a two-step procedure as described in detail elsewhere [14]. The first step was a telephonic screening interview. Subjects were located by cross-linking the database of the original study [12] with the population registry of the Israel Ministry of Interior, using the ID number (equivalent of United States social security number) as the linking identifier. All identified living participants in the original cohort were phoned, reminded of their participation in the original study and asked for their consent to participate in the new assessment. The subjects who consented to

participate were administered a 20-min phone interview including a sociodemographic questionnaire and the Hebrew version of the Modified Telephone Interview for Cognitive Status (TICS-m) [15]. The sociodemographic questionnaire included items that were not recorded during the original study in 1963, or that might have changed with time, such as marital status, retirement age, education, profession, leisure activities, smoking and drinking habits.

The TICS-m is based on the Mini-Mental State Examination (MMSE) [16]. It includes questions assessing long- and short-term memory, orientation to time and place, attention, language and abstraction. The scores of the TICS-m were highly correlated with the MMSE scores in clinical studies [17] and, the Hebrew version, in this cohort [14]. Using a threshold score of 27 out of 50 TICS-m points, the sensitivity of this test was above 99% (95% CI: 91–100%) and the specificity 86% (95% CI: 85–87%) for dementia against the gold standard clinical diagnosis [15]. The second step was a face-to-face interview with all the subjects with a TICS-m score of 27 or lower. The aim of the second phase of the study was to ascertain the diagnosis of dementia among subjects who were identified by the TICS-m as possibly cognitively impaired. The patients were assessed at their residences by a physician (a neurologist or psychiatrist with expertise and extensive experience in the diagnosis of dementia). Physicians were blind to the TICS-m score except for the knowledge that it was <28. The clinical assessment included the Dementia Questionnaire (DQ) [18–20], MMSE [16], Global Deterioration Scale [21] and Hachinski Ischemic Scale [22].

For persons with suspected dementia, the DQ assesses, via informants, the symptoms, course and features of the dementia, permitting a diagnostic classification of the presence and likely type of dementia. The DQ has previously demonstrated good interinformant and interrater agreement in Alzheimer's disease probands and normal elderly control populations for detecting the presence or absence of dementia and also, among identified cases of dementia, the type of dementia [19, 20]. More recently, several investigations have assessed the validity of this instrument. Compared with a clinical assessment of dementia, the DQ was found to have excellent sensitivity (100%; 95% CI: 73–100%) and very good specificity (95% CI: 63–100%) [23, 24]. In addition, in a series of deceased, autopsied elderly subjects, informant-based DQ were compared with independent neuropathological examinations; for Alzheimer's disease, the DQ was found to be only slightly less sensitive than direct clinical assessment, and its specificity was virtually at the same level [18].

Dementia was diagnosed using the DSM-IV criteria [25]. Subjects were classified as 'cognitively impaired no dementia' (CIND) if both subject and informant reported a memory problem but they had normal activities of daily living and were not demented. Thus CIND subjects did not qualify as either demented or 'no cognitive impairment'. The present analysis compares unequivocally demented to unequivocally nondemented subjects, excluding the CIND subjects, who are heterogeneous, with some subjects early in the course of cognitive decline.

A second physician, blind to the diagnosis assigned by the physician who did the face-to-face interview, examined the data gathered from each patient and assigned an independent diagnosis. In case of disagreement between the 2 physicians, the case was presented to a third physician for a consensus diagnosis. In 5 cases, the patient was approached again for this purpose.

According to the Israel Mortality Registry, 7,136 men had died by the beginning of the study in 1999; another 306 men died before being approached for a phone interview, and 13 subjects were lost in the matching process. The remaining 2,604 subjects qualified for a telephone interview, of whom 2,038 had phone contact. The telephone screening identified 799 potentially demented subjects for a home interview. Of these, 149 could not be examined. Of the remaining 1,239 subjects who were not identified as potentially demented by the TICS-m, 51 were examined at home for a sensitivity study of the phone interview instruments; 50 were cognitively intact and 1 cognitively impaired but not demented. The remaining 1,188 subjects were classified as nondemented. Thus, the follow-up study characterized the presence or absence of dementia in 1,889 subjects: 307 were demented, 175 had cognitive impairment not sufficient to meet diagnostic criteria for dementia (CIND9), and 1,407 elderly subjects had 'no cognitive impairment'.

