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A Conceptual View of Cognitive Intervention in Older Adults With and Without Cognitive Decline—A Systemic Review

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Background: Dementia is the one of the most common and prominent disease in the elderly person that results in the Cognitive interventions. In this study, we aim to conceptualize the cognitive intervention for older adults with and without cognitive dysfunction and to clarify the heterogeneity existing in this literature field by determining the main variables implicated.

Methods: We conducted a study analysis using previous literature highlighting the significant data reporting empirical results from cognitive intervention for healthy older adults and other seniors with different types of dementia. Each paper was reviewed in terms of compensatory cognitive training, cognitive remediation, enrichment, cognitive activation, brain training, cognitive stimulation, cognitive training, and cognitive rehabilitation. The research analysis was performed following rigorous inclusion and exclusion criteria with the purpose of collecting relevant answers to our research questions.

Results: We included a total of 168 studies in our review. Our findings indicated heterogeneity regarding methods, concepts, and procedures. Additionally, the values were integrated using different information existing in this field.

Conclusion: In conclusion, we highlighted that this is the first review that clarify the discrepancy of various existing definitions, methods, and procedures, as well as the overlapping information in the cognitive interventions.

Keywords: brain training, cognitive stimulation, cognitive training, cognitive rehabilitation, older adults

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INTRODUCTION

According to the World Health Organization (World Health Organization, 2017b), the world's population is rapidly aging. By 2050, it is been estimated that people over the age of 60 will account for about 22% of the world's total population. Falls, diabetes, depression and dementia continue to be the major causes of disability in the elderly (World Health Organization, 2017). Besides musculoskeletal, sensory, immune and other disorders, cognitive functioning is also a matter of concern regarding the health of the elderly, impacting their intrinsic and functional capacity (World Health Organization, 2015b). Intrinsic capacity encompasses both physical and mental attributes

people can rely on, throughout the course of their life, while functional capacity is related to having the abilities that allow them to be what they want to be (World Health Organization, 2015a). The significant increase in the average life expectancy in the last century has had consequences in this age group, namely the rapid growth of neurodegenerative dementias (Murman, 2015). Moreover, consequences have been seen at social and economic levels, particularly on both the health system and the labor market, directly affecting the elderly, who face new challenges related to cognitive deterioration (Hedden and Gabrieli, 2004).

Normal aging is a process of human development that inevitably entails biological and physiological (structural and functional) brain changes with neuropsychological and social consequences. However, the age factor may lead to different degrees of physical or mental decline (World Health Organization, 2015a). The key to healthy aging is to engage in both physically and mentally stimulating activities (Lee, 2000). Limitations in the ability to independently perform activities of daily living (ADL) are negatively associated with physical and mental well-being (Willis, 1996). In fact, the concept of 'activities of daily living' in the elderly is related to physical, emotional, and cognitive aspects. Cognitive aging in particular depends on intelligence, education, and sensory abilities (Drag and Bieliauskas, 2010).

The concept of healthy aging has been defined as a process of development and maintenance of functional capacity (World Health Organization, 2015) or adaptation to the physical, social, and psychological changes that allow the well-being of the elderly (Peel et al., 2004). Cognitive changes are core in this concept because of their close relationship to impairment that affects ADL and functional capacity (Yam and Marsiske, 2013). Thus, in the last decade, we have witnessed an increase in research on healthy aging and lifestyle associated with older adults' cognitive functioning, namely, the development of neuropsychological interventions using new technologies capable of promoting the older adults' quality of life (QoL).

There are three types of cognitive decline in the elderly: normal aging (normal cognitive decline), pre-dementia (mild cognitive deficit) (Petersen et al., 2001), and different types of dementia (severe cognitive deficit) (Alves et al., 2013). Cognitive intervention consists of various treatments based on different theoretical constructs, aimed to improve an impaired function, prevent cognitive decline, or, at least, maintain the functional level (Gates and Sachdev, 2014). Given that cognitive intervention encompasses several distinct concepts (e.g., compensatory cognitive training, cognitive remediation, cognitive training), it is important to further analyze these concepts, clarify their similarities and differences, so that these can be considered in future research. Therefore, the main aim of this study is to define the types of cognitive intervention and corresponding methodologies usually applied in older adults and clearly distinguishing the terms usually used in the literature. After reviewing the literature regarding older adults, there seem to be eight different types of cognitive interventions that are most commonly used, and main motivations are to focus on this work: Compensatory Cognitive Training, Cognitive Remediation, Enrichment, Cognitive Activation, Brain Training, Cognitive Stimulation, Cognitive Training, and Cognitive Rehabilitation.

