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The Effects of Intellectual, Physical, and Social Activity on Further Prognosis in Mild Cognitive Impairment

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Background: Our goal was to specify the relationship between the level of activity (intellectual, physical, and social) in persons diagnosed with mild cognitive impairment (MCI) and the further progression of cognitive dysfunction.

Material/Methods: We examined 193 patients diagnosed with MCI (according to the criteria of the Working Group on Mild Cognitive Impairment) and under treatment at our Mental Disorders Clinic. It was assumed that these persons would remain under systematic psychiatric observation until dementia was diagnosed. The present study results from a seven-year observation period. The mini–mental state examination (MMSE), the Activity Scale (with the intellectual, physical, and social subscales), and the Instrumental Activities of Daily Living (IADL) scale were used to evaluate the participants' status at baseline. The MMSE was re-administered after one year and again at the end of the observation (either upon diagnosis of dementia or after seven years). At each meeting with the participant, the clinical diagnosis was verified to determine if the patient had dementia or not. Of the 193 people initially qualified for the study, 75 were available for the final analysis.

Results: It was found that there was no statistically significant difference in the baseline MMSE scores between the persons with stable MCI and the persons who had progressed to dementia. However, statistically significant differences in the level of activity at baseline on both the global IADL scale and the Activity Scale between those with stable MCI and those who had progressed to dementia were found. These differences were manifested in the IADL subscales for telephone use, shopping, transportation, and personal finances, and in the physical activity subscale.

Conclusions: An evaluation of intellectual, physical, and social activity can be useful in determining the prognosis for the future course of MCI.

MeSH Keywords: Emotions • Memory • Mental Health • Social Behavior

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Background

The processes that lead to the gradual atrophy of brain cells, and thus to dementia, are affected by many different factors. Some researchers have called attention to the impact of activity over the lifespan, particularly in later periods of life, on the development of dementia. Although the results of research on this problem have been equivocal, many studies have shown that greater activity involving cognitive functions reduces the risk of dementia [1–3].

Activity manifests itself in diverse ways, in respect both to professional activity and to the realization of various personal interests.

In studies conducted in the mid-1990s at the Second Clinic for Mental Illnesses at the Gdansk Academy of Medicine, undertaken to identify risk factors for dementia of the Alzheimer type (DAT), attention was called to reduced activity in the premorbid period as a factor that occurred significantly more often in persons with dementia [5]. It turned out that persons who showed a heightened risk for dementia with primary degenerative processes had limited contact with other people and a lack of complex activity, e.g., after retirement. Other research conducted during the same time period also showed reduced activity in the preclinical phase of dementia [6–8]. In addition, our own research pointed to a correlation between reduced activity immediately after the first manifestation of symptoms and the rate of progression of cognitive symptoms [9].

The clinical manifestation of dementia is often preceded by many years of slight cognitive decline. It can be very difficult to differentiate the initial phases in the development of a dementive illness from other mental states that can also present with slight deterioration of cognitive functions. One such category is mild cognitive impairment (MCI). It is generally accepted that the appearance of MCI is associated with a serious risk of dementia developing within a few years [10]. Some studies have shown that within 3–4 years more than 50% of persons diagnosed with MCI will develop full-blown dementia. On the other hand, this means that a significant number of persons diagnosed with MCI will have no further deterioration of cognitive functions [11]. Research has been under way for some time now to identify the factors that would facilitate an accurate prognosis for persons diagnosed with MCI. However, despite the number of such studies, the results have been equivocal; therefore, it remains impossible at present to evaluate at an acceptable level of probability the degree of risk that MCI will develop into dementia.

Given that MCI can be treated in some cases as a preliminary phase of dementia, it is hardly a surprise that the risk factors and protective factors identified in earlier research on the preclinical stages of dementia have taken on increased importance. Among all these factors, attention has also been drawn to the level of activity manifested by persons with MCI as a possible predictive factor. Although the results achieved to date have been rather inconsistent, comparative analysis of a number of studies devoted to this problem have indicated that at least some kinds of activity manifested by study participants seem to be significant [12].

