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IHLE, Andreas, et al.

Abstract

Background: From a conceptual point of view, close friends are an important resource for promoting activity engagement in old age. Leisure activity engagement in turn is a key predictor of cognitive performance. Empirically, it remains unclear so far whether leisure activity engagement mediates between having close friends on the one hand and cognitive performance on the other, which we investigated in a large sample of older adults. Methods: We assessed cognitive performance (Mill Hill vocabulary scale and Trail Making Test parts A and B) in 2812 older adults. Participants reported information on leisure activity engagement and close friends. Results: A larger number of leisure activities and a larger number of close friends were significantly related to better cognitive performance in the Mill Hill vocabulary scale and Trail Making Test parts A and B. A larger number of close friends was significantly related to a larger number of leisure activities. The number of leisure activities mediated more than half of the relation of the number of close friends to performance in all three cognitive measures. Conclusions: Having [...]
The relation of close friends to cognitive performance in old age: the mediating role of leisure activities

Andreas Ihle¹,², Michel Oris², Marie Baeriswyl², and Matthias Kliegel¹,²

¹ Department of Psychology, University of Geneva, Geneva, Switzerland
² Center for the Interdisciplinary Study of Gerontology and Vulnerability, University of Geneva, Geneva, Switzerland

Correspondence: Andreas Ihle, CIGEV, University of Geneva,
Boulevard du Pont d'Arve 28, 1205 Geneva, Switzerland. E-mail: Andreas.Ihle@unige.ch
Phone: +41 22 37 98308
Abstract

Background: From a conceptual point of view, close friends are an important resource for promoting activity engagement in old age. Leisure activity engagement in turn is a key predictor of cognitive performance. Empirically, it remains unclear so far whether leisure activity engagement mediates between having close friends on the one hand and cognitive performance on the other, which we investigated in a large sample of older adults.

Methods: We assessed cognitive performance (Mill Hill vocabulary scale and Trail Making Test parts A and B) in 2812 older adults. Participants reported information on leisure activity engagement and close friends.

Results: A larger number of leisure activities and a larger number of close friends were significantly related to better cognitive performance in the Mill Hill vocabulary scale and Trail Making Test parts A and B. A larger number of close friends was significantly related to a larger number of leisure activities. The number of leisure activities mediated more than half of the relation of the number of close friends to performance in all three cognitive measures.

Conclusions: Having close friends may be helpful to stimulate and promote activity participation in old age. By enhancing individuals’ cognitive reserve this may finally preserve their cognitive performance level in old age.

Key words: cognition; cognitive reserve; leisure activities; close friends; older adults
Running title: Friends, activities, and cognitive performance

Introduction

In current gerontological research, a major goal is to understand how interindividual differences in cognitive functioning in old age emerge (Hultsch et al., 1999). To address this issue, the cognitive reserve concept postulates that interindividual differences in the effective recruitment of neural networks and cognitive processes explain differences in individuals’ capacity to cope with or compensate for age-related decline (Stern, 2009, 2012). In individuals with healthy cognitive functioning, these mechanisms contribute to the adaptation of brain activity when task difficulty level is increased and thereby enhance cognitive performance (Stern, 2012). Empirically corroborating the predictions of the cognitive reserve concept, evidence showed that engaging in leisure activities in old age contributes to the build-up of cognitive reserve and is related to better cognitive functioning such as memory and executive functioning in old age (Engelhardt et al., 2010; Ihle et al., 2017; Karp et al., 2006; Paillard-Borg et al., 2012; Wang et al., 2013; see Hertzog et al., 2008; Opdebeeck et al., 2016, for overviews).

Recently, a focus in research on this topic became to investigate the role of cognitive reserve markers (such as engaging in leisure activities) for explaining the relational pathways from other individual difference characteristics to cognitive functioning in old age (Ihle et al., 2016). Such characteristics may also concern social aspects of older adults’ life as for example the number of their close friends. This seems reasonable since prior empirical studies showed that having a larger number of close friends is related to better cognitive status and reduced cognitive decline in old age (Barnes et al., 2004; Ho, 2016; Kimura et al., 2017; Wang et al., 2015). In general, close friends can serve as or provide access to emotional resources (companionship, positive interactions, emotional support), instrumental resources...
(financial support, domestic support), and informational resources (exchange of knowledge and key information; Bourdieu, 1985). These resources may for example help to stimulate and enhance an individual’s activity participation. As empirically revealed, individuals show a greater engagement in a variety of leisure activities if they have a larger number of close friends (Flora and Segrin, 1998; Hamilton et al., 2017; Huxhold et al., 2014).

