Examination of the bidirectional influences of leisure activity and memory in old people: A dissociative effect on episodic memory

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Abstract

The present study examined the relationships between different types of social and cognitive activities and different types of episodic and semantic memory. A total of 794 adult men and women from five age cohorts (aged 65-85 at baseline), participating in the longitudinal Betula project on aging, memory, and health, were included in the study. The participants were studied over 10 years (1995-2005) in threes waves. Recognition and recall were used as episodic memory tasks, and knowledge and verbal fluency as semantic memory tasks. The results, after controlling for age, gender, education and some diseases, including heart disease and hypertension, as covariates, showed unidirectional effects of social activity on episodic memory on all test occasions (β = .10). Also, episodic memory predicted change in cognitive activity for all test waves (β = .21-.22). Findings suggest that social activity can be seen as protective factor against memory decline. It also seems that episodic memory performance is a predictor of cognitive activity in old people. However, the opposite direction does not hold true.

Keywords: Episodic memory; semantic memory; social activity; cognitive activity

Introduction

In recent years, there has been increasing interest in investigating the influences of leisure activities on cognitive performance. Numerous studies have tried to examine the unidirectional or bidirectional influences of activities and cognitive performances (e.g., Aartsen, Smits, van Tilburg, Knipscheer, & Deeg, 2002; Ghisletta, Bickel, & Lövdén, 2006). In general, three types of activities, including cognitive, social, and physical activities, have been suggested by researchers in the field (see Bielak, 2010; Fratiglioni, Paillard-Borg, & Winblad, 2004; Hertzog, Kramer, Wilson, Lindenberger, 2009, for a review). Regarding the relationship between activity engagement and cognitive performance, there are two suggested hypotheses, which are differentiated on the basis of which variable comes first. The first hypothesis, expressed in the adage 'use-it-or-lose-it' predicts that engagement in cognitive, social, and physical activities results in less cognitive decline over time, and possibly provides protection against dementia (see Small, Hughes, Hultsch, & Dixon, 2007). The second hypothesis is based on viewing the relationship in the opposite direction (see Salthouse, 2006), meaning that a minimum level of cognitive performance is needed for individuals to be capable of different types of activities, and especially cognitive activity. According to Salthouse (2006), we should distinguish between 'differential preservation' and 'preserved differentiation'. Differential preservation, which is similar to the use-it-or-lose-it hypothesis, suggests that individuals who practice their cognitive skills demonstrate higher preservation of their baseline cognitive performance. Activity engagement, in general, and cognitive activity, in particular, not only have an influence on initial level of performance but also slow the rate of decline. By contrast, the preserved differentiation hypothesis suggests parallel aging trajectories (i.e., differences in the average level but the same rate of decline) for individuals who do and individuals who do not exercise their cognition. In other words, the preserved differentiation hypothesis views an individual's current level of (cognitive) activity as at least partly a manifestation of his or her prior level of cognitive function (Salthouse, 2006). Salthouse (2006) suggests that there is little evidence in the literature to support the differential preservation hypothesis.

In the literature, there are some studies, both cross-sectional and longitudinal, consistent with the use-it-or-lose-it hypothesis, showing that engaged and active lifestyle is associated with less cognitive decline. Lövdén and colleagues (2005) investigated the reciprocal influences of an engaged and active lifestyle and perceptual speed in 516 participants aged 70-103 years, using a longitudinal data set. The results revealed that social participation influences subsequent change in perceptual speed, but that there is no influence in the opposite direction. In similar longitudinal studies (Ghisletta, Bickel, & Lövdén, 2006; Newson and Kemps 2005), different cognitive tasks including perceptual speed and verbal fluency were studied on the basis of different types of activities of elderly participants. The results demonstrated that increase in activity may lessen the decline in some cognitive tasks such as perceptual speed, but not in verbal fluency. By contrast, cognitive performance did not affect activity.

However, some previous studies have not supported the use-it-or-lose-it hypothesis (e.g., Salthouse, Berish, & Miles, 2002). In line with Salthouse's hypothesis (2006), that of preserved differentiation, some studies have found no influence of activity on cognitive functioning or found an influence in the opposite direction of cognitive performance on activity. Salthouse, Berish, and Miles (2002) did not find any evidence for activity mediated, age-related differences in spatial ability, reasoning, vocabulary, and episodic memory. Hultsch, Hertzog, Small, and Dixon (1999) found that changes in activity levels over 6 years were not associated with corresponding changes in cognitive performance, including episodic memory, vocabulary, reading comprehension, and verbal fluency. In another study Aartsen and colleagues (2002) investigated the influences of three types of everyday activities – social, experiential, and developmental – on several cognitive tasks among 2076 participants, 55-85 years-old, on two occasions at a 6-year interval. It was found, with one exception, that there were no bidirectional impacts of different types of everyday activities and different cognitive tasks.