Differences between the individuals who had participated in the original cohort and survived until 1999 and those who had not survived are detailed elsewhere [26]. In short, the individuals who had survived were younger, taller, had a lower BMI and lower total cholesterol, systolic and diastolic blood pressure and glucose, were less likely to be diabetic and less likely to have been smokers in 1963. Their SES was slightly lower. The groups had similar average weight and high-density lipoprotein (HDL) cholesterol levels.

The study was approved by the Sheba Medical Center ethics committee.

Statistical Analysis

Statistical analysis employed χ^2 tests to compare the prevalence of dementia among survivor groups defined by midlife RT and other attributes. A test of trend was used to test the departure of sample results consistent with a 'dose-response' association between midlife RT categories and late-life dementia prevalence from a null hypothesis of an independence of dementia rates from RT or other categories. Logistic regression was used to estimate the covariate-adjusted odds ratios for dementia prevalence, associated with having been at the lowest quartile composite RT score, compared to the 3 others. An order-directed score test for trend was used for detecting trend [27].

The kappa coefficient of agreement was employed to assess agreement between RT in response to problems in different domains (family, and work problems with superiors and with co-workers). The tests were two-tailed.

Results

Cardiovascular Characteristics of RT Groups at Baseline

The groups of subjects according to composite RT score (Rt 1: 'usually forget'; Rt 2: 'tend to forget'; Rt 3: 'tend to think repetitively'; Rt 4: 'usually think repetitively') did not differ at baseline or at the follow-up of survivors in 1999/2000 in age, diastolic and systolic blood pressure, total cholesterol and HDL cholesterol, diabetes or smoking status (table 1).

Table 1. Baseline cardiovascular profile of rumination groups

	Rt 1	Rt 2	Rt 3	Rt 4
Number ¹	3,268 (39.4)	3,243 (39.0)	1,192 (14.4)	596 (7.2)
Age, years	49.2 ± 6.8	49.1 ± 6.7	48.7 ± 6.5	49.0 ± 6.8
BMI	25.7 ± 3.6	25.7 ± 3.2	25.4 ± 3.2	25.6 ± 3.1
Systolic BP, mm Hg	136 ± 20	134 ± 20	134 ± 21	134 ± 19
Diastolic BP, mm Hg	83.6 ± 10.8	84.0 ± 11.3	83.4 ± 11.4	83.9 ± 10.6
Cholesterol, mg/dl	207 ± 40	209 ± 39	211 ± 40	210 ± 40
HDL, mg/dl	36.7 ± 9.6	36.2 ± 9.4	36.6 ± 9.2	35.9 ± 8.5
Hemoglobin, g/dl	15 ± 1.2	15 ± 1.2	14.9 ± 1.3	15.0 ± 1.3
Diabetes prevalence	5.5 (22.8)	3.8 (19.2)	3.8 (19.1)	4.0 (19.7)
Ever smoked	69 (46)	68 (47)	69 (46)	70 (46)

Values denote means ± SD or numbers with percentages in parentheses. BP = Blood pressure.

¹ Percentage of total at baseline.

Table 2. Association of SES with RT (n)

	Rt 1	Rt 2	Rt 3	Rt 4	Total
1 (low)	1,026 (49)	717 (34)	216 (10)	124 (6)	2,083 (100)
2	822 (41)	766 (38)	296 (15)	121 (6)	2,005 (100)
3	937 (36)	1,091 (42)	399 (15)	180 (7)	2,607 (100)
4	246 (30)	358 (43)	138 (17)	88 (11)	830 (100)
5 (high)	225 (30)	304 (40)	140 (19)	80 (11)	749 (100)
Total	3,256 (39)	3,236 (93)	1,189 (14)	595 (7)	8,274 (100)

Rt 1 is the group with the lowest composite RT score, Rt 4 the group with the highest score. Figures in parentheses are percentages.