From a conceptual perspective, combining the interplay of the aforementioned relationships in one overarching framework, one could predict that activity participation mediates between having close friends on the one hand and cognitive performance in old age on the other. Such mechanisms would be in line with more general gerontological models such as activity theory (Havighurst, 1951) and continuity theory (Atchley, 1989), which postulated that older adults would age successfully if they continued engaging in the same activities as in midlife and, when maintenance was no longer possible, found alternative leisure activities. Yet, even if maintaining a variety of activities or engaging in new activities in old age becomes difficult, with the help of resources and support that close friends can provide, engagement in activities will be promoted, which in turn will have positive aftereffects on cognitive functioning.

Hence, it seems an appealing question whether activity participation mediates between having close friends on the one hand and cognitive performance in old age on the other. However, empirically, this question has not been investigated so far. Therefore, with a large sample of older adults our specific goal was to investigate whether the number of leisure activities mediated the relation of the number of close friends to cognitive performance (i.e., vocabulary, cognitive processing speed, and cognitive flexibility).

**Methods**
Participants

Data were collected in 2011 and 2012 and come from the Vivre-Leben-Vivere (VLV) survey (Ihle et al., 2015; Ludwig et al., 2014; Oris et al., 2016), which is a part of the research program LIVES on vulnerability processes across the life course. Participants were randomly selected in the cantonal and federal Swiss administrations’ records and stratified by age (65-69 years, 70-74, 75-79, 80-84, 85-89, and 90+), sex, and canton (Bale, Berne, Geneva, Ticino, and Valais). Two thousand eight hundred and twelve participants with cognitive performance assessment served as sample for the present study. Mean age was 77.9 years ($SD = 8.2$, range 65-101). The sample comprised 1330 women (47.3%) and 1482 men (52.7%). All participants gave informed consent and the present study included adherence to the declaration of Helsinki and had been approved by the local ethics commission.

Materials

Cognitive performance

Mill Hill. We administered the Mill Hill scale (Deltour, 1993) measuring vocabulary. For each item, participants had to underline the word (which was intermixed with five distractor words) that semantically matched the target word. After one practice item, participants had to complete ten items. The Mill Hill score was the proportion of correctly completed items.

TMT A. We administered the Trail Making Test part A (TMT A; Reitan, 1958) measuring cognitive processing speed. After seven exercise trails (connecting the numbers from 1 to 8), participants had to connect the numbers from 1 to 25 as fast as possible and without error in ascending order. The TMT A completion time was the time in seconds needed to correctly connect the 25 numbers.
TMT B. We administered the Trail Making Test part B (TMT B; Reitan, 1958) measuring cognitive flexibility. After seven exercise trails (connecting 1-A-2-B-3-C-4-D), participants had to connect the numbers 1 to 13 in ascending order and the letters A to L in alphabetic order while alternating between numbers and letters (i.e., 1-A-2-B-3-C ... 12-L-13) as fast as possible and without error. The TMT B completion time was the time in seconds needed to correctly connect the 25 numbers / letters.

**Number of leisure activities**

We interviewed participants regarding their leisure activities such as sports and other physical exercises, go to the cinema, go to conferences, go into a restaurant, journeys, artistic activities, table games, and municipality activities. For analyses, we calculated the overall number of leisure activities participants engaged in.

**Number of close friends**

We asked participants to indicate the number of their close friends (Barnes et al., 2004; Ho, 2016).

**Covariates**

We additionally repeated mediation analyses simultaneously controlling for the following covariates: age, sex, highest educational level attained (i.e., primary school level, inferior secondary school level, apprenticeship graduation, superior secondary school level, technical college or superior vocational college degree, or university degree), marital status (i.e., single, married, separated, divorced, or widowed), retirement status (i.e., retired or not), subjective health status (i.e., based on a rating scale ranging from 0 = “worst imaginable health” to 100 = “best imaginable health”), and BMI (i.e., calculated as the self-reported weight in kg divided by the squared self-reported height in m).
**Procedure**

A face-to-face questionnaire was administered using the CAPI (Computer Assisted Personal Interview) method. This session contained (besides a larger set of other questionnaires) a socio-demographic survey, the questions regarding leisure activities and close friends, and the paper-pencil assessment of the three cognitive measures. Participants were individually tested by trained research personnel, who always assured that participants fully understood and followed the instructions.