In general, it seems that, although there is support for both hypotheses in the literature, neither of them can yet be regarded as conclusively confirmed. There are several complications that may explain the mixed pattern of findings in the literature. In previous studies, there has been no general agreement about the influence of different activities on cognitive functions. Although some studies (Aartsen et al., 2002; Salthouse, Berish, and Miles, 2002) found no influence of activity on cognitive functions, other researchers (Lövdén et al., 2005; Ghisletta et al., 2006; Newson & Kemps, 2005) have found such an influence. There is also the question of different types of cognitive tasks. In some studies (Ghisletta et al., 2006; Newson & Kemps, 2005), an influence of activity on verbal fluency tasks was not found, but influences were detected on other types of cognitive tasks (perceptual speed, picture naming, and incidental recall). Another question relates to types of activities. Whereas some studies have used general leisure activity (e.g., Mackinnon et al., 2003; Newson & Kemps, 2005), others (e.g., Aartsen et al., 2002) have used some specific kinds of activities.

In the present study, by using more specific memory tasks, we explored further the disparity between these earlier studies with regard to the differentiated influences of social and cognitive activities. Social and cognitive activities are two important types of activities (Fratiglioni, Paillard-Borg, & Winblad, 2004; Hertzog, Kramer, Wilson, Lindenberger, 2009), which some studies have shown to be significantly different in terms of cognition (e.g., Niti et al., 2008). We therefore investigated different types of activities separately, and not simply activity in general. We selected items that are directly connected to cognitive and social activities, and an attempt was made not to use items that overlapped different types of activities. We were interested in whether the relationship between different types of leisure activities and cognitive performance is different from each other. In other words, it is possible that some types of activities have an influence on cognitive function (the use-it-or-lose-it hypothesis), whereas some other types of activity are affected by cognitive performance (the preserved differentiation hypothesis).

We further explored both the unidirectional and bidirectional effects of activity and memory performance. Accordingly, we investigated whether an active lifestyle aids memory function, and also whether good memory function facilitates the maintenance of an active lifestyle, in a large population-based sample (Nilsson et al., 1997, 2004). In this study, we focused on subtypes of two important memory systems, namely, episodic memory and semantic memory. Whereas episodic memory is about the encoding, storage and retrieval of temporally dated events or episodes, semantic memory is involved in the encoding, storage and retrieval of general knowledge, of the meaning of words, and of facts without a specific time or place reference (Tulving, 1983). Episodic memory is the only kind of memory that, at time of retrieval, operates backwards in time. The person has to travel back in time mentally to access the information needed. Subtypes of episodic memory are recall and recognition, and subtypes of semantic memory are knowledge and verbal fluency (Nyberg et al., 2003).

Previous research has shown that there is a clear dissociation between episodic and semantic memory in relation to different variables, such as gender (e.g., Herlitz et al., 1997, 1999), age (e.g., Nilsson et al., 1997; Nyberg et al., 2003), genetic factors (Nilsson et al., 2006), and marital status (Mousavi-Nasab, Kormi-Nouri, Sundström, Nilsson, 2012). In general, episodic memory has been found to be more affected by these variables than semantic memory. Longitudinal studies, however, show a relatively stable performance level up to middle age, which is then followed by a sharp decline for episodic memory. There is a relatively constant performance level across the adult life span for semantic memory (Rönnlund, Nyberg, Bäckman, & Nilsson, 2005). Gender differences in favor of women have been found in different episodic-memory tasks, such as word recognition (Hill et al., 1995), name recognition (Larrabee & Crook, 1993), recognition of concrete pictures and objects (Herlitz, Airaksinen, & Nordström, 1999), and word recall (Kramer, Delis, Kaplan, O'Donnell, & Prifitera, 1997). By contrast with episodic memory, semantic memory tasks do not show any performance difference between males and females (Herlitz et al., 1997; 1999). In the present study, we wanted to explore whether such dissociation can be observed in relation to activity variables as well. In other words, it is possible that certain activities may act to promote only certain specific cognitive functions. We included age and gender as covariates in all the analyses. Education also has a positive influence on memory function, especially in the case of semantic memory. Bäckman and Nilsson (1996) suggested that education is a more important factor than age per se for semantic memory performance. Thus, education was also included as a covariate in all the analyses. Since some diseases, such as heart disease and hypertension, are known to affect cognitive performance (Bäckman, Jones, Small, Aguero-Torres, & Fratiglioni, 2003; Nilsson & Söderlund, 2001), we also treated these diseases as covariates in all the analyses. All in all, we controlled for the impacts of age, gender, education, and health, so as to be able specifically to investigate the relationship between activity and memory function.