Association between Tendency toward RT and Survival

Survival beyond the age of 75 years was 60.5, 62.4, 64.5 and 62.8% for composite RT score groups Rt 1, Rt 2, Rt 3 and Rt 4, respectively. Thus, no clear association between the tendency toward RT and survival beyond the age of 75 years was observed.

Association of RT with Socioeconomic Factors

Socioeconomic Status. Higher SES scores were associated with higher RT composite scores (table 2).

Number of Problems and RT. As shown in table 3, a positive association was found between the baseline tendency toward RT and the number of serious or very serious problems in family and work (superiors and peers) settings. The men reporting the least number of serious

Table 3. Association between number of serious problems at work and tendency for RT (n)

	Rt 1	Rt 2	Rt 3	Rt 4	Total
Number of serious problems – superiors					
0	1,858 (35)	538 (23)	118 (15)	24 (7)	2,538 (29)
1	1,669 (31)	662 (28)	143 (19)	48 (14)	2,522 (29)
2	907 (17)	518 (22)	159 (21)	55 (17)	1,639 (19)
3	893 (17)	644 (27)	342 (45)	207 (62)	2,086 (23)
Total	5,327 (100)	2,362 (100)	762 (100)	334 (100)	8,785 (100)
Number of serious problems – peers					
0	2,939 (42)	558 (31)	121 (25)	17 (19)	3,635 (39)
1	2,420 (35)	611 (33)	135 (28)	16 (18)	3,182 (34)
2	875 (12)	287 (16)	101 (21)	18 (21)	1,281 (14)
3	743 (11)	360 (20)	129 (26)	37 (42)	1,269 (13)
Total	6,977 (100)	1,816 (100)	486 (100)	88 (100)	9,367 (100)

Figures in parentheses are percentages.

problems with superiors at work had the lowest tendency toward RT (7% had the highest score for RT), whereas those reporting the highest number of serious problems had the highest tendency toward RT (62.0% had the highest score for RT). Similarly, only 19% of those with the least number of problems with peers at work had the highest tendency toward RT compared to 42.0% of those with the largest number of problems.

Number of Problems and Risk for Dementia. A positive association was found between the number of problems

Table 4. Association of RT in family and work settings with dementia

Tendency toward rumination	Percent dementia when setting		
	hurt by wife or children	hurt by coworkers	hurt by superiors
1 Forget	21	23	24
2 Tend to forget	18	16	19
3 Tend to think repetitively	14	16	15
4 Usually think repetitively	14	15	14

reported and the risk for dementia; survivors who reported a higher number of serious problems were at a higher risk for dementia (odds ratio = 1.12; 95% CI: 1.02–1.24), so that each rise in score for the number of problems reported increased the risk for dementia by 12%.

Association between Tendency toward Retaliation, Anxiety and Tendency toward RT

The individuals with the lowest composite retaliation score (reflecting higher tendency for retaliation) had a mean composite RT score of 6.53 (SD: 2.65) compared to 6.40 (SD: 2.54) and 6.12 (SD: 2.50) in the individuals with intermediate and the highest composite retaliation scores, respectively.

Thus, subjects who tended to think repetitively had a higher tendency toward retaliation.

The mean composite retaliation score was 1.35 (SD: 0.60) in the individuals with the lowest anxiety score compared to 1.20 (SD: 0.61), 1.12 (SD: 0.60) and 1.12 (SD: 0.66) in the individuals with intermediate and the highest anxiety scores, respectively, suggesting tendency for retaliation is associated with anxiety.

The mean composite RT score was 5.72 (SD: 2.3) in the individuals with the lowest anxiety score compared to 6.64 (SD: 2.54), 7.3 (SD: 2.7) and 7.8 (SD: 2.72) in the individuals with intermediate and the highest anxiety scores, respectively, suggesting tendency for RT is associated with anxiety.

Association between Tendency toward RT in 1963 and Dementia in 1999–2000

The association of the tendency toward RT with dementia is reported for RT in familial situations and work situations as well as for the composite RT score, which assembles the sum of the individual scores in all situations.