From the methodological point of view, it is no easy task to make an accurate evaluation of the level of activity displayed by research subjects. Many studies have taken the average number of hours of activity in the course of a week as the measure of activity, without differentiating the types of activity. Other studies, although they have distinguished between intellectual, physical, and social activity, have not really identified the constitutive elements of any of these types. Moreover, it is not common practice to base the evaluation of activity on a measurement method that would make it possible to quantify the results [13].

The goal of our study was to specify the relationship between the level of activity (intellectual, physical, and social) in persons diagnosed with MCI and the further progression of cognitive dysfunction.

Material and Methods

The initial population consisted of persons who had reported to our Mental Health Clinic in the period from 2005 to 2007. It was assumed that these individuals would be under systematic psychiatric observation until dementia was diagnosed. The present study resulted from a seven-year observation period. Subjects were qualified for the study according to the following inclusion criteria:

- Informed consent to participate.
- A diagnosis of MCI based on the criteria published by the Working Group on Mild Cognitive Impairment [14], assuming that dementia has been ruled out; i.e., that there has been a perceptible decline in cognitive function (based on self-evaluation or the reports of a caregiver, and then verified objectively by an examination confirming cognitive impairment and/or objective measures of a deterioration of cognitive functions over time), and that basic activities of daily living are preserved, with a slight or minimal level of impairment in carrying out complex activities.
- No psychiatric pharmacotherapy at the time of enrollment.
- The availability of an individual from the patient's own environment, someone who lives with the patient or at least visits several times a week, and who expresses a willingness to participate in the process of evaluating the patient's activity by providing information.

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- A score on the Global Deterioration Scale of Reisberg et al. [15] placing the patient on the third level (slight impairment of cognitive functions).
- A score on the Mini Mental State Examination (MMSE) [16] in the range from 24 to 30 points.

The exclusion criteria were as follows:
- A diagnosis of dementia, regardless of its etiology.
- An MMSE score below 24 points.
- The presence at examination or in the history of affective disorder, schizophrenia, alcoholism, addiction to medications or drugs, epilepsy, Parkinson's disease, or intellectual handicap.
- The presence at examination or during the evaluation period of disorders of consciousness or disturbances of locomotion, vision, or hearing that would impede compliance with instructions and procedures included in the clinical scales used in this study.
- Other serious somatic illness, especially in the decompensation phase.
- Refusal to participate in the study at each period of observation.

We initially enrolled 193 persons. All those who were qualified for enrollment were subjected to a complete examination, which included the MMSE, the Activity Scale, and the Instrumental Activity of Daily Living (IADL) scale.

Point scores of the MMSE can range from 0 (severe dementia) to 30 (lack of cognitive impairment) [16]. Due to the impact of age and education on the MMSE score, the raw scores were adjusted for these two factors, based on the equation proposed by Mungas et al. [17] and verified for Polish conditions by Jozwiak et al. [18]. The adjusted score (MMSE-C) was used for statistical analysis.

The Activity Scale was developed by Christensen and Mackinnon in 1993 [19], and consists of three subscales covering intellectual (mental), physical, and social activity. The number of activities undertaken is evaluated (the degree of diversification of activity), as well as the average number of hours spent in particular activities. However, in the course of pilot research involving 10 patients who met the enrollment criteria, both the subjects and their caregivers had considerable difficulty in specifying the number of hours occupied by the various activities. Accordingly, we made a major modification of the Activity Scale by introducing a point scale to measure the intensity of the activity, ranging from 0 (no activity) to 3 (active for most of the day), and applying one score (0–3 points) for each type of activity, instead of the original three parameters (number of differentiated activities, average number of hours spent on each activity, and the ratio of the one to the other) used by Christensen and Mackinnon [19].

The particular elements of the Activity Scale were divided into intellectual, physical, and social activity. Intellectual activity was divided into five types: (1) reading books and magazines or doing crosswords; (2) watching TV, listening to the radio, or using a computer on the internet; (3) personal creative activity, such as keeping a diary, working on collections, or professional work; (4) participation in discussions or lectures; and (5) playing chess, cards, or logical games. Physical activity was divided into three types: (1) participation in sports and recreation, such as bicycling, skiing, aerobics, or gymnastics; (2) physical work around the home, including gardening and yard work; and (3) going for walks, including the deliberate avoidance of mechanical transportation while attending to errands. Social activity was divided into five types: (1) participation in social organizations; (2) work for others, outside of institutional work; (3) receiving guests and visiting others; (4) informal meetings and conversations with other people, e.g., while walking or shopping; and (5) playing games or having a good time with others, or going on trips with others.

