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Cognitive test performance in relation to psychotic symptoms and paranoid ideation in non-demented 85-year-olds

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ABSTRACT

Background. Clinical studies suggest that psychotic and paranoid states in late life are associated with cognitive dysfunction. However, it is not clear whether this finding would be observed in general population samples of non-demented elderly, particularly after adjustment for potential confounding factors.

Method. A representative sample of non-demented 85-year-olds living in the community or in institutions in Göteborg, Sweden ($N=347$) was examined using a psychiatric and physical examination (including a medical history), key-informant interview, psychometric testing and review of medical records. Individuals with psychotic symptoms and paranoid ideation were compared with the mentally healthy regarding tests of verbal ability, inductive logical reasoning, spatial ability, perceptual speed, basic arithmetic, primary memory and secondary memory.

Results. Non-demented 85-year-olds with psychotic symptoms or paranoid ideation performed specifically worse on tests measuring verbal ability, logical reasoning and two tests of spatial ability after adjustment for sex, education, hearing impairment, visual deficits, somatic disorders, depression, 3-year-mortality rate and incident dementia.

Conclusions. Psychotic symptoms and paranoid ideation were associated with lower performance on cognitive tests related to verbal ability, logical reasoning and spatial ability in non-demented 85-year-olds after adjustment for potential confounders.

INTRODUCTION

Clinical studies report that psychotic states arising in late life are associated with cognitive dysfunction. Individuals with late-onset schizophrenia perform significantly worse than age-matched controls on measures of executive functions, learning, motor skills and verbal ability (Miller *et al.* 1991; Almeida *et al.* 1995; Jeste *et al.* 1995). It is not clear whether these findings can be applied to the non-demented elderly in the general population. In one population-based study, non-demented elderly with psychotic symptoms performed worse on a test of mental speed compared to those without psychotic symptoms, but showed no difference on a test of recent memory and in a test of global cognitive function (Henderson *et al.* 1998).

Several factors, such as incipient dementia, depression (Yaffe *et al.* 1999; Palsson *et al.* 2000), sex (van Exel *et al.* 2001), educational level (Farmer *et al.* 1995; Leibovici *et al.* 1996), hearing impairment (Gates *et al.* 1996; Hallgren *et al.* 2001), visual deficits (Kempen *et al.* 1994), physical disorders (Breteler *et al.* 1994; Tatemichi *et al.* 1994; Starr *et al.* 1997; Stewart

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& Liolitsa, 1999; Ahles & Saykin, 2001) and terminal decline (Hassing *et al*. 2002) may affect test performance in the elderly. A number of these factors may also affect cognitive test performance in elderly individuals with psychotic symptoms.

One possible reason for the reported association between psychotic symptoms and cognitive dysfunction may be that previous studies have only adjusted for a few confounders, such as sex and educational level. We examined cognitive test performance using a battery of psychometric tests in relation to psychotic symptoms and paranoid ideation in a representative sample of non-demented 85-year-olds and also adjusted for factors previously shown to be associated with cognitive performance deficits and psychotic symptoms.

METHOD

Sample

In 1986–87, all 85-year-olds born 1 July 1901 to 30 June 1902 and registered for census purposes in Göteborg Sweden were invited to participate in a health survey, the Longitudinal Gerontological and Geriatric Population Study (H70) in Göteborg, Sweden. A neuropsychiatric examination was performed on a systematic subsample ($N=494$) (response rate 63%). This sample was representative of its population base with regard to sex, marital status, status as psychiatric outpatients or in-patients, institutionalization rate and 3-year mortality (Skoog *et al*. 1993). DSM-III-R (American Psychiatric Association, 1987) criteria were used to exclude individuals with dementia ($N=147$) or mental disorders other than psychotic ($N=86$). Thus, 261 individuals remained eligible to participate in the study. All participants gave their informed consent for inclusion in the study. The study was approved by the Ethics Committee for Medical Research at Göteborg University.

Procedure

Participant examinations at age 85 included a physical examination (which included history of previous and current diseases), an electrocardiogram (ECG), a chest X-ray, a battery of blood tests and computerized tomography (CT) of the brain. A semi-structured psychiatric examination, a key-informant interview and review of medical records from all major hospitals, and geriatric and psychiatric institutions and out-patient services in Göteborg, were conducted by experienced psychiatrists. The psychiatric examination assessed symptoms during the preceding month, while information gathered during the key-informant interview and from medical records, represented symptoms occurring at any time during an individual's 85th year.

