# Changes in high level cognitive processes during midlife: a scoping review protocol

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## ABSTRACT

**Background:** Middle-age or midlife is an age period spanning from 40 to 65 years old. This specific period of life is associated with its share of changes including in cognitive performance. Indeed, some high-level cognitive functions seem to decline such as memory or executive functions whereas other aspects of cognition seem to improve such as spatial orientation. However, the few studies that tackled the subject also showed a high inter-subject' variability for individuals within the same age-group.

**Objective:** The goal of this scoping review is to identify all previous studies and synthetize the changes in the functioning of high-level cognitive processes associated with middle-age.

**Eligibility criteria:** All published and unpublished papers investigating cognition during midlife (both quantitative and qualitative) will be included. Only studies written in English and French will be included, from 1990 to present. Participants should be aged from 40 to 65 with the absence of a pathological condition. The concepts that will be examined are high-level cognitive processes from a neuropsychological point of view (e.g., memory, attention, and executive functions).

**Methods:** An extensive literature search will be held in five bibliographic databases: MEDLINE (Ovid), PsycINFO (Ovid), Scopus (Reed Elsevier), Embase (Elsevier), and OpenGrey. All articles will be uploaded to Covidence and assessed by two independent reviewers for selection. The reference listed in all selected articles and in the present scoping review will be scanned as well for additional relevant papers. Key data extracted from the selected articles will be summarized in tables. Summary tables will contain information about the Joanna Briggs Institute PCC mnemonic (Population, Concept and Context) and others factors relevant to our research questions.

# Introduction

Most studies targeting age-related effects on cognition have been used to compare a "younger" and an "older" group while the midlife period has been understudied in research, probably for one (or several) of the following reasons: it was regarded as a quiet period with little change, there is too much variability to capture the midlife experience, or middle-aged subjects are difficult to obtain for research because of their busy work and family schedules (Lachman & James, 1997). Only more recently, midlife has begun to catch researchers' interest. However, the million-dollar question is what is middle-age?

The word "midlife" first appeared in Funk and Wagnall's Standard Dictionary in 1895. Midlife was defined as "the part of life between youth and old age." However, boundaries for midlife are blurred, with no obvious borders (Lachman, 2004). Classically, midlife is recognized to begin at 40 and to end at 60-65 (Lachman et al., 1994; Lachman & James, 1997) with a 10-year range on either end, so that middle age can also be considered to run from 30 to 75 (Lachman, 2002). Besides chronological age, becoming middle-aged is also defined by life events such as children leaving home, becoming a grandparent, reaching career goals, or experiencing menopause. The timing of entry and exit into midlife is also linked to social class. People in lower socioeconomic status (SES) groups typically report earlier entry and exit years for midlife (Kuper & Marmot, 2003). This could be related to social class differences in health (Marmot et al., 1997) or to earlier transitions into life roles such as grandparent or retirement (Kim & Moen, 2001). The nature of midlife varies as a function of numerous factors such as gender, ethnicity, culture, region, personality, as well as marital, parental, employment, and health status.

Most of the time, middle-aged people have to simultaneously care for others (e.g., young children, aging and sometimes ill parents, coworkers) and to meet their own needs and high responsibilities such as being efficient in their job, dealing with an unpleasant boss, managing technical issues (house working, car maintenance, paying bills), caring for health (chronic illnesses such as high blood pressure, cholesterol or arthritis start at midlife) and trying to keep a satisfying well-being (leisure activities). Therefore, middle-aged individuals may be frequently forced to balance the negative and positive aspects of relationships and other aspects of life. Both happiness (Blanchflower & Oswald, 2008) and well-being (Stone et al., 2010) have been found to follow a U-shaped curve as a function of age, reaching their minimum in people's mid to late 40s, and then increasing after the age of 50. However, midlife is also associated with positive changes such as better emotional regulation (Magai & Halpern, 2001), increased practical intelligence (Baltes et al., 1999), or a strong sense of mastery (Lachman & Bertrand,

2001) and middle-aged individuals are seen as more competent, responsible, knowledgeable, and powerful (Lachman et al., 1994).

From a more cognitive point of view, it has long been assumed that midlife performance falls somewhere in between that of young and older people (Lachman, 2004). For example, reasoning, speed of processing and memory in middle-aged have been shown to fall on average between those of younger and older individuals (Lachman et al., 2015). However, there are wide individual differences within age groups and the age distributions overlap. This means there are some in middle age whose cognitive performances are comparable to young adults and others who resemble older adults to a greater extent.