All of the elements comprising one area (intellectual, physical, or social) were evaluated for average involvement during the preceding months on a scale from 0 (no involvement) to 1 (sporadic involvement) to 2 (rather frequent involvement) to 3 (frequent involvement). The sum of the points for each of the elements constituted the score in each area of activity. The scores for intellectual and social activity could range from 0 to 15 points, while the physical activity score could range from 0 to 9 points. The overall score could thus range from 0 to 39 points.

The IADL scale [20] was developed by M. P. Lawton and E. M. Brody in 1969. This scale serves to evaluate functioning in daily living, and covers such activities as using the telephone, shopping, preparing meals, cleaning house, laundry, transportation, taking medications, and personal finances. The scores for particular functions ranged from 1 (full functionality) to a maximum of 3, 4, or 5, depending on which element was evaluated. The overall score ranged from 8 (no dysfunction) to 31 (no possibility of independent functioning).

The MMSE was re-administered to all patients in the study group after approximately one year (in practice, this occurred from 9 to 13 months after the baseline). The next administration of the MMSE took place when the observation period ended: that is, either at the point when dementia was diagnosed or after seven years of observation. Because all of these individuals were under the immediate care of the first and second authors of the present study, their mental state was monitored systematically, usually several times a year.

At each successive psychiatric consultation, the clinical diagnosis was verified, with particular attention to confirming or

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Table 1. Mean scores recorded for the research population of ambulatory patients diagnosed with MCI at enrollment (abbreviations explained in the text).

	Ave.	SD	Min.	Max.
Age	77.13	9.18	57.00	96.00
MMSE(C) I	27.34	2.96	21.55	33.50
MMSE(C) II	25.59	3.17	18.51	31.80
MMSE(C) I–II	1.75	2.21	-4.00	6.00
MMSE(C) VII	22.92	5.45	5.00	31.19
IADL	11.48	2.37	8.00	16.00
A-intellectual	2.83	1.77	1.00	6.00
A-physical	4.68	2.79	1.00	10.00
A-social	5.13	3.57	1.00	11.00
A-Total	12.77	7.14	3.00	26.00

precluding dementia. If dementia was diagnosed, further tests were performed, including laboratory and radiological tests, in order to established the etiology. The diagnostic criteria used were those of the DSM-IV-TR [21].

For statistical purposes, we used the two-tailed test for two independent means. Only those test results that were equal to or less than 0.05 (that is, $p \leq 0.05$) were regarded as statistically significant. The chi-squared test was used to verify the assumption of normal distribution in the research population (using tests for two means), whereas the assumption of equal variance was verified with the test for two variances.

Ethics statement

According to the guidelines of the Helsinki Declaration (2008), subjects participating in the experiment were informed in detail about the test procedure and provided written consent for participation in the project. The study protocols received ethical approval from the Ethical Committee of the Regional Medical Chamber NKBBN/279/2014.

Results

Of the 193 persons initially enrolled for the study, 75 were available for the final analysis because they had either gone through the preset limit of seven years or had been diagnosed with dementia, regardless of how much time had passed since the baseline.

During the observation period, dementia appeared in 34 subjects, including 16 with DAT, 4 with vascular dementia, 2 with Lewy-body dementia, 3 with fronto-temporal dementia, and 9 for whom there was either no basis for establishing the etiology at the time when the results were being analyzed, or a mixed dementia had been diagnosed. The types of dementia were not subjected to further analysis, due both to the small numbers and to the relatively large percentage of patients with no final (etiological) diagnosis.

Based on the final clinical diagnosis, in which dementia was either confirmed or precluded, we divided the subjects into two groups:

- Those with MCI that had converted to dementia at some point within the seven-year period (n=34), referred to hereinafter as MCI-C.
- Those whose MCI was stable, i.e., they had not developed dementia within that same period (n=41), hereinafter referred to as MCI-S.