The inter-observer reliability for assessing psychotic symptoms and signs was calculated using dual ratings of 49 single interviews by two psychiatrists. The agreement was 100·0% for delusions (kappa 1·00), 98·0% (kappa 0·92, 95% confidence interval (CI) 0·74–1·00) for auditory hallucinations, 95·7% (kappa 0·49, 95% CI 0·47–1·00) for other hallucinations, 98·0% (kappa 0·66, 95% CI 0·00–1·00) for visual hallucinations and 95·8% (kappa 0·79, 95% CI 0·49–1·00) for paranoid ideation.

Dementia, mood and anxiety disorders were diagnosed according to DSM-III-R criteria based on information from the psychiatric examination (American Psychiatric Association, 1987; Skoog *et al*. 1993). Dementia diagnoses were also based on information from the key-informant interview (Skoog *et al*. 1993).

Classifications of hallucinations, delusions and paranoid ideation were based on information from three sources, psychiatric examinations, key informant interviews and medical records, and evaluated by an experienced psychiatrist, according to the Glossary of Technical Terms in the DSM-IV (American Psychiatric Association, 1994). These symptoms were not considered if they occurred during an acute medical condition, a suspect delirium, or in the terminal stage of life (Östling & Skoog, 2002).

Mentally healthy individuals were defined as 85-year-olds without dementia, mood or anxiety disorders, psychotic symptoms, or paranoid ideation.

Assessment of cognitive status

A psychologist, blinded to the outcome of other examinations, administered the following cognitive tests (described in detail elsewhere (Berg, 1980)): (1) Synonym Test (SRB 1), this measures verbal ability (individuals are given a list of 30 words and must identify one synonym among five given alternatives, maximum

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score = 30); (2) Figure Classification Test (SRB 2), this measures inductive logical reasoning (individuals identify one figure among five that is not constructed according to a principle shared by the other four figures, maximum score = 30); (3) Block Design Test (SRB 3), measures spatial ability (individuals organize wooden cubes in accordance with seven patterns presented on cards, maximum score = 42); (4) Identical Forms Test (PSIF), measures perceptual speed (individuals identify a pattern that is identical to a stimulus pattern, maximum score = 60); (5) Thurstone Picture Memory Test, measures episodic memory and is a non-verbal, long-term memory test (individuals are shown 28 pictures and immediately asked for recognition of these pictures among distractors, maximum score = 28); (6) Digit Span, measures short-term or working memory (individuals immediately recall increasingly longer sequences of digits, in the forward part (maximum score = 9) individuals are asked to recall the digits in the same order as they were presented, in the backward part (maximum score = 8), they are instructed to recall them backwards). All of the above tests, except Digit Span, are from Dureman & Sälde (1959). Block Design and Digit Span are also components of the WAIS test battery (Wechsler, 1958).

The following neuropsychological tests were also administered: (1) Clock Test, this is a spatial test similar to the widely-used Draw-a-Clock procedure (I) but with the addition of having individuals set (II) and tell (III) the time on a large wooden clock, maximum score = 15; (2) Coin Test, which is designed as a sorting task, uses familiar stimuli to test concept formation and basic arithmetic abilities (maximum score = 8); (3) MIR Memory Test, requires individuals to place 10 real-life objects in different rooms of a three-dimensional model of an apartment (tests of free recall and recognition are administered to determine the ability to remember objects and their locations, maximum score in each subtask = 10); (4) Prose Recall Test, this is similar to the prose passages in the Wechsler Memory Test (maximum score = 16); (5) Ten-Word Memory Test, this is a traditional supra-span list learning task, containing two 10-word lists – of animals (I) and one of clothes (II) – corresponding to a modified version of Buschke & Fuld (1974) (maximum score for each list = 10). The first four tests have been described in detail previously (Johansson & Zarit, 1991).

Assessment of confounders

The diagnosis of myocardial infarction was based on medical history and ECG. Cerebrovascular disorders (stroke, transient ischaemic attacks and brain infarcts) were diagnosed using information from physical examinations, CT scans, psychiatric examinations, and key-informant interviews. Information on cancer was obtained from the Swedish Cancer Registry. Hearing impairment and visual deficits were rated if the symptoms interfered with conversation and execution of tasks at the psychiatric examination. Level of education was self-reported and classified as low ($\leqslant$6 year) or high ($>$6 year).

Three-year-mortality-rate between ages 85 and 88 was used to control for the effect of terminal decline. Information on the date of death was available from the census register in Göteborg, which records all deaths in the region. Incident dementia, defined as developing dementia according to DSM-III-R criteria during the 3-year follow-up, was used to control for incipient dementia. The diagnosis of incident dementia was based on information from psychiatric examinations and close informant interviews at age 88 and on information from medical records (Aevarsson & Skoog, 1996).