Consequently, it is important to discuss what are the most critical differences between these distinct non-pharmacological treatments, relating to definitions, methods, and procedures.

STUDIES CHARACTERISTICS

We found total 168 articles (**Figure 1**) through database searching (**Supplementary Appendix S1**) in which 59 were randomized controlled studies with post-intervention follow-up of the participants, 74 were randomized controlled trials without follow-up, 28 used a pre and post-test design with a 3–12-month post-intervention follow-up, two non-randomized pilot studies, two were descriptive and exploratory studies, two were longitudinal studies, and one was a single-blind wait list-controlled study.

Mostly in studies investigated the sample size was approximately 97 both healthy or composed healthy older adults, 26 studies were on older adults with mild cognitive impairment (MCI) or amnestic MCI (aMCI), two studies on psychotic disorders, 19 studies on older adults with dementia or mild to moderate dementia, 21 studies on Parkinson's disease (PD), Alzheimer's disease (AD), and older adults with cognitive impairment, and one studied stroke, HIV-associated neurocognitive disorders in older adults, and older adults with major depression.

The studies included were thoroughly reviewed in terms of the following types of cognitive intervention: Compensatory Cognitive Training, Cognitive Remediation, Enrichment, Cognitive Activation, Brain Training, Cognitive Stimulation, Cognitive Training, and Cognitive Rehabilitation (**Table 1**). The criteria for determining the type of cognitive intervention used in each study are summarized in **Table 2**. Our review includes 35 studies on Cognitive Stimulation and 11 on Cognitive Rehabilitation intervention where most of the tasks did not include computerized tasks; 102 studies on Cognitive Training intervention where most of the tasks were presented in computerized form; three studies on Enrichment, six on Cognitive Remediation and seven on Brain Training that included computer-based training or video game; and four studies on Compensatory Cognitive Training where external compensation strategies were used.

COGNITIVE INTERVENTIONS

Cognitive Interventions (CI) is used as term to describe the variety of therapeutic approaches designed to address psychological problems at the cognitive (conscious mind) level, by the activation and analysis of thoughts, experiences, senses and memories. By using these techniques therapist helps enlist patients to develop solutions to problems going on in their mind that will be effective and permanent. Through intervention, therapist can draw the attention of the patients

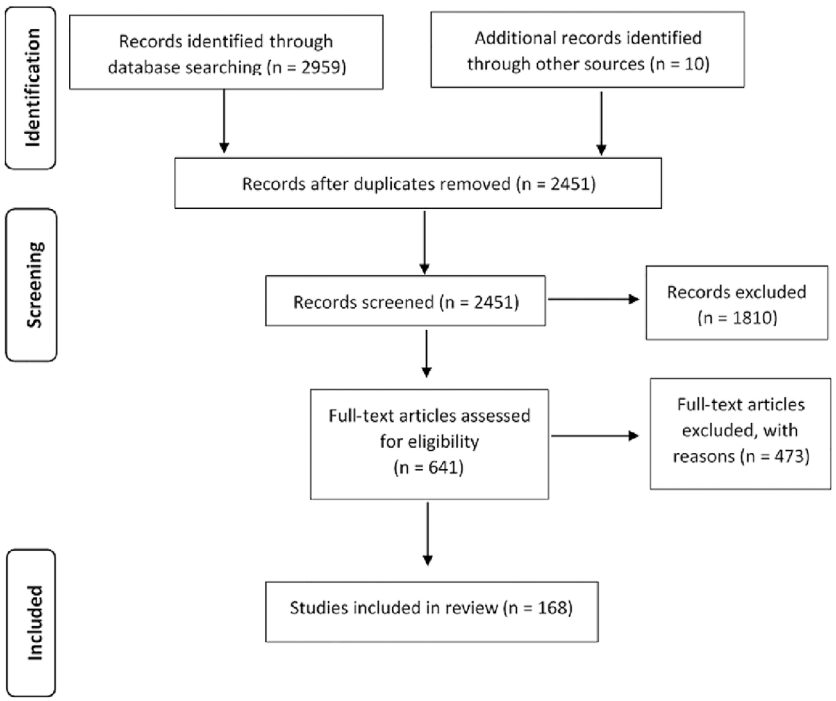

FIGURE 1 | Literature search flow on cognitive interventions.

TABLE 1 | Types of cognitive intervention defined in the literature.