Table 1 gives the average values of the analyzed variables for those persons who completed the planned observation period (n=75). The average MMSE scores, with the adjustment proposed by Mungas et al. (MMSE-C), are given for the baseline (I) and second examination after one year (II), with the differences between the baseline and second examinations given on the row below; the results at the end of the study are given as MMSE-C VII.

It was found that there were no statistically significant differences in the baseline MMSE between the persons with stable MCI and the persons who had progressed to dementia.

Table 1 also provides the means from the two activity scales: the global score for the IADL and the scores for the three main

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Table 2. Comparison of age, MMSE scores, and global and category scores from the IADL and the Activity Scale at baseline, broken down by research group: MCI-C (MCI converting to dementia) and MCI-S (stable MCI).

	MCI-C (n=34) mean ±SD	MCI-S (n=41) mean ±SD	t	df	p	F variance	p variance
Age	78.79±8.40	75.76±9.67	1.44	73	0.16	1.33	0.41
Gender	1.09±0.29	1.22±0.42	–1.55	73	0.13	2.12	0.03
MMSE(C)-I	27.20±3.08	27.45±2.89	–0.36	73	0.72	1.13	0.70
MMSE(C)-II*	24.70±3.37	26.33±2.83	–2.28	73	0.03	1.42	0.29
MMSE(C) I–II*	2.50±2.03	1.12±2.17	2.82	73	0.01	1.14	0.71
MMSE(C) VII*	19.14±5.40	26.06±2.93	–7.05	73	0.00	3.39	0.00
IADL-tele*	2.41±0.61	1.76±0.80	3.93	73	0.00	1.72	0.11
IADL-shop*	1.91±0.45	1.49±0.60	3.41	73	0.00	1.74	0.10
IADL-meal	1.62±0.49	1.46±0.50	1.33	73	0.19	1.05	0.90
IADL-clea	1.29±0.46	1.32±0.47	–0.21	73	0.83	1.04	0.92
IADL-laun	1.29±0.46	1.29±0.46	0.01	73	0.99	1.01	0.97
IADL-tran*	1.24±0.43	1.05±0.22	2.43	73	0.02	3.90	0.00
IADL-meds	1.18±0.39	1.05±0.22	1.80	73	0.08	3.15	0.00
IADL-pfin*	1.76±0.82	1.05±0.22	5.38	73	0.00	14.09	0.00
IADL-global*	12.71±1.82	10.46±2.30	4.61	73	0.00	1.61	0.17
A-intellectual	2.62±1.76	3.00±1.79	–0.93	73	0.36	1.04	0.93
A-physical*	3.38±2.47	5.76±2.60	–4.03	73	0.00	1.10	0.78
A-social	4.65±3.45	5.54±3.67	–1.07	73	0.29	1.13	0.72
A-global*	10.65±6.94	14.58±6.89	–2.44	72	0.02	1.01	0.96

* Statistically significant differences ($p \leq 0.05$). Abbreviations for the IADL: tele – telephone use; shop – shopping; meal – meal preparation; clea – cleaning house; laun – laundry; tran – transportation; meds – medications; pfin – personal finances; global – global score on the IADL. For other abbreviations cf. Table 1.

areas of activity (A-intellectual, A-physical, A-social) and the global score (A-global) on the Activity Scale.

Table 2 presents the means for the analyzed variables in the two study groups: those with MCI-S and those with MCI-C, regardless of the etiology. There were statistically significant differences between the groups in the global scores from both instruments measuring activity. The patients from the two groups also had significantly different scores in the physical activity subscale and in four of the subscales of the IADL: telephone use (IADL-tele), shopping (IADL-shop), transportation (IADL-tran), and personal finances (IADL-pfin).

In Table 3, the basis for dividing the subjects into two groups was the difference between the MMSE scores at baseline and at the second examination (after one year). Based on the average difference (1.75 points), we divided the population into one group with a smaller difference (MMSE-C I–II: S) and one group with a greater difference (MMSE-C I–II: G) between the adjusted scores on the MMSE-C I–II.

Table 4 shows the number of persons presenting a low level of physical activity (1–4 points) and a high level of physical activity (5–10 points) in two groups of patients: those with MCI-C and with MCI-S. The basis for distinguishing between a low level and a high level of physical activity was the average score in this area (4.68 points) for the entire research group.