Statistical methods

Eighty-five-year-olds with psychotic symptoms or paranoid ideation were cross-sectionally compared to the mentally healthy. First, a stepwise logistic regression model was used to evaluate factors related to non-participation in the psychometric tests. Secondly, using the mentally healthy as the reference group, mean psychometric test scores were compared using *t* tests. Two-tailed tests were used at a significance level of $P < 0{\cdot}05$. Thirdly, a stepwise linear regression model predicting individual test scores was used to adjust for sex, educational level, hearing impairment, visual deficits, physical disorders and major depressive syndrome. Finally, using data obtained during the 3-year follow-up period, death between age 85 and 88 and incident dementia were added to the stepwise linear regression model.

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Table 1. *Number of individuals who completed psychometric tests compared with mentally healthy*

	Mentally healthy ($N=210$)	Psychotic symptoms ($N=35$)	Paranoid ideation ($N=16$)	Psychotic symptoms and paranoid ideation ($N=51$)
	N (%)	*N* (%)	*N* (%)	*N* (%)
Synonym Test (SRB 1)	184 (87·6)	22 (62·9)***	13 (81·2)	35 (68·6)**
Figure Classification Test (SRB 2)	175 (83·3)	20 (57·1)***	12 (75·0)	32 (62·7)**
Block Design Test (SRB 3)	197 (93·8)	28 (80·0)*	14 (87·5)	42 (82·4)*
Identical Forms Test (PSIF)	189 (90·0)	24 (68·6)**	12 (75·0)	36 (70·6)***
Thurstone Picture Memory Test	180 (85·7)	20 (57·1)***	11 (68·7)	31 (60·8)***
Digit Span				
Forward	203 (96·7)	34 (97·1)	16 (100·0)	50 (98·0)
Backward	203 (96·7)	33 (94·3)	16 (100·0)	49 (96·1)
Clock Test	199 (94·8)	32 (91·4)	16 (100·0)	48 (94·1)
Coin Test	203 (96·7)	32 (91·4)	16 (100·0)	48 (94·1)
MIR Memory Test				
Free recall	197 (93·8)	28 (80·0)*	15 (93·7)	43 (84·3)*
Recognition	198 (94·3)	28 (80·0)**	15 (93·7)	43 (84·3)*
Prose Recall Test	194 (92·4)	29 (82·9)	15 (93·7)	44 (86·3)
Ten Word Memory Test				
I	196 (93·3)	29 (82·9)*	15 (93·7)	44 (86·3)
II	197 (93·8)	29 (82·9)*	15 (93·7)	44 (86·3)

* $P<0·05$; ** $P<0·01$; *** $P<0·001$.

RESULTS

Among the 261 non-demented 85-year-olds eligible to the study, psychotic symptoms and paranoid ideation were identified in 51 (14·7%). Forty-two (20·0%) mentally healthy and 19 (37·3%) individuals with psychotic symptoms or paranoid ideation, died during the 3-year follow-up period. In addition, 31 (14·8%) mentally healthy and 17 (33·3%) with psychotic symptoms or paranoid ideation developed dementia. Thus, 141 (67·1%) mentally healthy and 20 (39·2%) individuals with psychotic symptoms or paranoid were alive and non-demented at the end of the 3-year follow-up period.

The number of individuals who performed the cognitive tests varied, and ranged from 175 to 203 individuals (Table 1). A stepwise logistic regression analysis, controlling for the presence of major depressive disorder, somatic disorders (previous myocardial infarction, hypertension, congestive heart failure, cerebrovascular disorder, diabetes mellitus or cancer), hearing impairment, visual deficits, incident dementia and terminal decline, showed that psychotic symptoms independently contributed to non-participation in the SRB 1 (odds ratio (OR) 4·5, 95% CI 1·4–14·1, $P=0·014$), the SRB 2 Test (OR 4·0, 95% CI 1·5–10·2, $P=0·006$), and the Thurstone Picture Memory Test (OR 5·4, 95% CI 2·0–14·8, $P=0·002$). Test participation did not differ between the mentally healthy and those with paranoid ideation.