Thereafter, by using structural equation modeling (SEM), we studied the bidirectional influences of different types of leisure activities (cognitive and social) and memory performances (episodic and semantic) on three test occasions at 5-year intervals.

Method

Participants

From the Betula project's data set, we selected 794 participants from the first sample (Sample 1) and the third sample (Sample 3) of old people in five age cohorts (aged 65, 70, 75, 80, and 85 at Time 1, or T1). In general, there are 6 samples in the Betula project, of which only Sample 1 and Sample 3 have been retested over more than two waves (see Nilsson et al., 1997, 2004 for further details). For the Betula project, participants were recruited by random sampling of the population register in Umeå, Sweden, a city with a population of about 110,000 inhabitants (see Nilsson et al., 1997). The participants in the present study were tested over 10 years on three occasions. For the current study, we excluded participants from the samples if they had been diagnosed with dementia up to 2005 (n = 172) and stroke (n = 3).The recruited participants were tested at Time 1 (T1: 1993-1995), Time 2 (T2: 1998-2000), and Time3 (T3: 2003-2005). The sample characteristics are summarized in Table 1.

(Table 1 about here)

Measurement variables

Leisure activity. Participants completed a questionnaire about their leisure and daily activities, which included 16 items with the following response options: "never", "once in a while", "a couple of times a month", "once a week", and "daily". The items referred to traveling, taking exercise, reading books, reading magazines, watching TV or listening to radio, going to a restaurant, visiting family and friends, reading newspapers, attending a course or study, attending religious meetings, playing an instrument, working with handicrafts, hunting or fishing, attending to committee work, going to the movies, concerts, or theater, and other hobbies and activities.

On the basis of the literature (e.g., Hertzog et al., 2009; Aatsern et al., 2002; Gallucci et al., 2009; Niti et al., 2008), we sought to select items that are directly connected to cognitive and social activities, and also to avoid overlap between any two types of activities. It should be noted that there is strong consensus between the authors for the items related to cognitive or social activity. “Reading books” and “attending a course or study” were selected as items for cognitive activity. “Visiting family and friends”, “traveling”, “going to a restaurant” and “going to the movies, concerts, or theater” were selected as items for social activity. Two items, “reading newspapers” for cognitive activity, and “attending religious meeting” for social activity, were also selected on the basis of the literature. However, since they showed low correlations with the other items for each type of activity, they were excluded from the analyses. We also performed confirmatory factor analyses for social activity. The model for social activity demonstrated adequate model fit: χ^2 (2) = 3.09, CFI = .99; RMSEA = .03, SRMR = .02. The results also demonstrated relatively acceptable reliability estimates for cognitive activity (.67) and social activity (.66).

The present analyses were based on 10 episodic memory tests (7 recall and 3 recognition tests) and 4 semantic memory tests (1 vocabulary and 3 verbal fluency tests). Rönnlund and Nilsson (2006) have shown acceptable psychometric properties for the measures that were used in the Betula project. The results revealed good reliability estimates for both episodic memory (r

= 0.83) and semantic memory (r = 0.82). They also demonstrated that stability coefficients were high (r = 0.77-0.83).

Episodic memory tests: recall

Free recall of actions. Two lists of 16 verb-noun sentences were presented to the participants, with each sentence on each list representing a simple action. For one list, participants were asked to enact each sentence using a specified object (8 s/item). For example, for the sentence ‘‘Lift the book’’ the experimenter provided the participant with a book, and the participant was told to use the object to enact the sentence. The object was removed from sight after each presentation. The other list was tested without enactment. The nouns in the sentences belonged to four categories (e.g., fruits, musical instruments, carpentry tools, and body parts) for each list. Performance score was number of sentences (including the correct verb and noun) recalled in the enacted condition.

Cued recall of nouns. This task was based on the one described above, i.e. of free recall of sentences with and without enactment. The participants were given visual presentations of objects in eight categories (fruits, four-footed animals, musical instruments, reading materials, kitchen utensils, clothes, body parts, and carpentry tools), which functioned as cues. The participants were requested to recall as many of the nouns as possible from the two lists of sentences presented earlier. Number of nouns recalled from the enacted condition served as the outcome measure for the analyses.

Activity recall. At the end of the memory test session, the participants were asked to recall all the tasks they had performed during the session.

Recall/divided attention. Participants were presented with four lists, each of 12 nouns. The items on each list were read aloud to the participant at a rate of 2 s per item. After presentation of the last item on each list, participants were invited to recall as many of the nouns as possible in any order at a given pace (2 s/item), as indicated by a metronome. For one list, the task was performed under conditions of full attention on study and at retrieval. Study/retrieval of words on the other lists was accompanied by the performance of a secondary task. This task consisted in sorting red and black cards into two piles on basis of color (2 s/item). Under one condition, division of attention took place on study of the nouns, but not at retrieval. Under another condition, participants were requested to sort the cards at retrieval of the nouns, but not on study. Under a final condition, both study and retrieval of words took place alongside the card sorting.