**Statistical analyses**

The following analyses were run: We inspected relations between performance in Mill Hill, TMT A, TMT B, the number of leisure activities, and the number of close friends (by calculating Pearson’s correlation coefficients $r$). Regarding our specific goal, we investigated whether the relation of the number of close friends to performance in Mill Hill / TMT A / TMT B was mediated via the number of leisure activities. For these mediation analyses, we used a path model approach, with an individual mediation model for each cognitive measure. These models contained three paths (see Figure 1 for an illustration): path a, the number of leisure activities regressed on the number of close friends; path b, performance in Mill Hill / TMT A / TMT B regressed on the number of leisure activities; and path c, performance in Mill Hill / TMT A / TMT B regressed on the number of close friends. Importantly for evaluating mediation, the applied path model approach allowed simultaneously estimating the residual direct (non-mediated) relation of the number of close friends to performance in Mill Hill / TMT A / TMT B (i.e., the coefficient of path c) and the indirect (mediated) relation via the number of leisure activities (i.e., the product of the coefficients for paths a and b), including their significance. The proportion of the size of the mediated relation and the total relation (i.e., the sum of the mediated and the non-mediated direct relation) allowed
quantifying the portion of the relation of the number of close friends to performance in Mill Hill / TMT A / TMT B that was exerted indirectly via the number of leisure activities as mediator. For all analyses, to achieve that higher values represented better performance across all variables (as common in correlative studies), for TMT A and TMT B the distribution of completion time of all participants was reversed based on the sample mean so that interindividual differences remained identical.

Results

Descriptive statistics
Mean performance in Mill Hill was 59.4 percent correct ($SD = 25.7$). Mean completion time in TMT A was 66.20 seconds ($SD = 30.61$). Mean completion time in TMT B was 127.59 seconds ($SD = 52.66$). Mean number of leisure activities was 8.15 ($SD = 3.50$). Mean number of close friends was 1.90 ($SD = 1.23$).

Bivariate relations between measures
A larger number of leisure activities and a larger number of close friends were significantly related to better performance in all three cognitive measures. In addition, a larger number of close friends was significantly related to a larger number of leisure activities (see Table 1 for the full descriptive correlation matrix).

Mediation analyses
Regarding our specific goal, we found that the relation of the number of close friends to all three cognitive measures was partly mediated via the number of leisure activities. Specifically, the number of leisure activities mediated about 50.5% to 59.1% of the relation of the number of close friends to cognitive performance (see Table 2 for an overview).
**Additional control analyses**

We additionally repeated mediation analyses simultaneously controlling for age, sex, educational level, marital status, retirement status, subjective health status, and BMI. In these control analyses, the mediation of the relation of the number of close friends to all three cognitive measures via the number of leisure activities remained significant. The number of leisure activities mediated about 53.0% to 85.6% of the relation of the number of close friends to cognitive performance (see Table 3 for an overview).

**Discussion**

The present study set out to investigate whether the number of leisure activities mediated the relation of the number of close friends to cognitive performance in a large sample of older adults. First of all, results showed that greater engaging in leisure activities was related to better performance in all three investigated cognitive measures. This further corroborates the conceptual view that an active lifestyle in late adulthood may further contribute to cognitive reserve, thereby being related to better cognitive status in old age (Ihle et al., 2015; Hertzog et al., 2008; Opdebeeck et al., 2016). Furthermore, again coherently for all three investigated cognitive measures, our results are in line with prior empirical studies showing that having a larger number of close friends is related to better cognitive performance in old age (Barnes et al., 2004; Ho, 2016; Kimura et al., 2017; Wang et al., 2015). Present results also confirm that individuals show a greater engagement in a variety of leisure activities if they have a larger number of close friends (Flora and Segrin, 1998; Hamilton et al., 2017; Huxhold et al., 2014).

Following our specific goal, notably coherently for all three investigated cognitive measures, we found that activity participation mediated between having close friends on the one hand.
and cognitive performance in old age on the other. Specifically, the number of leisure activities mediated more than half of the relation of the number of close friends to cognitive performance. Importantly, this finding was robust to adjustment for a wide array of potentially confounding variables including age, sex, educational level, marital status, retirement status, subjective health status, and BMI. This confirms that close friends are an important resource in old age (Barnes et al., 2004; Bourdieu, 1985; Huxhold et al., 2014; Kimura et al., 2017; Wang et al., 2015). For instance, if maintaining a variety of activities or engaging in new activities in old age becomes difficult, with the help of resources and support that close friends can provide, engagement in activities could be promoted, which in turn may have positive aftereffects on cognitive functioning. This also suggests that for cognitive functioning in old age it seems not only important to have a number of close friends but also to use the resources and support offered by those friends such as encouragements to pursue an active life. In conclusion, present results suggest that having close friends may be helpful to stimulate and promote activity participation in old age. By enhancing individuals’ cognitive reserve this may finally preserve their cognitive performance level in old age.