In univariate analyses, individuals with psychotic symptoms and paranoid ideation showed lower performance, compared to the mentally healthy, on several tests (Table 2, *P* values in column I, P1). After adjustment for potential confounders present at age 85 (sex, education, hearing impairment, visual deficits, somatic disorders and major depressive disorder), psychotic symptoms and paranoid ideation were associated with worse performance on SRB 1, SRB 2, SRB 3, PSIF, Clock Test, MIR Memory Test (recognition), Prose Recall Test and Ten Word Memory Test (I) (Table 2, *P* values in column II, P2). After further adjustment for incident dementia and 3-year-mortality-rate, psychotic symptoms and paranoid ideation were associated with a poorer performance on the SRB 1, SRB 2, SRB 3, and the Clock test (Table 2, *P* values in column III, P3). The results were essentially in the same direction when self-report and key informant interviews were analysed separately (data not shown).

Finally, we excluded all who died or developed dementia during follow-up. In these analyses, those with psychotic symptoms and

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Table 2. *Cognitive performance in relation to psychotic symptoms and paranoid ideation in non-demented 85-year-olds*

	Mentally healthy ($N=210$)			Psychotic symptoms ($N=35$)						Paranoid ideation ($N=16$)						Psychotic symptoms and paranoid ideation ($N=51$)					
	N	Mean	(S.D.)	*N*	Mean	(S.D.)	I P1	II P2	III P3	*N*	Mean	(S.D.)	I P1	II P2	III P3	*N*	Mean	(S.D.)	I P1	II P2	III P3
Synonym Test (SRB 1)	184	16·8	(6·7)	22	11·9	(7·4)	**	**	*	13	13·6	(8·3)				35	12·5	(7·6)	***	***	*
Figure Classification Test (SRB 2)	175	15·3	(8·1)	20	7·7	(7·5)	****	****	**	12	10·9	(8·2)				32	8·9	(7·8)	****	****	**
Block Design Test (SRB 3)	197	11·1	(6·6)	28	8·1	(6·5)	*			14	6·0	(5·5)	**	**		42	7·4	(6·2)	***	**	*
Identical Forms Test (PSIF)	189	13·2	(5·8)	24	9·9	(5·5)	*			12	10·3	(6·5)				36	10·0	(5·7)	**	*	
Thurstone Picture Memory Test	180	18·9	(5·2)	20	16·2	(6·9)	*			11	15·8	(8·1)	*			31	16·1	(7·2)	**		
Digit Span																					
Forward	203	5·3	(1·0)	34	5·1	(1·0)				16	4·7	(1·5)		*		50	5·0	(1·2)			
Backward	203	3·9	(1·3)	33	3·6	(1·1)				16	3·1	(1·5)	*	**		49	3·4	(1·3)			
Clock Test	199	12·8	(3·2)	32	10·8	(4·6)	**			16	11·0	(5·0)	*			48	10·9	(4·7)	***	**	**
Coin Test	203	7·6	(1·0)	32	7·5	(1·1)				16	7·1	(2·0)	*			48	7·3	(1·5)			
MIR Memory Test																					
Free recall	197	7·8	(6·3)	28	6·3	(2·7)				15	6·4	(4·1)				43	6·3	(3·2)			
Recognition	198	9·8	(5·9)	28	8·9	(2·4)	****	*		15	9·6	(3·7)				43	9·1	(2·9)		*	
Prose Recall Test	194	9·5	(7·7)	29	8·2	(4·3)				15	6·8	(5·0)		*		44	7·7	(4·6)	**	*	
Ten Word Memory Test																					
I	196	5·7	(1·7)	29	5·1	(1·9)				15	4·9	(2·4)		*		44	5·1	(2·1)	*	*	
II	197	6·2	(1·7)	29	5·6	(2·2)				15	5·9	(2·4)				44	5·7	(2·2)			

P1: *P* value comparing test result between individuals with psychotic symptoms or paranoid ideation and mentally healthy after (unadjusted). P2: *P* value comparing test result between individuals with psychotic symptoms or paranoid ideation and mentally healthy after adjustment for sex, education, hearing impairment, visual deficities, somatic disorders and major depressive syndrome in a stepwise linear regression model. P3: *P* value comparing test result between individuals with psychotic symptoms or paranoid ideation and mentally healthy after adjustment for all factors above with the addition of incident dementia and terminal decline (3-year mortality) in a stepwise linear regression model.

* $P<0{\cdot}05$; ** $P<0{\cdot}01$; *** $P<0{\cdot}001$; **** $P<0{\cdot}0001$.

paranoid ideation at age 85 performed worse than mentally healthy on SRB 2 ($P=0{\cdot}007$), SRB3 ($P=0{\cdot}006$) and Digit Span backward ($P=0{\cdot}034$).