Episodic memory tests: recognition

Face and name recognition. Sixteen color photos with faces of 10 year-old children, along with the first name and family name of each child, were shown to the participants, and they were instructed to remember the faces and the family names for a later test. The time was set at 8 s per face and name presentation. After a delay of about 45 min during which other cognitive tests were administered, participants were shown 24 faces at random, including 12 faces from the study phase and 12 new faces. The presentation time was set at 15 s per item. During this time, the participants were requested to recognize the face (a yes/no recognition test), the first name, and the family name. For the recognition of names, four alternatives with different combinations of names were presented together with each photo. The performance scores were the number of hits minus false alarms for faces, and number of hits for family names.

Recognition of nouns. Participants were asked to determine, from among 16 distractor nouns, and 16 previously presented nouns, that half belonged to a list of enactment, and the other half to a list of nonenactment. The time for recognizing (yes/no) was 5 s per item. Number of hits minus false alarms for nouns from the nonenacted condition served as the final measure.

Semantic memory tests

Vocabulary. A modified version of a 30-item multiple-choice synonym test by Dureman, (1960) was used (Nilsson et al., 1997). The task involved selecting the synonyms of target words from among five alternatives. Seven minutes were allowed for completing the test. The performance score was the number of correctly identified synonyms.

Verbal fluency. Three verbal fluency tasks were administered, in which the experimenter instructed participants to produce aloud as many words as possible in 1 minute. There were differences between the tasks concerning which words to generate. In the first test, the participants were to say aloud as many words as possible with the initial letter A. The second test was to generate as many words as possible beginning with M and containing five letters. The third test was to produce as many names of professions as possible with the initial letter B.

Statistical analyses

Cross-lagged analyses using Mplus 5 (Muthen & Muthen, 2007) were performed to examine links between leisure activity, including social and cognitive activities, and different types of memory function, including episodic and semantic memory in adulthood and old age. For all model testing, we used full-information maximum likelihood (FIML) estimation to handle missing data. FIML has come to be regarded as the most efficient and least biased method of estimation, and also relies on less restrictive assumptions about the mechanisms resulting in missing values than other procedures (Mcartney, Burchinal, & Bub, 2006). FIML estimates missing values by using all the available information in a data set directly to fit an a-priori specified model. FIML is a suitable method for estimation even when data are not missing either partly or completely at random (Little & Robin, 2002).

For all the models, the following paths were included: (a) stability paths for activity and memory function (intervals of five years), (b) correlations between activity and memory function at each wave, (c) cross-lagged paths between earlier and later activity and memory function in each interval, (d) paths from covariates (age, gender, education, health) to activity and memory at T1, and (e) associations between different covariates. Raw scores on the scales for free recall of actions, cued recall of nouns, activity recall, the four tests of recall with divided attention, face recognition, name recognition, and recognition of nouns were used as indicators of a latent variable representing episodic memory. Raw scores on one knowledge test and three tests in verbal fluency were used as indicators of a latent variable representing semantic memory. "Visiting family and friends", "traveling", "going to a restaurant" and "going to the movies, concerts or theater" were used as indicators of a latent variable representing social activity. "Reading books" and "attending a course or study" were selected as indicators of a latent variable representing cognitive activity.

The error terms of the indicators of the latent variables – episodic memory, semantic memory, cognitive activity and social activity – were allowed to correlate over time. Also, the cross-lagged paths were constrained to the same value over time in all of the longitudinal models. For example, in the social activity and episodic memory model, the path from social activity at T1 to episodic memory at T2 and the path from social activity at T2 to episodic memory at T3 were constrained to the same value. Similarly, the path from episodic memory at T1 to social activity at T2 and the path from episodic memory at T2 to social activity at T3 were constrained to the same value. This constraint procedure was adopted for all the models. We also included age, gender, education, heart disease, and hypertension as covariates in all models. It should be noted that heart disease and hypertension were included as covariates only if participants had been diagnosed before T3. Our general schema for a cross-lagged model is shown in Figure 1. We considered several indices of model fit: the comparative fit index (CFI; Bentler, 1990), the root mean square error of approximation (RMSEA; Browne & Cudeck, 1993), and the standardized root mean square residual (SRMR; Hu & Bentler, 1998). For the CFI, values greater than .90 indicate an acceptable fit and values greater than .95 a good fit (Hu & Bentler, 1999). For the RMSEA and the SRMR, values less than .05 indicate a good fit and values less than .08 an acceptable fit (Browne & Cudeck, 1993).