Some functions are well maintained or even improved in middle-age (Eichorn et al., 1981; Hultsch et al., 1998; Schaie, 2005). It is the case for the pragmatic aspects of functioning, such as tacit knowledge (Baltes et al., 1999; Lachman, 2002), that depends on experience as well as vocabulary, inductive reasoning, and spatial orientation (Willis & Schaie, 1999). By contrast, some other functions such as episodic memory (Cansino et al., 2015; Erngrund et al., 1996; Kwon et al., 2016; Park et al., 2013), speed of processing (Salthouse, 2009; Zimprich & Mascherek, 2010), working memory (Baltes et al., 1999; Cansino et al., 2013), or executive functions (Singh-Manoux, 2003) start to decline. Accordingly, the study of Zhou et al. (2011) found that the executive brain network was the most affected by age compared to alerting and orienting networks. These results also suggested that an age-related cognitive decline, especially for the executive effect, begins relatively early during middle-age. In agreement with this study, Ferreira et al. (2015) administered 101 middle-aged (40-50 years) and 40 older adults (65 years) a comprehensive neuropsychological battery covering many functions (processing speed, attention, executive functions, verbal and visual episodic memory, procedural memory, visuoconstructive, visuoperceptive and visuospatial functions, and language) and found subtle executive dysfunctions before the age of 50, together with a slowing in processing speed later in the transition to older age. Beyond this slowdown in mean processing speed, changes in intra-individual variability (IIV) of reaction times (RTs) is also a marker of cognitive aging. Accordingly, studies converge to the finding that IIV on simple RT tasks remain stable until about 50-60 while IIV in more complex tasks (e.g., choice RT tasks) progressively increase with age (Anstey et al., 2005; Der & Deary, 2006) and this increase can already be observable in the 40s (Bielak et al., 2014).

In 2014, Wolkorte et al. administered their participants with a two-choice RT task in which one of the stimuli occurred more often than the other stimulus, allowing subjects to be more

prepared to react to the frequent stimulus. In this study, they aimed at investigating RTs as well as response preparation in young versus middle-aged people. Such a preparation to the frequent stimulus classically leads to faster RTs for the frequent stimulus but more errors for the infrequent one. Results of this study showed that middle-aged were globally slower and less prepared to frequent stimuli than young people. However, middle-aged were more accurate than young people. RT differences between the two groups were particularly marked on the frequent stimuli (i.e., middle-aged slower than young people for frequent stimuli more than for infrequent stimuli) while differences in accuracy were more obvious in the infrequent stimuli (i.e., young people made more errors than middle-aged). Results of this study echo results from a study bearing on cognitive fatigue which also showed that young people tend to favor speed while middle-aged rather favor accuracy (de Jong et al., 2018).

Nevertheless, results are scarce and sometimes contradictory due to high inter-variability in cognitive performance between individuals (Lachman et al., 2015). To our knowledge, there is no systematic reviews focusing on changes in high level cognitive functions associated with midlife during healthy aging. Therefore, the examination of the available evidence on the subject could benefit future researchers interested in the middle-aged population but also clinicians. In fact, several studies investigating cognition in middle-age measure global cognition instead of high-level cognition (Ferreira et al., 2015). These measurements do not seem sufficiently sensitive for clinical purpose.

Thereby, a scoping review seems to be the best method to synthesize a whole body of literature which is still unclear and can provide discrepant results. In fact, a scoping review should be highly relevant because it will map and qualitatively synthesize all information's to date. This will also be a good starting point for more precise incidence and prevalence systematic reviews.

## Review questions

This review seeks to scope changes in high level process (e.g., episodic memory, working memory, attention, executive functions) which can occur during middle-age. By listing all the changes in cognitive functioning, we want to pave the way for future studies conducted with middle-aged participants.

Therefore, the research question is as follows: What are the changes in high-level cognitive functions observed at midlife in the context of healthy aging studies?

In addition, this review will focus on the following sub-questions: In which ethnicity and/or socioeconomics context are the changes in high-level processes the most prominent?

# Inclusion criteria

The Joanna Briggs Institute (JBI) PCC strategy was used to develop the following inclusion criteria regarding population, concept, and context (Peters et al., 2020).

## Participants

This scoping review will consider all research papers that included adults from both sexes, aged between 40 and 65 years (i.e., middle-age). Participants should not present a pathological condition that has direct effects on cognition such as chronic fatigue syndrome, cancer with chemo brain syndrome, neurological or psychiatric disorder. Adults older than 60 years will not be included. Low socio-economics status will not be considered as an exclusion criterion.

## Concept

This scoping review will include studies that focus on high level cognitive functions commonly assessed during a neuropsychological evaluation. That is, the main outcome measures include differences in performances during the completion of neuropsychological tasks. Neuropsychological evaluation comprises standardized or experimental tests designed to assess working memory, long term memory, attention, and executive functions.

Differences between groups mean change in other markers of cognitive functioning (socioeconomics, gender, etc.) will be investigated if these data are available in a sufficient number of studies.

## Context

The review will focus on middle-aged people in the context of healthy ageing, which is defined by the World Health Organization as "the process of developing and maintaining the functional ability that enables wellbeing in older age".