The chi-squared result at df=1 was 13.38 (p=0.0003). With the Yeats correction, the chi-squared result was 11.73 (p=0.0006).

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Table 3. Comparison of age, global scores, and category subscores from the IADL and the Activity Scale for persons who showed smaller (MMSE(C) I–II: S) and greater (MMSE(C) I–II: G) differences in their MMSE(C) results between baseline and second examination (the dividing point is the mean difference of 1.75).

	MMSE(C) I–II: S (n=42) ave. ±SD	MMSE(C) I–II: G (n=33) ave. ±SD	t	df	p	F variance	p variance
Age	76.86±7.83	77.48±10.78	–0.29	73	0.77	1.90	0.05
MMSE(C)-I*	28.26±2.95	26.17±2.58	3.22	73	0.00	1.31	0.43
MMSE(C)-II	24.97±3.32	26.38±2.81	–1.94	73	0.06	1.39	0.33
MMSE(C) I–II*	3.29±1.29	–0.21±1.43	11.09	73	0.00	1.22	0.54
MMSE(C) VII	22.33±5.69	23.68±5.11	–1.07	73	0.29	1.24	0.54
IADL-tele*	2.26±0.80	1.79±0.70	2.70	73	0.01	1.31	0.43
IADL-shop*	1.71±0.51	1.64±0.65	0.58	73	0.56	1.65	0.13
IADL-meal	1.64±0.48	1.39±0.50	2.18	73	0.03	1.05	0.88
IADL-clea	1.29±0.46	1.33±0.48	–0.44	73	0.66	1.10	0.77
IADL-laun	1.36±0.48	1.21±0.42	1.37	73	0.18	1.36	0.37
IADL-tran*	1.14±0.35	1.12±0.33	0.27	73	0.79	1.14	0.70
IADL-meds	1.14±0.35	1.06±0.24	1.14	73	0.26	2.14	0.03
IADL-pfin*	1.45±0.71	1.27±0.63	1.15	73	0.25	1.27	0.49
IADL-global*	12.00±2.24	10.82±2.39	2.20	73	0.03	1.14	0.69
A-intellectual	2.55±1.66	3.18±1.88	–1.55	73	0.13	1.29	0.44
A-physical*	3.95±2.70	5.61±2.67	–2.65	73	0.01	1.02	0.96
A-social	4.81±3.46	5.55±3.73	–0.88	73	0.38	1.16	0.65
A-global*	11.51±7.04	14.33±7.06	–1.71	72	0.09	1.00	0.98

* Statistically significant differences ($p \leq 0.05$).

Table 4. The number of persons exhibiting low or high levels of physical activity at baseline in persons whose MCI later converted to dementia (MCI-C) and those in whom it did not (MCI-S).

Group	Low physical activity	High physical activity	Total
MCI-S	14	27	41
MCI-C	26	8	34
Total	40	35	75

Discussion

A diagnosis of MCI carries with it a substantial risk that dementia will develop later. A significant number of persons with MCI show symptoms of dementia within several years. On the other hand, many others will not experience any further loss of cognitive functions. In predicting what will happen in the course of MCI, an evaluation of the level of activity can play an important role, as indicated by many previous studies of dementia.

In our research, we attempted to evaluate the level of activity manifested by persons with MCI in light of their further history in terms of cognitive functions. The basis for this evaluation was our modification of the Activity Scale developed by Christensen and Mackinnon [19], which enabled us to evaluate three areas of activity: intellectual, physical, and social. Activity in these three areas was evaluated in respect to particular activities performed in the course of one month preceding each examination. On the one hand, this approach could

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cause some activities to be overlooked, but on the other, it enabled us to make, in our opinion, a more precise evaluation. The previous effort to estimate activity in a more global framework, and to express it in terms of the number of hours spent (e.g., in the course of a week), even if particular kinds of activity were taken into account (intellectual, physical, social), seems to entail a greater risk of error due to the retrospective and highly subjective nature of the judgments involved, especially in regards to the various domains of activity.

The second scale we used was the IADL [20]. This scale evaluates the level of disturbances in the performance of basic social activities, such as shopping, transportation, etc.