For all the models we first tested a basic model, in which all paths of interest were estimated. At a second step, in testing the hierarchical models (Kline, 2010), we set the paths from the covariates to activity and memory function at zero, both one-by-one and separately. Then, we fixed the predictive paths that did not significantly contribute to the fit of the overall model. Comparisons of model fits were performed, using chi-square difference tests to establish which model had the best fit.

Results

In general, the results obtained showed that the model fit indices of each type of leisure activity for episodic memory and semantic memory are acceptable. The indices are shown in Table 2.

(Table 2 about here)

The effects of the covariates on the activity variables at T1 showed that some have a significant influence on both cognitive and social activities. At T1, although social activity was affected by age (β = -.48), cognitive activity was not affected. Older people engage in social activity to a lesser extent. Education was positively related to both cognitive activity (β = .38) and social activity (β = .28), indicating that a higher level of education is associated with higher levels of activity of both kinds. Gender was related only to cognitive activity (β = .16), in that females showed a greater amount of cognitive activity than males. There was no association between heart disease or hypertension and either of the types of activities.

The covariates had a significant influence on the different types of memory tasks at T1. At T1, both kinds of memory were negatively affected by age (β = -.52 for episodic memory, and β = -.36 for semantic memory). Education was positively related to both episodic memory (β = .26) and semantic memory (β = .32), indicating that higher levels of education are associated with higher levels of memory function. Gender was also related to episodic memory (β = .13). Females showed better episodic memory function than males. There was also a relationship between heart disease and episodic memory (β = -.07). The participants without heart disease demonstrated significantly better episodic memory performance.

Regarding the relationships between social activity and episodic memory over time, the results showed that, after controlling for the effects of the covariates, the associations between episodic memory and social activity, and the stability paths, social activity at T1 significantly predicted change in episodic memory at T2 ($\beta = .10$), and social activity at T2 significantly predicted change in episodic memory at T3 ($\beta = .10$). The relationship in the opposite direction, from episodic memory to social activity, was not significant. As can be seen from Table 3, none of the cross-lagged paths between social activity and semantic memory function was significant at either T2 or T3.

Regarding cognitive activity function and episodic memory performance, episodic memory at T1 significantly predicted change in cognitive activity at T2 ($\beta = .22$), and episodic memory at T2 predicted change in cognitive activity at T3 ($\beta = .22$). Also, in the model for cognitive activity and semantic memory, none of the cross-lagged paths between cognitive activity and semantic memory function was significant at either T2 or T3. All cross-paths are shown in Table 3.

(Table 3 about here)

Discussion

In the present study, we studied the relationships between two important subsystems of memory and different types of activities, both social and cognitive. Using a cross-lagged procedure, we found that social activity was a longitudinal predictor of episodic memory performance, but there was no influence of social activity on semantic memory function. The unidirectional influence of cognitive activity on episodic memory performance was not significant, but episodic memory did predict change in cognitive activity. Again, no such relationship was found between semantic memory and cognitive activity.

It has been shown many times that there is a link between level of participation in activities and performance on various cognitive tasks, in both longitudinal studies (Ghisletta et al., 2006; Lövdén et al., 2005; Newson & Kemps, 2005), and cross-sectional studies (e.g., Christensen et al., 1996; Hill, Wahlin, Winblad, & Bäckman, 1995; Luszcz, Bryan, & Kent, 1997). Taken as a whole, these studies show that greater participation in activities is related to higher levels of cognitive performance (use-it-or-lose-it hypothesis). However, to our knowledge, no previous longitudinal study has investigated the relationship between activity and memory over 10 years, and across a relatively large age range, with regard to specific categories of activities.

Our study, in consistent with some previous research (Fratiglioni, Paillard-Borg, & Winblad, 2004; Gallucci et al., 2009; Lövdén et al., 2005), demonstrates that individuals with a socially more engaged lifestyle tend to have better memory function. The results of the present study have extended the findings of positive effects of social activity engagement on cognition found in previous studies to more specific memory systems and subsystems. There is evidence that social activity is protective against cognitive decline. For example, Bassuk and colleagues (1999) found that different types of social activities (e.g., membership of groups, monthly contacts with friends or relatives) were related to rate of cognitive decline over a 12-year follow-up period. Barnes and colleagues (2004) tested a group of adults, on up to 3 occasions over approximately 5 years, and observed that higher levels of both social contact and social activity were associated with a reduced rate of cognitive decline. Fratigioloni and colleagues (2000) showed that an extensive social network protects against dementia. Individuals living alone and those without any close social ties run a greater risk of developing dementia than individuals who live with others or have close social ties. Mousavi-Nasab and colleagues (2012) also found that the rate of memory decline was significantly larger for singles and the widowed than for married people over a 5-year time period across middle and old age.