DISCUSSION

Psychotic symptoms and paranoid ideation were common in non-demented 85-year-olds, with a total prevalence of nearly 15%. We found that these symptoms were related to poor psychometric test performance, even after adjusting for factors such as incipient dementia, terminal decline, major depressive syndrome, visual deficits, hearing impairment, education and physical disorders. Performance was most affected on cognitive tasks measuring general cognitive abilities, such as verbal ability, logical reasoning and spatial ability (SRB 1, SRB 2, SRB 3), while memory test performance (the MIR Memory Test (recognition), the Prose Recall Test, the Ten Word Memory Test) was no longer significantly associated with psychotic symptoms and paranoid ideation after controlling for incident dementia and mortality rate. Those tests that were impaired were generally those that were more complex and tax general cognitive abilities. It should be emphasized that the magnitude of cognitive dysfunction in 85-year-olds with psychotic symptoms and paranoid ideation was considerably milder than that observed in dementia disorders.

Our findings are in line with previous clinical and population-based reports. For example, our results are similar to those identified in hospital-based studies on late-onset schizophrenia (Almeida *et al.* 1995; Jeste *et al.* 1995). These studies however, only adjusted or matched on a few confounders, such as sex and educational level. In addition, in line with a previous population-based study, we found that non-demented elderly with psychotic symptoms show decreased mental speed (Henderson *et al.* 1998). However, this association disappeared after multivariate adjustments. Individuals with early onset schizophrenia show a broad range of cognitive deficits affecting memory, executive functioning, verbal ability, mental speed, attention and spatial perception (Weickert *et al.* 2000). The design of the present study did not allow examinations of differential effects of various onset ages for psychotic disturbances.

Among the strengths of this study are the high age, the representativeness of the sample and the comprehensive examinations. However, there are also some limitations and methodological factors that need to be addressed.

First, even though the response rate was only 63%, this is a satisfactory response for this age group. A comparison between responders and non-responders showed that the sample was representative of its population-base of 85-year-olds (Skoog *et al.* 1993). Secondly, individuals with psychotic symptoms were less likely to participate in different psychometric tests compared to the mentally healthy. We therefore may have underestimated the effect of psychotic symptoms. However, after adjustment for potential confounders, psychotic symptoms only explained a minor part of non-participation in different tests, primarily those that were more complex and required more sustained cognitive efforts. The regression analysis also showed that non-participation was related to impaired vision, hearing impairment, major depressive disorder and incident dementia (data not shown). Thirdly, since we used 14 different psychometric tests, some of the findings may have been due to multiple comparisons. However, in all 42 comparisons, those with psychotic symptoms or paranoid ideation always had lower mean scores than the mentally healthy. Thus, the lack of significant associations observed for some of the tests may be due to small sample sizes. Fourthly, psychotic symptoms are common in dementia. Therefore, exclusion of demented individuals is crucial for a study on cognitive function. The use of key-informants to obtain a history of cognitive decline increased the likelihood of excluding subjects with very mild dementia at baseline. In fact, 30% of the sample was excluded because of dementia. Finally, even if demented at baseline are excluded, there is a risk that cognitive performance may be influenced by incipient dementia. We therefore controlled for incidence dementia in our analyses. Incidence dementia was diagnosed at a follow-up examination at age 88, and in those who died or were lost to follow-up for other reasons by examinations of medical records from health care departments in Gothenburg. Although almost all individuals in Sweden seek medical treatment in the public health system and thus have the same chance of being noted in a

medical record and that sufficient follow-up information was obtained on 92% of those non-demented at age 85 (Aevarsson & Skoog, 1996), symptoms of dementia might not have been noted in medical records in some of those who were lost to follow-up. We think that this potential bias is partly minimized as we also controlled for death in the analyses. Including only those individuals who were actually examined at follow-up leads to a power problem due to small sample size. However, the results were similar in this subgroup.

We found that psychotic symptoms and paranoid ideation in the non-demented elderly were independently related to worse cognitive performance in the domains of language, logical reasoning and spatial skills, but not to memory. These subtle symptoms may either be risk factors for or consequences of a psychotic syndrome. First, mild cognitive dysfunction may result in misinterpretations and difficulties in evaluating objects and situations, and thus to delusions and paranoid ideation. Secondly, incipient brain disorder may lead to both cognitive dysfunction and psychotic symptoms. Thirdly, cognitive symptoms may be part of the broader psychopathology shown by those with a psychotic syndrome. Because of the cross-sectional design of our study, we cannot elucidate the direction of the association between cognitive performance and psychotic symptoms.

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