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Cognitive Reserve Attenuates the Relation between Gastrointestinal Diseases and Subsequent Decline in Executive Functioning

- Short Report -

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Abstract

Aims: We investigated whether the longitudinal relationship between gastrointestinal diseases and subsequent decline in executive functioning over six years differed by cognitive reserve.

Methods: We analyzed longitudinal data from 897 older adults (*M* = 74.33 years) tested on TMT parts A and B in two waves six years apart. Participants reported information on education, occupation, leisure activity engagement, and gastrointestinal diseases.

Results: There was a significant interaction of gastrointestinal diseases with leisure activity engagement on latent change in executive functioning. Specifically, only for individuals with low (but not those with high) leisure activity engagement, gastrointestinal diseases significantly predicted a steeper subsequent decline in executive functioning across six years (i.e., increases in TMT completion time).

Conclusion: Cognitive reserve may attenuate the detrimental influences of gastrointestinal diseases on subsequent decline in executive functioning.

Keywords: decline in executive functioning; cognitive reserve; leisure activity engagement; gastrointestinal diseases; longitudinal study

Word counts: Abstract = 131, document = 1950

Introduction

Gastrointestinal diseases such as peptic ulcer disease, chronic diarrhea, and chronic constipation are associated with increased risk of cognitive impairments in midlife and old age [1, 2]. With respect to such impairments, the cognitive reserve concept postulates that lifelong cognitive stimulation builds up a buffer that is instrumental for preserving cognitive functioning in aging [3]. Frequently-used proxies of cognitive reserve are education in early life, cognitively demanding jobs in midlife, and leisure activity engagement across adulthood, which contribute to the accumulation of cognitive reserve and are for example related to better executive functioning in old age [4-7].

Notably, previous research has demonstrated that cognitive reserve may help to overcome cognitive impairments that are related to health risk factors such as metabolic syndromes and other physiological stressors [8-10]. Yet, to the best of our knowledge, there is no investigation to date regarding the role of cognitive reserve in modifying the relationship between gastrointestinal diseases and cognitive functioning. Moreover, with respect to the different contributions to the accumulation of cognitive reserve across the lifespan it needs to be identified which of the key proxies (education, cognitive demand of jobs, or leisure activity engagement) may play the most important role in this context. To address this major gap in the literature, we investigated whether the longitudinal relationship between gastrointestinal diseases and subsequent decline in executive functioning over six years as measured through performance changes in the Trail Making Test (TMT) differed by key frequently-used proxies of lifelong cognitive reserve accumulation (i.e., education, cognitive demand of jobs, and leisure activity engagement).

Methods

Participants

We analyzed data from 897 individuals who participated in the two waves of the Vivre-Leben-Vivere (VLV) survey [11]. Respondents were first interviewed during 2011

(Wave 1; W1) and again in 2017 (Wave 2; W2) using face-to-face computer-assisted personal interviewing (CAPI) and paper-pencil questionnaires. For further details regarding the rationale, design, recruitment, materials, and procedures of the VLV survey see [11]. Mean age of these respondents in W1 was 74.33 years (*SD* = 6.50, range 65-96); 51.4% were men.

Materials

In both waves, we administered the Trail Making Test parts A and B (TMT A and TMT B, respectively, with completion time recorded in seconds [12]). Participants reported in W1 whether they suffered from gastrointestinal diseases such as peptic ulcer disease, chronic diarrhea, and chronic constipation (solely assessed via self-report). We used the Cognitive Reserve Index questionnaire (CRIq [13]) to assess proxies of accumulated cognitive reserve across the lifespan in terms of education, cognitive demand of jobs, and leisure activity engagement.

Statistical Analyses

Using latent change score modeling, we modeled latent executive functioning factors of TMT completion time [in seconds] in W1 (constructed from TMT parts A and B in W1) and W2 (constructed from TMT parts A and B in W2) as well as a latent change in executive functioning variable regarding change in TMT completion time from W1 to W2. We included the following covariates to predict latent change: gastrointestinal diseases in W1, the proxies of cognitive reserve (education, cognitive demand of jobs, and leisure activity engagement), age in W1, sex, and the interactions of gastrointestinal diseases in W1 with the proxies of cognitive reserve. We also included interrelations of all covariates to take the dependencies among them into account.

Results

The latent change score model provided a very good statistical account of the data (χ^2 = 25.45, *df* = 17, *p* = .085, *CFI* > .99, *IFI* > .99, *RMSEA* = .02, *SRMR* = .02).

There was a trend for gastrointestinal diseases in W1 predicting a larger subsequent increase in TMT completion time from W1 to W2 (i.e., steeper decline in executive functioning, β = .08, *p* = .074). Older age in W1 significantly predicted a larger increase in TMT completion time from W1 to W2 (β = .35, *p* < .001). Greater past leisure activity engagement across adulthood significantly predicted a smaller increase in TMT completion time from W1 to W2 (i.e., a smaller decline in executive functioning, β = -.13, *p* = .005). Education, cognitive demand of jobs, and sex did not predict changes in TMT completion time (*p*s > .196). Notably, there was a significant interaction of gastrointestinal diseases in W1 with past leisure activity engagement (β = -.09, *p* = .043). Specifically, for individuals with low past leisure activity engagement (-1 *SD*), gastrointestinal diseases in W1 significantly predicted a larger subsequent increase in TMT completion time from W1 to W2 (i.e., steeper decline in executive functioning, β = .14, *p* = .024). In contrast, for individuals with high past leisure activity engagement across adulthood (+1 *SD*), this longitudinal relationship between gastrointestinal diseases and subsequent decline in executive functioning was not significant (β = .01, *p* = .930). Besides that, no other interactions of gastrointestinal diseases in W1 with the proxies of cognitive reserve on latent change in TMT completion time were observed.

Discussion

Present longitudinal results have important implications. As the primary study so far, we demonstrated a substantial interaction of gastrointestinal diseases with past leisure activity engagement on latent change in executive functioning. Specifically, for individuals with low past leisure activity engagement, gastrointestinal diseases in the first wave of data collection predicted a steeper subsequent decline in executive functioning across six years (i.e., indicated by increases in TMT completion time). In contrast, for individuals with high past leisure activity engagement across adulthood, this longitudinal relationship between gastrointestinal diseases and subsequent decline in executive functioning was not evident. Disentangling the

individual contributions to cognitive reserve accumulation across the lifespan, we found that (in contrast to education and cognitive demand of jobs) leisure activity engagement played the key role in this context. Thereby, our observations dovetail with findings that greater leisure activity engagement contributes to cognitive reserve and is associated with reduced decline in executive functioning [5].

In conclusion, present results suggest that the detrimental influences of gastrointestinal diseases on subsequent decline in executive functioning may be attenuated in individuals who have accumulated greater cognitive reserve through leisure activity engagement across their life. Therefore, especially a lifelong stimulating activity engagement is crucial for building up cognitive reserve in order to promote the maintenance of executive functioning in old age. Future longitudinal research will have to include a larger set of cognitive abilities as well as medical reports on gastrointestinal diseases.

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Author Contributions

AI formulated the research question, analyzed the data, and wrote the manuscript. ERG, BRG, and SZ were involved in writing the manuscript. MK formulated the research question, conceptualized the study, supervised the data collection, and participated in writing.

Statement of Ethics

All participants gave their written informed consent before participating in the study that was conducted in accordance with the Declaration of Helsinki.

Disclosure Statement

The authors have no conflicts of interest to disclose.

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