It has been suggested that the cognitive reserve hypothesis explains the effect of social activity on memory function. The hypothesis postulates that certain aspects of life experience, such as occupation, amount of education, and engaged lifestyle, provide individuals with a cognitive reserve that makes them less sensitive to and better able to cope with cognitive pathology (Stern, 2002). A socially engaged lifestyle may increase synaptic density in the neocortical association cortex through stimulation (Katzman, 1993), which may result in the more efficient cognitive functioning of unaffected neurons that might be able to compensate for the loss of function of affected brain areas in a pathological process. Another explanation may lie in the fact that the benefit of engagement in social activities is associated with higher social support from other people, which ameliorates depression and the adverse effects of stress and related elevation of cortisol (Bassuk, Glass, & Berkman, 1999). In general, it may be that a combination of several mechanisms can directly or indirectly account for the positive effect of social activity on memory performance.

Some studies (e.g., Niti et al., 2008; Verghese et al., 2003; 2006) have demonstrated that there is an association between cognitive activity and memory performance. Intellectually stimulating activities, such as reading, playing mental games, and doing crossword puzzles, have been found to be associated with reduced dementia risk (Kawashima et al., 2005; Wilson et al., 2002). However, the results of the present longitudinal study do not confirm this. In line with the preserved differentiation hypothesis, we found that episodic memory can positively predict changes in cognitive activity. This finding demonstrates that, as suggested by Salthouse (2006), active individuals are likely always to have had higher levels of cognitive functioning, and that their enduring higher cognitive function allows them to be more active in old age. Also, Aartsen and colleagues (2002) found a unidirectional positive effect solely of one type of cognition (information-processing speed) on developmental activity (with one item: attending a course or study) in a longitudinal study.

However, questions remain as to why there is an effect of episodic memory on cognitive activity but not on social activity, and why social activity is predictive of episodic memory while cognitive activity is not. On the basis of the literature, it seems that the discussion about the relationship between activity engagement and cognitive performance initially had a greater concentration on cognitive activity. For example, most of the works suggested by Salthouse have focused on the role of mental activity, not on the roles of other types of activities, like the social or the physical. It seems that, in recent years, hypotheses in this field have been extended to social and physical activities as well. Accordingly, it is possible that certain types of activities have more of a relationship with certain specific hypotheses. In such case, our results show that the use-it-or-lose-it hypothesis is more relevant to social activity, whereas the relationship between cognitive performance and cognitive activity is more consistent with preserved differentiation. As described by Hultsch and colleagues (1999), high cognitive ability leads to intellectually active living, and general cognitive decline predicts a decline in cognitive activities. We considered both hypotheses simultaneously. In line with our speculation, although some longitudinal studies (Ghisletta et al., 2006; Lövdén et al., 2005) have shown that activity can have a positive influence on cognitive performance, their results focus on social activity participation. Some other researchers (Newson & Kemps, 2005; Mackinnon et al., 2003) also found an effect of general activity on cognitive performance, but not effects on certain specific types of activities. Accordingly, we assume that, although social activity can be seen as protective against cognitive decline, having good cognitive performance, in turn, is a predictor of cognitive activity. However, we should be cautious in drawing any definite conclusions.

Based on the findings of previous research (Nilsson, 2003), we expected that the relationship between activity and memory would be more pronounced in episodic memory than in semantic memory. Whereas episodic memory is about remembering episodes or events from the personally experienced past, and exists in subjective time and space, semantic memory is about general knowledge without specific time and place. Episodic memory is a recently evolved, late-developing, and early-deteriorating past-oriented memory, which is more vulnerable than other memories to neuronal dysfunction (Tulving, 2002). Evidence that declarative memory can be divided into two different systems comes from many sources (see Nyberg & Tulving, 1996, for a review). Some neuroimaging and lesion studies have demonstrated that the neural bases of episodic and semantic memory differ from each other (see Mayes & Montaldi, 2001; Moscovitch, Nadel, Winocur, Gilboa, & Rosenbaum, 2006, for a review). Also, a variety of correlational studies using different statistical techniques, such as structural equation modeling (SEM), show findings consistent with the notion of dissociation between the episodic and semantic memory systems (Nyberg, 1994; Nyberg et al., 2003). Some researchers have indicated that aging does not impair all declarative memory functions equally. Rather, aging seems to have more negative effects on episodic memory than on semantic memory (e.g., Nyberg et al., 2003). Further, previous studies have shown that females perform at a higher level than males on episodic memory tasks, although there is no difference between males and females on semantic memory tasks (e.g., Herlitz et al., 1997). Previous research has also indicated that some genetic factors, like APOE4, do not have a general effect on memory performance. Rather, the magnitude of APOE4-related deficits is primarily observed in tests of episodic memory, and only small effects are detectable in tests of semantic memory (Nilsson et al., 2006). Episodic memory is also more sensitive to marital status than is semantic memory. Married people demonstrate better episodic memory performance than single people. And, whereas the extent of episodic memory decline has been found to be greater for single and widowed people than for married people, no such differences have been observed in the case of semantic memory (Mousavi-Nasab et al., 2012). In the present study, we found a dissociative effect of episodic memory. Social activity seems to have a strong positive influence on episodic memory over time. Good episodic memory performance, in turn, can also have a positive influence on cognitive activity. However, there appears to be no such relationship between activity and semantic memory.