In research on the preclinical phase of dementia, reduced competence in activities of daily living is a very common finding. In both of our research groups, MCI-C and MCI-S, we did not find at baseline any major difficulties in activities of daily living that would impair social functioning, as indicated by the average IADL scores in both groups: 12.71 and 10.46 respectively, where the minimum score is 8.

However, despite the very slight difficulties experienced by persons with MCI, the scores on the scale (both the overall score and the subscores for some of its elements) proved to be significant discriminating factors for persons with greater progression of cognitive symptoms, culminating in dementia with onset during the observation period. In our research, the elements of daily functioning in which difficulties appear sooner include using the telephone, shopping, using transportation, and personal finances. In other studies, similar aspects of functioning have also been identified in the preclinical phase of dementia, where the earliest difficulties appear [18,19]. It is generally recognized that losing the ability to use the telephone, avoiding the need to use transportation, poor management of personal finances, and problems with proper self-administration of medications can be predictive of the imminent onset of the disease [22].

Differences in scores (shopping and taking medications) seem rather to result from certain differences in functioning caused by social circumstances. For example, the persons qualified for some studies available in the literature most often did not prepare meals without assistance, which would make it more difficult to measure any possible problems in the area of shopping.

An analysis of the result from the Activity Scale (our own modification of the Christensen and Mackinnon scale) points up a lower level of activity among those persons who declined into dementia during the seven-year observation period. Although the persons from our MCI-C group (conversion to dementia) had lower scores on the Activity Scale in each domain, this tendency still was confirmed statistically only in respect to physical activity. The lack of statistical significance in respect to intellectual activity can probably be explained on methodological grounds. The particular elements that contribute to the physical activity score consist of facts that are clearly delineated in time and differentiated from daily routine. By contrast, the particular activities that characterize intellectual activity may be harder to evaluate due to the difficulty inherent in distinguishing them from other activities being performed at the same time.

One gets the general impression that in much of the research to date, more attention has been paid to intellectual activity, which can be related more directly to the concept of neurocognitive reserve. Tasks that require considerable intellectual engagement have particularly been regarded as a protective factor against progressive loss of cognitive functions and the resultant decline into dementia [23,24].

Distinguishing the various domains of activity seems to have considerable importance because it very often points to different impacts on the process of cognitive decline [12]. In view of the fact that the level of activity is typically evaluated retrospectively, prospective studies deserve particular attention. In one such study, one year's observation of persons subjected to systematic exercises involving both cognitive and physical activity demonstrated a positive clinical effect [25].

A thorough analysis of the data obtained from studies of the neuroprotective effect of physical exercise (or more generally physical activity *per se*) shows a marked reduction of the risk of dementia [13]. It is worth noting that this does not necessarily refer only to activity manifested just before onset, but rather to a level of activity in middle age, which is to say many years, for the most part, before the presentation of the first symptoms of cognitive decline. Yet even among those persons who are already showing signs of such decline, physical activity can contribute to a milder course of the disease. Some results have suggested that the activity is associated with greater volume of the hippocampus [26]. Other studies have suggested that physical activity can be associated with slowing the atrophy of gray matter. An evaluation of the neural network in functional magnetic resonance imaging tests has shown an increase in connectivity within the neural network after several months of systematic physical exercise [27]. These observations are also supported to some extent by studies on animal models. It seems that physical activity has an excitatory effect on the neurotrophic factors [28–30].

Physical activity has also been shown to have a significant impact on reducing the risk of a number of vascular factors that can also lead to dementia [13]. It has also been observed that there is a rise in the level of the brain-derived neurotrophic factor in response to physical activity [28].

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We make a significant error, however, if we evaluate only the activity manifested by persons with MCI without considering other factors as well. It is essential to remember that a number of important factors determine how active an individual will be, including education, physical health, physical fitness, and the status of the sensory organs. The level of activity an individual shows over the lifespan is significantly affected by certain personality traits, which are surprising seldom taken into account in the research. Persons who display a more open and extraverted personality, with more activity, present with a higher level of cognitive ability later in life, as compared with persons who have other personality traits [31]. In our own research, unfortunately, we were able to include only a few of the many factors that can affect the person's level of activity. Our inclusion criteria eliminated from the study those persons who were afflicted by significant disorders affecting their daily functioning. We did not, however, perform a more detailed analysis of the sensory systems of our subjects; moreover, their personality traits were not measured.