Cognitive intervention	Definition	Authors
Compensatory cognitive training	Use of low-tech intervention strategies (internal, external, or environmental) to compensate for cognitive impairment, reducing its impact on activities of daily living and quality of life	Greenaway et al. (2013), Huckans et al. (2013), Kim and Kim (2014), Lenze and Bowie (2018), Twamley et al. (2012), Velligan et al. (2000)
Cognitive remediation	Neuropsychological intervention proposed by therapists for life functional and social recovery and competence development. May or not include computerized exercises to improve cognitive performance	Lenze and Bowie (2018), Medalia et al. (2002), Medalia and Richardson (2005), Medalia and Choi (2009), Mowszowski et al. (2010), Vance (2009), Vance et al. (2009)
Enrichment	All activities (activity/cognitive stimulation, social, physical, and intellectual) with a positive impact on cognitive functioning that enhance cognitive enrichment. Implementation of motor, sensory, and cognitive stimuli in the person's environment	Hertzog et al. (2008), Steinerman (2010), Patel (2012)
Cognitive activation	Computer-based training to maintain their functioning, often with at least orientation or facilitation by people who are not therapists	Lenze and Bowie (2018)
Brain training	Is a concept mostly used by companies that commercialize to the public cognitive intervention programs. A program or activity (e.g., video games, music, computerized training, physical exercise) repeated over a period of time to improve cognitive deficits or performance in other cognitive tasks, including daily life activities (e.g., driving). brain training (Simons et al., 2016)	Heugten et al. (2016), Rabipour and Raz (2012), Simons et al. (2016)
Cognitive stimulation	Participation in activities that generally improve cognitive and social functioning. Includes multiple group activities under a social environment and multisensory stimulation	Clare and Woods (2004), Eckroth-Bucher and Siberski (2009), Gates and Sachdev (2014), Kim and Kim (2014), Kueider et al. (2014), Mowszowski et al. (2010), Steinerman (2010)
Cognitive training	Training of specific cognitive functions such as memory, executive functioning, language, and attention, involving guided practice and repetitive training Presented in paper and pencil or computerized form, with the objective of identifying, tracking, and monitoring the user	Bahar-Fuchs et al. (2013), Chaikham et al. (2016), Clare et al. (2003), Clare and Woods (2004), Eckroth-Bucher and Siberski (2009) Gates et al. (2019), Kueider et al. (2014), Lenze and Bowie (2018), Mowszowski et al. (2010), Steinerman (2010)

(Continued on following page)

TABLE 1 | (*Continued*) Types of cognitive intervention defined in the literature.

Cognitive intervention	Definition	Authors
Cognitive rehabilitation	Individualized approach, developed based on the goals of each user, i.e., in cognitive deficits, functional, and behavioral problems, and in real life. The planning and implementation of the cognitive rehabilitation plan involves the person with cognitive deficits, family members, and a set of health professionals	Bahar-Fuchs et al. (2013), Cicerone et al. (2000), Clare et al. (2003), Kueider et al. (2014), Mowszowski et al. (2010), Steinerman (2010), Wilson (2002)

TABLE 2 | Criteria for type of cognitive intervention: compensatory cognitive training, cognitive remediation, enrichment, cognitive activation, brain training, cognitive stimulation, cognitive training, and cognitive rehabilitation.

Cognitive intervention	Characteristics	Tasks
Compensatory cognitive training	Attention, memory, executive functioning, learning of meta-cognitive strategies	External strategies such as calendar use, self-talk, note-taking, navigation devices, and a six-step problem-solving method Internal strategies such as mnemonic techniques, using visual imagery; using structured problem-solving, and planning methods Environmental strategies such as alter the workplace by removing visually distracting stimuli
Cognitive remediation	Attention, memory, processing speed, and executive function training	Computer-based cognitive training Cognitive-behavioral therapy and attention process training intervention; do not include computerized tasks
Enrichment	Learning, perceptual speed, memory, visuospatial skills, attention, processing speed, concentration, and executive functions	Internet-based training Combined physical and cognitive intervention
Brain training	Working memory, attention, memory, visuoperceptual and visuospatial skills, intelligence, language, executive functions, processing speed, and reasoning	Video games and computer-based cognitive training
Cognitive stimulation	Global cognition, fluid intelligence, executive functions, working memory, praxis, language, memory, attention, concentration, orientation, perception, processing speed, problem-solving, reasoning, and visuospatial skills	Computer-based cognitive training Combined physical and cognitive intervention Mobile and tablet-based cognitive training programs Cognitive stimulating activities (e.g., puzzles, quizzes, origami, autobiographical memory) that do not include computerized training Multiple group activities (e.g., music, poetry, museums, visual arts)
Cognitive training	Global cognition, fluid intelligence, executive functions, working memory, praxis, language, memory, attention, orientation, perception, processing speed, problem-solving, reasoning and visuospatial skills	Computer-based cognitive training Video games TV and tablet-based cognitive training programs Combined physical and cognitive intervention Combined behavioral interventions and computerized tasks Paper and pencil tasks
Cognitive rehabilitation	Global cognition, language, memory, executive functions, attention, concentration, problem-solving, reasoning, perception, and visuospatial abilities	Computer-based cognitive training Virtual environment Multiple group activities (e.g., self-assertiveness training, relaxation techniques, stress management, anxiety management strategies) Internal and external strategies such as books, diaries, post-it notes, timers, calendars that do not include computerized training Cognitive rehabilitation groups to train specific cognitive functions (e.g., language, memory)