Our results show clearly that semantic memory performance scores are not influenced by previous scores on engagement in activity. Moreover, no effects were detected to relate semantic memory performance to level of activity. This finding is consistent with some previous studies (Ghisletta et al., 2006; Newson, Kemps, 2005), who concluded that none of the types of activities they considered, including both general activity and special types of activities, could predict semantic memory function. There is a fairly constant performance level of semantic memory across the adult life span (Nilsson, 2003). We can conclude that the relationship between activity engagement and cognitive performance is limited to certain cognitive functions.

Some limitations of the present study should be noted. One general limitation relates to the activity scale. It seems that the selection of items for different types of activity may have been somewhat arbitrary. Since we were interested in comparing our findings with previous longitudinal studies in this field, we chose to select similar items for two types of activity, social and cognitive, as in previous studies. However, it should also be noted that there is consensus in the literature about the classification some activities. For example, in most previous studies, reading a book and attending a course of study have been regarded as cognitive activities (e.g., Aatsern et al., 2002; Gallucci et al., 2009; Niti et al., 2008). A further limitation was that the items on the activity scale did not have much variability. For example, we had few items to measure cognitive activity, and they may not be representative of cognitive activity overall. Future work in this field of research needs to consider this issue by analyzing more items, in order to figure out the exact relationship between activity and cognition. Another limitation was related to the sensitivity of the leisure activity measure. For example, there is a difference between the response options ‘once a week’ and ‘daily’. There is a possibility that someone participate several times per week, but not necessarily every day.

To sum up, this study showed that social activity has a positive impact on the performance of subtypes of episodic memory tasks. People with high social activity demonstrate better memory performance over time. In other words, inadequate social activity can predict episodic memory decline across the life span. Also, good episodic memory performance can have a positive influence in that it enables greater participation in cognitive activities.

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Table 1.

Descriptive sample statistics at three points in time.

	Mean (SD) [a]		
Variable	W1	W2	W3
N	794	499	322
Covariates			
Age	74.12 (7.1)		
Education	7.91 (2.96)		
Gender (% female)	55%		
Heart disease (%)	7.8%		
Hypertension (%)	7.4%		
Recall tasks [b]			
Free recall of actions (0-16)	6.34 (3.02)	5.48 (3.11)	4.68 (3.31)
Cued recall of nouns (0-16)	8.08 (2.95)	7.23 (3.15)	6.62 (3.21)
Activity recall (0-31)	8.27 (3.54)	7.38 (3.79)	5.41 (3.88)
Recall/divided attention 1 (0-12)	4.57 (1.58)	4.17 (1.58)	3.6 (1.75)
Recall/divided attention 2 (0-12)	3.29 (1.39)	2.92 (1.45)	2.73 (1.33)
Recall/divided attention 3 (0-12)	3.7 (1.52)	3.45 (1.5)	3.03 (1.49)
Recall/divided attention 4 (0-12)	2.93 (1.39)	2.62 (1.49)	2.42 (1.32)
Recognition tasks			
Face recognition (0-12)	4.41 (2.94)	4.03 (2.08)	3.65 (2.85)
Name recognition (0-12)	6.18 (2.66)	6.25 (2.7)	6.5 (2.77)
Recognition of nouns (0-16)	4.03 (2.17)	4.04 (2.9)	3.67 (2.21)

Verbal fluency tasks			
Verbal fluency A	9.28 (4.73)	8.67 (4.41)	7.88 (4.9)
Verbal fluency M5	4.66 (3.03)	4.29 (3.13)	4.12 (3.09)
Verbal fluency BP	3.92 (2.23)	3.4 (2.23)	3.2 (2.36)
Knowledge (0-30)	19.54 (6.0)	18.95 (6.1)	18.14 (6.2)
Social activity			
Visiting family and friends (1-5)	3.85 (1)	3.84 (.92)	3.8 (.98)
Traveling (1-5)	2.05 (1.02)	1.98 (1.01)	1.91 (1.03)
Going to a restaurant (1-5)	1.38 (.62)	1.39 (.66)	1.38 (.62)
Going to movies, concert, theater (1-5)	1.44 (.66)	1.35 (.61)	1.27 (.66)
Cognitive activity			
Reading books (1-5)	2.98 (1.57)	2.93 (1.56)	2.9 (1.59)
Attending a course or study (1-5)	1.58 (1.06)	1.42 (.98)	1.45 (1.06)

Note: [a] The statistics reported here are after estimation of missing data. [b] The numbers in parentheses for the memory and activity scales refer to the range of scores.