## Type of sources

For this scoping review, we will include published and unpublished (e.g., preprint articles, theses, and dissertations) papers which distinct age groups including middle-age. We will consider both quantitative and qualitative studies such as cohort and case studies. Systematic reviews and meta-analyses will not be taken into account. No geographical search limitations will be applied. Only studies published in English and in French will be eligible.

# Methods

Our systematic review will follow the JBI methodology canvas for scoping reviews (Peters et al., 2020); the present protocol and its corresponding scoping review were assessed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping

Reviews (PRISMA-ScR) checklist (Tricco et al., 2018). The present protocol will be uploaded on the Open Science Framework platform (https://osf.io/).

## Search strategy

A pilot search was conducted in January 2023 on PsycINFO (Ovid) in order to identify articles on the topic. Based on the text words specified in the titles, abstracts and index terms used to describe the relevant articles, we will develop our full search strategy (Appendix I). The search strategy will be conducted in February 2023. It will be adapted for each of the chosen databases and will focus on two concepts: middle-age and cognitive functioning. More precisely, we will use a set of keywords mixed with controlled terms. Due to the lack of a clear definition for the term "middle-age" in past research, we will search the following sources from 1990 to 2022:

- Electronic databases: MEDLINE (Ovid MEDLINE®), PsycINFO (Ovid), Scopus (Reed Elsevier), EMBASE (Elsevier).
- Grey Literature: OpenGrey.
- References of selected papers.

The strategy will be run one last time in April 2023.

## Sources of evidence selection

All identified sources of evidence will be uploaded into Covidence (https://www.covidence.org/). Duplicates will be automatically removed. Following the pilot test in January 2023, the review process will be conducted in two phases during February and March 2023. During the first phase, titles and abstracts will be screened by two independent reviewers (J.R. and N.B.). That is to determine their potential eligibility according to the inclusion criteria. During the second phase, the full text of the selected papers will be retrieved. The same two independent reviewers will screen in detail these papers according to the inclusion criteria. Reasons for excluding sources of evidence at the full-text reading phase will be reported in the scoping review. At both phases, in case of discrepancies between the two reviewers' opinions during the selection process, we will resolve the issue by consulting an additional reviewer (F.R.). Before beginning to select studies, the selection process will be tested using 10% of the identified articles to ensure that the reviewers agree on the inclusion criteria. The results of the search and study selection will be reported in full in the final scoping review and presented in a PRISMAScR flow diagram generated by Covidence (Tricco et al., 2018).

### Data charting

Two independent reviewers (J.R. and N.B.) will extract data from included evidence sources. This process will follow a data charting form developed by the two reviewers. Reviewers will adapt the form, if necessary, during the process of extracting data from selected papers. Any modifications will be described in the final publication. In addition, reviewers will meet after extracting data from the first five papers. This is to ensure the consistency of the extraction process.

### Data items

Key data will be extracted from selected papers be two independent reviewers (J.R. and N. B.). This includes study characteristics (title, author name(s), year of publication, country of origin, study type and design), aims of the study, sample characteristics (sample size, gender proportion, age, country, education, inclusion or exclusion criteria), assessment modalities (neuropsychological function assessed with descriptions, name of assessment tools, in case of longitudinal studies: interval between completion of two evaluations, control condition, group differences at baseline, controlled variables), primary outcome(s) of the assessment and study limitations. A table of key elements of the literature describe above will be used to chart the data. Any missing data will be requested from corresponding authors and excluded from the analysis if not received within two months.

### Data presentation

As far as possible, results will be presented with summary tables to synthetize, characterize, and identify the key findings related to the review questions. An overall table regrouping the key findings will be dived in several sections, one section for each high-level cognitive function. A narrative synthesis will accompany the tables to describe the changes in cognitive functioning occurring at midlife. The results will be discussed considering the existing literature in other age groups.

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# APPENDICES

Appendix I: Search strategy conducted on PsycINFO/Ovid in January

Database: APA PsycInfo <1806 to January Week 4 2023>

Search Strategy:

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1 Cognitive Aging/ (1318)

2 ((cognitive or healthy or normal) adj3 aging).ti,ab. (10876)

3 Executive Function/ (13598)

4 ((executive or high order) adj3 (process* or function*)).ti,ab. (33451)

5 Attention/ (39427)

6 Short Term Memory/ (29975)

7 Long Term Memory/ (5567)

8 ((working or short term or long term or episodic) adj3 memory).ti,ab. (64656)

9 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 (139172)

10 Middle Adulthood/ (3402)

11 (middle adj2 (age* or adult*)).ti,ab. (17952)

12 midlife.ti,ab. (5789)

13 10 or 11 or 12 (23103)

14 9 and 13 (1647)

15 limit 14 to yr="1990 -Current" (1611)

16 limit 15 to (english or french) (1556)

17 limit 16 to 360 middle age <age 40 to 64 yrs> (951)

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