to the unreasonable pictures that mind has created and then begin to create tools for dealing with those pictures.

The cognitive approach to psychology assumes that your emotions, behaviors and psychology are controlled by the way you view the things that have happened around you, and cognitive interventions are launched from this point of view. In other words, if you see problems that minds create, they can be removed by changing the way of thinking and exercising your mind to work in different ways.

TYPES OF COGNITIVE INTERVENTION

Compensatory Cognitive Training

The literature refers to Compensatory Cognitive Training as the use of low-tech intervention strategies (internal, external, or environmental) to compensate for cognitive impairment in order to reduce its impact on ADL and QoL (Velligan et al., 2000; Twamley et al., 2012; Greenaway et al., 2013; Huckans et al., 2013; Kim and Kim, 2014; Lenze and Bowie, 2018). In general

terms, it has been shown to improve memory and functionality in ADL (Greenaway et al., 2013).

This type of cognitive intervention has been implemented in various populations, including older adults, namely, individuals with aMCI, using external memory compensatory strategies (Troyer et al., 2008; Greenaway et al., 2013), and individuals with psychotic disorders (Twamley et al., 2012). Velligan et al. (2000), who tested the effect of compensatory strategies on apathy, disinhibition, and improvement of executive functions in 45 older adults with schizophrenia, indicated that patients using compensatory strategies showed greater improvement in motivation and overall functioning than those under other treatments.

However, this type of intervention's training and applicability are controversial. It is intended for people with severe cognitive impairment and considerable functional impairment (Lenze and Bowie, 2018). Compensation focused interventions encompass cognitive interventions mainly aiming to enhance frontally mediating functions or to compensate specific cognitive functions that are adversely affected by aging. The results of a literature review by Kim and Kim (2014), which considered empirical studies with healthy, impaired, or demented older adults, indicated that Compensatory Cognitive Training is probably most effective when the intervention specifically supports frontal mediation activity and facilitates primarily compensatory adaptation in the brain according to the direction of indigenous adjustments in the aging brain.

Cognitive Remediation

Cognitive remediation is a therapy that uses set of techniques designed to teach 'thinking skills' that can be thought as a form of cognitive rehabilitation. This involves training in a set of tasks that are designed to improve cognitive abilities and social functioning. The domain targeted depends upon client needs, but might include attention, working memory, planning, and executive function. However, CRT has been studied most often in schizophrenia/psychosis, but also in other conditions such as anorexia nervosa. Schizophrenia patients mainly show cognitive deficits in executive functioning, verbal fluency, and distractibility (Wykes and van der Gaag, 2001). Whereas, patients with anorexia nervosa have difficulties in set shifting tasks which are believed to correspond to cognitive inflexibility/rigid thinking that is seen in these patients group (Tchanturiaet al., 2007).

Cognitive Remediation mainly focuses on global cognitive training (e.g., theater training) or particular cognitive competencies (e.g. memory) and uses different techniques/methods of intervention, such as paper and pencil exercises, group activities, workshops, video, or computers (Vance, 2009; Vance et al., 2010). Based on a neuropsychological approach, this cognitive intervention uses a set of exercises to maintain, ameliorate, or mitigate the loss of cognition or abilities in the elderly (Vance et al., 2009). Therapists propose this type of intervention for functional and social recovery, as well as competence development (Medalia et al., 2002; Medalia and Richardson, 2005; Medalia and Choi, 2009; Vance, 2009; Vance et al., 2009; Mowszowski et al., 2010; Lenze and Bowie, 2018).