Table 2.

Model fit indices for each cross-lagged model of activity and memory performance.

Model fit indices	χ^2	df	CFI	RMSEA (90% C.I.)	SRMR
Social activity					
Episodic memory	1812.05	1001	.90	.03 (.03-.03)	.06
Semantic memory	497.39	352	.97	.02 (.02-.03)	.05
Cognitive activity					
Episodic memory	1400.82	746	.91	.03 (.03-.04)	.06
Semantic memory	326.03	206	.97	.03 (.02-.03)	.04

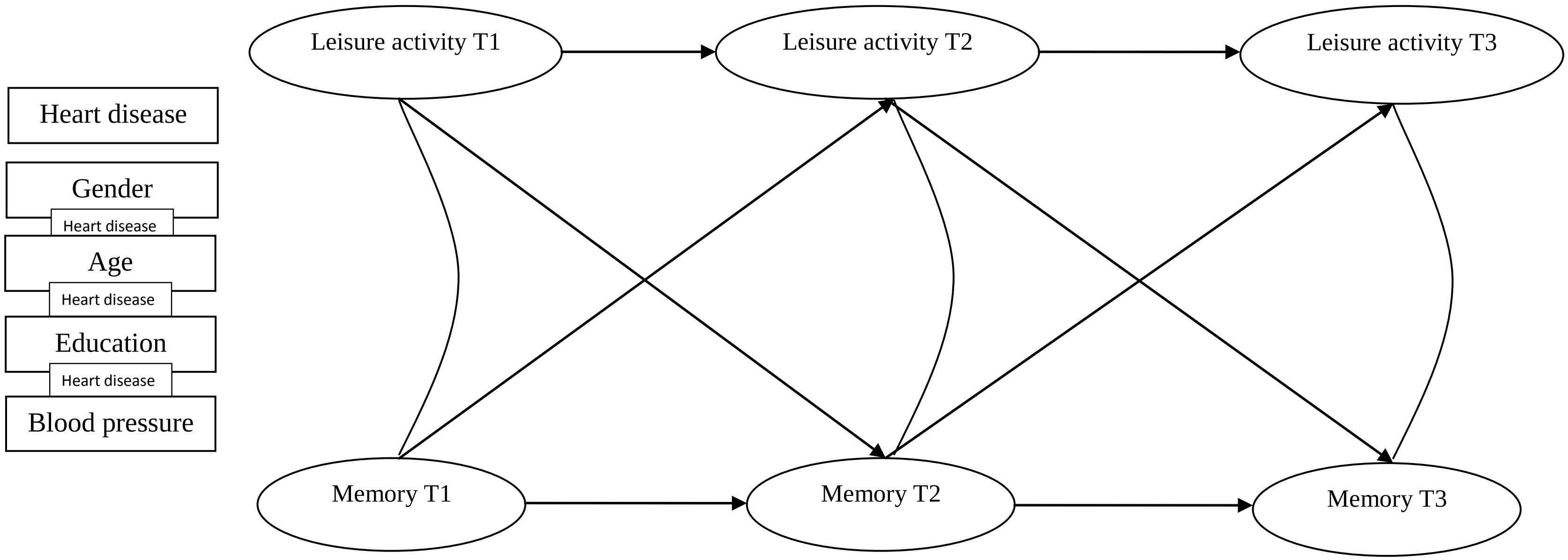
Table 3.

Cross-path estimates for paths between different types of leisure activity and memory performance.

	Cross-path estimate
Social activity → Episodic memory	
T1 → T2	.10***
T2 → T3	.10***
Episodic memory → Social activity	
T1 → T2	.04
T2 → T3	.03
Social activity → Semantic memory	
T1 → T2	.04
T2 → T3	.04
Semantic memory → Social activity	
T1 → T2	.01
T2 → T3	.01

Cognitive activity → Episodic memory	
T1 → T2	-.05
T2 → T3	-.04
Episodic memory → Cognitive activity	
T1 → T2	.22**
T2 → T3	.21**
Cognitive activity → Semantic memory	
T1 → T2	.06
T2 → T3	.05
Semantic memory →Cognitive activity	
T1 → T2	.17
T2 → T3	.16

Note. $^{**}p < .01$, $^{***}p < .001$.



Note: Paths from covariates on the latent variables leisure activity T1 and memory T1, associations between indicators of latent variables, and also associations among covariates were included in the model, but only cross-lagged, stability paths and correlated change associations are displayed.

Figure 1.

General schema of our cross-lagged models for leisure activity and memory.