In terms of possible practical and policy implications one could argue that promoting activity participation with the help of older adults’ social networks might perhaps contribute to their cognitive health. However, given the limitations of present cross-sectional data we underline that future longitudinal studies will have to further investigate the present observations before making suggestions. In the context of the latter notions, we acknowledge that the present study is limited by its cross-sectional design that does not allow for causal inferences. The directionality of observed relationships cannot be established with present cross-sectional data. Thus, we cannot clearly disentangle between individuals who decline because of reducing activities and those who reduce activities because of cognitive decline. More generally, analyses of the present study give only information about interindividual
differences in cognitive status but do not allow drawing conclusions regarding cognitive decline (i.e., intraindividual changes over time). For instance, present observations may be affected by selection issues. Those individuals with lower cognitive functioning from early in life may attract fewer friends and may pursue fewer leisure activities later in life. Moreover, although present findings were robust to adjustment for a wide array of potentially confounding variables including age, sex, educational level, marital status, retirement status, subjective health status, and BMI, there may be other covariates that have not been assessed and therefore could not be controlled for. Thus, the present study identifies important associations, but cannot address causal relations. Therefore, the present study may stimulate future longitudinal research assessing changes in a comprehensive set of cognitive domains, activities, and social networks to gain further insights into the interplay of having close friends, engagement in leisure activities, and cognitive functioning in old age.

Conflict of interest

None.

Description of authors’ roles

A. Ihle formulated the research question, analyzed the data, and wrote the manuscript. M. Oris and M. Baeriswyl formulated the research question, conceptualized the study, supervised the data collection, and participated in writing. M. Kliegel contributed to formulate the research question and was involved in writing the manuscript.

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References


Table 1

*Full descriptive correlation matrix of measures*

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mill Hill</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. TMT A</td>
<td>0.24***</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. TMT B</td>
<td>0.28***</td>
<td>0.62***</td>
<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Number of leisure activities</td>
<td>0.23***</td>
<td>0.39***</td>
<td>0.33***</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>5. Number of close friends</td>
<td>0.11***</td>
<td>0.17***</td>
<td>0.12***</td>
<td>0.27***</td>
<td>---</td>
</tr>
</tbody>
</table>

*** p < 0.001.
Table 2

Results of mediation analyses

<table>
<thead>
<tr>
<th>Variable</th>
<th>Indirect relation</th>
<th>Residual direct relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill Hill</td>
<td>0.06*** (50.5%)</td>
<td>0.05**</td>
</tr>
<tr>
<td>TMT A</td>
<td>0.10*** (59.1%)</td>
<td>0.07**</td>
</tr>
<tr>
<td>TMT B</td>
<td>0.07*** (58.2%)</td>
<td>0.05*</td>
</tr>
</tbody>
</table>

Note. Results of mediation analyses to investigate whether the relation of the number of close friends to performance in Mill Hill / TMT A / TMT B was mediated via the number of leisure activities. Left panel: Values represent indirect (mediated) relation sizes $\beta$. In parentheses the portion of the relation of the number of close friends to performance in Mill Hill / TMT A / TMT B that was exerted indirectly via the number of leisure activities is given. Right panel: Values represent residual direct (non-mediated) relation sizes $\beta$. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. 
### Results of mediation analyses (controlling for covariates)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Indirect relation</th>
<th>Residual direct relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mill Hill</td>
<td>0.03*** (85.6%)</td>
<td>&lt; 0.01 ns</td>
</tr>
<tr>
<td>TMT A</td>
<td>0.06*** (53.0%)</td>
<td>0.05**</td>
</tr>
<tr>
<td>TMT B</td>
<td>0.04*** (69.7%)</td>
<td>0.02 ns</td>
</tr>
</tbody>
</table>

*Note.* Results of mediation analyses to investigate whether the relation of the number of close friends to performance in Mill Hill / TMT A / TMT B was mediated via the number of leisure activities, simultaneously controlling for age, sex, educational level, marital status, retirement status, subjective health status, and BMI. Left panel: Values represent indirect (mediated) relation sizes $\beta$. In parentheses the portion of the relation of the number of close friends to performance in Mill Hill / TMT A / TMT B that was exerted indirectly via the number of leisure activities is given. Right panel: Values represent residual direct (non-mediated) relation sizes $\beta$. *** $p < 0.001$; ** $p < 0.01$; ns = non-significant, $p > 0.05$. 

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Figure 1. General structure of the path models applied to investigate whether the relation of the number of close friends to cognitive performance in old age was mediated via the number of leisure activities. These models allowed simultaneously estimating the residual direct (non-mediated) relation of the number of close friends to performance in Mill Hill / TMT A / TMT B (c) and the indirect (mediated) relation via the number of leisure activities (a*b).