The correlation between the level of activity over the lifespan and cognitive function, and thus the degree of impairment in the process of aging, can be explained at least partially by appealing to what is usually called the neurocognitive reserve [32]. This concept pertains primarily to the degree of complexity of intersynaptic connections, which supports the performance of tasks that involve cognitive functions. The neurocognitive reserve is formed throughout the lifespan, but it would appear that the earlier periods of life are of key importance. Good socioeconomic conditions, a low level of stress, and exposure to a diversified environment that requires creative adaptation, including the possibility of education – all these factors seem to support the formation of a greater neurocognitive reserve, which indirectly reduces the clinical impact of the progression of cognitive decline in old age [33,34].

Although the younger years are of crucial importance for the formation of the neurocognitive reserve, a number of external factors can still have a positive or negative impact in every period of life. It has been demonstrated that any kind of activity that engages cognitive functions can have a protective effect [35].

Persons with a greater neurocognitive reserve can compensate for the sequelae of neurodegenerative processes for a much longer period of time, which causes any possible dementive illness to present much later in life, if at all [36].

It would be an oversimplification, however, to consider the whole concept of mental reserve exclusively in terms of the neural network. The broader category of mental reserve should also include the whole set of both conscious and unconscious cognitive strategies, developed and enriched in the process of formation. Thanks to a wide repertoire of such strategies, the individual can compensate for impaired functionality. In this way, complex cognitive functioning will have a protective impact, though it is important to clarify at this point that by "protective activity" we are referring to the delayed appearance of clinical signs of decline, and not to the stopping or slowing of the neurodegenerative process itself [37].

In order to interpret properly the results reported here, some rather important limitations of the present study should be taken into account.

There are certain objections that could be raised against the use of the MMSE as the basis for the assessment of cognitive decline. We are fully aware that the MMSE is not a very precise instrument for measurement, and does not enable the clinician to evaluate precisely any particular area of cognition. The purpose of our research, however, was not to make any such detailed analysis of cognitive domains, but only to assess overall functioning. Moreover, and perhaps especially, the practical aspect has been dominant in research on MCI. The tools used here are those that can be used in daily clinical practice involving a large number of subjects. Although the MMSE can be widely used in outpatient practice, many other more complex, elaborate instruments, especially those that are very time-consuming, cannot be used on such a scale. Even though we used a simplified instrument, it was possible to detect measurable differences within the first year of observation between persons who were well on their way to dementia and those who were not (cf., Table 2).

Another limitation, this one also resulting from the number of persons included in the research group, was the impossibility of taking treatment under consideration. Although at the moment of enrollment none of the participants were taking psychotropic drugs, within the first year of observation (the most essential period for the analysis of results) some of them (n=39) were already taking such drugs. The reasons for beginning treatment were typically anxiety, depressed mood, or sleep disturbances, but there were also instances of aggressive or impulsive behavior. Whether or not it is actually possible to absolutely exclude the impact of such drugs on neurodegenerative mechanisms in the brain, their possible impact on the results of cognitive tests (the MMSE) would seem to be an essential factor. Our study was observational in character, which made it impossible to suspend treatment (if there was any) during the period preceding our assessment of cognitive functions.

Finally, the quantitative assessment of the level of activity displayed by individuals will always be a process subject to considerable simplification of the whole phenomenon, because a wide range of environmental factors [38,39] and other factors

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with direct or indirect influence on activity scores [40–42] are not taken into account. The use of quantifying instruments, though justified for methodological reasons, necessarily entails a narrowing of the field of observation.

Despite the importance of all these limitations, the results obtained in our study seem to confirm the hypothesis (not a new one, to be sure, but not a well-documented one, either) that activity has a positive impact on the course of cognitive decline in advanced age. Therefore, our results clearly point to the practical utility of the functional assessment of persons with MCI, especially the level of activity they display, in establishing a prognosis.

Conclusions

Our results indicate that an assessment of the level of activity can be useful in establishing a prognosis for the future course of MCI.

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