The age-adjusted prevalence rates of dementia in the 4 groups of tendency toward RT in the familiar setting were 21% for survivors of group Rt 1, with a low RT score, and 18, 14 and 14% for the counterparts in groups Rt 2, Rt 3 and Rt 4, respectively (table 4). The score test for trend of odds in this setting was $\chi^2(1) = 8.13$ ($p = 0.004$). The rates for the 4 groups of tendency toward RT with coworkers at work were 23, 16, 16 and 15% for groups 1 through 4, respectively (table 4). The score test for trend of odds in this setting yielded $\chi^2(1) = 10.13$ ($p = 0.0015$). The rates for the 4 groups of tendency toward RT with superiors at work were 24, 19, 15 and 14% for groups 1 through 4, respectively (table 4). The score test for trend of odds in this setting yielded $\chi^2(1) = 13.71$ ($p = 0.0002$).

Controlling for factors associated with an increased risk for dementia (i.e. year of birth, country of birth and socioeconomic status) in a logistic regression, the odds for dementia relative to the group with the lowest composite RT score (Rt 1) were 0.74 (95% CI: 0.53–1.01), 0.68 (95% CI: 0.44–1.05) and 0.59 (95% CI: 0.33–1.08) for groups Rt 2, Rt 3 and Rt 4, respectively. These results remained substantially unchanged after controlling for education in the logistic regression; the odds for dementia relative to the group with the lowest RT score (Rt 1) were 0.72 (95% CI: 0.52–0.99), 0.65 (95% CI: 0.42–1.00) and 0.58 (95% CI: 0.32–1.06) for groups Rt 2, Rt 3 and Rt 4, respectively.

Logistic regressions for dementia demonstrated similar relative odds for dementia according to composite RT score in men who were below and above 50 years of age at baseline, suggesting this effect was not specific to a certain birth cohort.

Thus, dementia rates decreased in a stepwise manner as the tendency toward RT increased among survivors. Upon further adjustment for the number of serious or very serious problems reported, the odds ratio estimates remained almost unaltered: 0.74 (95% CI: 0.53–1.05), 0.71 (95% CI: 0.45–1.13) and 0.56 (95% CI: 0.3–1.07), respectively.

Discussion

The present study demonstrated that the tendency toward RT over problems encountered in family settings as well as in work settings was associated with a smaller risk for dementia 37 years later among the IIHD survivors, contrary to our original hypothesis. The distribution of dementia rates was similar for the RT scores in different settings (work or family).

The groups of subjects, divided according to composite RT scores, did not differ in their cardiovascular profile, diabetes or smoking status. Men with higher composite RT scores tended to have a higher socioeconomic status and were more likely to report a higher number of significant problems. However, the association between RT and dementia was not altered after controlling for socioeconomic status and the number of self-reported problems in midlife.

Previous studies have addressed the association between personality traits and dementia, demonstrating that proneness to distress is a risk factor for incident mild cognitive impairment and dementia [10, 28–30], and that low neuroticism combined with high extraversion was associated with a lower risk for dementia [31]. In these studies, personality characteristics were assessed at an advanced age (mean age at baseline: >80 years) [10, 31], which carries a high risk for the conversion to dementia, in contrast to our study, where psychological-cognitive characteristics were measured several decades prior to the dementia assessment. Though personality traits tend to remain stable throughout adult life, changes in personality and psychological coping style regarding stress may constitute a very early sign of dementia, at a stage in which cognitive impairment and functional decline are not yet measurable.

Neuroticism is generally characterized by a heightened sensitivity to life stressors and proneness to distress [32, 33]. Neurotic individuals tend to ruminate, a form of RT considered to be maladaptive, and be self-focused, possibly increasing the risk for major depressive episodes in terms of frequency, duration and severity [34–37]. Lifetime exposure to major depression, in turn, has been demonstrated by some to increase the risk for dementia [11]. Apparently, our results are therefore counterintuitive to the conceptualization that some forms of RT in response to stress, such as rumination, are expected to increase the risk for dementia.

One way of interpreting our results would be to consider a survival bias, suggesting that some forms of RT such as rumination may be associated with increased morbidity and mortality, and that those who tended to ruminate, but survived until the time of follow-up, are protected by some unknown mechanism, and are therefore not representative of the entire study sample. This assumption may be plausible in the absence of a dementia characterization of the 7,453 subjects in the original IIHD study reported dead before the follow-up study was conducted. Several possible contributors to health and survival (such as availability and quality of medical services,

adherence to pharmaceutical treatment, etc.) were not available to us. Nevertheless, available data demonstrated that RT during midlife was not associated with increased mortality. Additionally, baseline variables related to a high risk of mortality, mainly smoking, diabetes mellitus and hypertension, did not differ between the groups of subjects stratified according to composite RT score, among the entire IIHD cohort or those who had survived until follow-up in 1999.

Our results may also be explained by the fact that RT is a heterogenic entity [7, 38], with some forms being adaptive [39, 40] and others maladaptive. The adaptive and maladaptive qualities of RT differ depending on thought content (positive vs. negative), intrapersonal context (positive vs. negative) and construal level of thinking (concrete vs. abstract) [7, 38]. The tendency toward RT as detected in this study may differ in etiology and results from the maladaptive rumination characteristic of neuroticism.

In our study, subjects who tended to think repetitively over stressful situations were also prone for retaliation. Both tendencies were reported to be increased in subjects who had higher anxiety scores. The causality of, duration and outcome of anxiety were not assessed in this study; therefore, the exact interaction of the mode of thinking with this specific emotion cannot be evaluated, as is the case for the intrapersonal context of the tendencies toward RT and retaliation.

The mode of thinking in response to stress may have intellectual associations as well as emotional ones. Intellectual activity has been demonstrated in several studies to provide protection from dementia [1, 2, 6]. In most studies, intellectual activity has been measured addressing the frequency and duration of participation during midlife in activities such as reading, working jigsaw puzzles, playing musical instruments, crafts, etc. [1, 2, 6]. RT over problematic situations encountered at work or in familial settings resulting in intensive cognitive activity directed toward problem solving may be a similar form of cognitive activity, and thus be associated with a protective effect against dementia. Another possibility, supported by the association of RT score with socioeconomic status (composed of the types of education and employment), is that RT is associated with IQ. The baseline cognitive status, however, was not available to us, thus preventing a further assessment of this association.

The main limitation of this study, as discussed above, is the lack of information on the incidence of dementia in the subjects of the original IIHD study reported dead before the follow-up study was conducted. The dementia

diagnosis was primarily based on the dementia questionnaire and lacked an extensive neuropsychological battery. Nevertheless, the dementia questionnaire is based on in-depth clinical dementia assessment, performed by experienced psychiatrists and neurologists in the field. Additionally, we chose to compare unequivocally demented to unequivocally nondemented subjects, excluding the CIND subjects, which is the most complex population for cognitive assessment in daily clinical practice. Only males were included in the current study. The association of one form of RT, rumination, with depression, which has been hypothesized to be a mechanism underlying the predisposition of females to depression [41], may be less relevant for male subjects.

Our measurement of the tendency toward RT has not been validated. The questions measuring the tendency toward RT addressed the settings triggering this mode of thinking and its intensity. However, the content of thought, intrapersonal context (positive vs. negative) and extent of concrete versus abstract form of thought were not assessed. This limits our ability to characterize the type of RT. Of note, though, indicators for perceived family problems, family support and coping style as assessed at baseline in the IIHD have also been demonstrated to be related to a long-term risk of dying from stroke [42], similar to findings on other groups [43, 44], supporting

the content validity. Additionally, depression, an important contributor to and result of some forms of RT, i.e. rumination [45], and associated with an increased risk for dementia, was not assessed in the study.

The strengths of our study are the relatively large sample size, longitudinal design and cognitive style evaluation at midlife when cognitive style is not expected to be affected by the dementing process. In addition, an abundance of midlife demographic, psychological, social and biomedical data, all of which may affect late-life cognitive status, was available to us. These variables were controlled for when analyzing the association of the tendency toward RT with dementia risk.

Our findings add to the complexity and diversity of risk factors associated with the clinical diagnosis of dementia at old age. Further studies should address the association between types and contents of RT, their efficacy in the reduction of stress and in problem solving, and the risk for cognitive decline and dementia.

Acknowledgment

This study was supported by NIA grant No. K01 AG023515-01 for M.S.B.

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