Currently, most Cognitive Remediation programs use computerized tasks to train various cognitive functions, namely, attention, memory, processing speed, and executive function (Morimoto et al., 2014). Examples are the game exercises (Sweep Seeker, Bird Safari, Target Tracker, Master Gardener, and Double decision) from the ACTIVE study (Vance et al., 2017), Mindfit (Verghese et al., 2010), and PSSCogRehab (Choi et al., 2018). Only two of the included studies followed a pre and post-test design, including cognitive-behavioral therapy and attention process training (not using computerized tasks), applied to participants with PD (Mohlman et al., 2011; Mohlman et al., 2017).

Besides the elderly, Cognitive Remediation has also been used in psychiatric populations (e.g., schizophrenia). In this case, this intervention is applied according to different theoretical perspectives, often in conjunction with psychosocial interventions or complementary to pharmacological treatment (Morimoto et al., 2012).

Cognitive Activation

Contrary to Cognitive Remediation, the Cognitive Activation intervention is directed to healthy individuals or individuals with MCI who are autonomous and functional. Thus, therapists are not mandatory for its administration, as computer tasks are used. Moreover, there is no group intervention, and the transfer of cognitive gains to the functioning of ADL is not expected (Lenze and Bowie, 2018). Actually, the main aim of Cognitive Activation is to maintain the users' functioning. However, for this review, we have emphasized very few results of this type of intervention on relevant literature.

Cognitive Training

Cognitive Training involves the guided practice and repetitive training of cognitive functions using either computerized or paper and pencil methods. These cognitive intervention aims both to improve cognitive deficits (Duda and Sweet, 2020) and to identify, track, and monitor the user's cognitive performance (Clare et al., 2003; Clare and Woods, 2004; Eckroth-Bucher and Siberski, 2009; Zelinski, 2009; Mowszowski et al., 2010; Steinerman, 2010; Bahar-Fuchs et al., 2013; Kueider et al., 2014; Chaikham et al., 2016; Lenze and Bowie, 2018; Gates et al., 2019). It has been used in persons with age-related cognitive decline (VanVleet et al., 2018), mild to moderate AD (Farina et al., 2006; Kanaan et al., 2014; Amieva et al., 2016; Giuli et al., 2016; Nousia et al., 2018; Liang et al., 2019), and loss of functionality or mild to moderate dementia, which may include structured weekly training facilitated by a therapist (De Luca et al., 2016).

Cognitive Training essentially trains specific rational functions, such as memory, executive functioning, processing speed, language and attention, through repetitive training, in older adults with or without cognitive impairment (Auffray and Juhel, 2001; Clare et al., 2003; Günther et al., 2003; Clare and Woods, 2004; Barnes et al., 2009; Eckroth-Bucher and Siberski, 2009; Irigaray et al., 2011; Zelinski et al., 2011; Cheng et al., 2012; Herrera et al., 2012; Irigaray et al., 2012; Bahar-Fuchs et al., 2013; Ball et al., 2013; Garcia-Campuzano et al., 2013; Naismith et al.,

2013; Netto et al., 2013; Rebok et al., 2013; Kanaan et al., 2014; Peña et al., 2014; Rebok et al., 2014; Nouchi et al., 2016; Lee et al., 2018; Marusic et al., 2018; Smith et al., 2018; Gates et al., 2019; Matysiak et al., 2019). Previously, Kim and Kim (2014) or Thompson and Foth (2005) in most of there studies focus on memory training because problems in this cognitive domains are the most prominent concerns in the elderly.

A significant part of the studies in this review (**Supplementary Appendix S1**) used computerized programs to train various cognitive functions in older adults with or without cognitive alterations. Souders et al. (2017) applied the Mind Frontiers Game to 60 healthy older adults to train general reasoning, spatial reasoning, planning, processing speed, task switching and working memory. Similarly, Whitlock et al. (2012) applied the game World of Warcraft to 39 older adults to train spatial ability, executive function, and memory to detect an improvement in the intervention group's attention. Furthermore, Basak et al. (2008) designed a video game (Rise of Nations) to train executive control functions (switching, inhibition, reasoning, working memory, short-term memory) in 40 older adults and achieved an improvement in the executive control functions. Simpson et al. (2012) also applied computerized Cognitive Training (www.mybraintrainer.com) to 34 healthy older adults, using a randomized, single-blind design with a 3-week follow-up period, and observed an improvement in reaction time, choice reaction time, and processing speed in the intervention group.

Several studies focused on the applicability of TV (Nouchi et al., 2019) and tablet-based Cognitive Training programs, either in healthy older adults (Vaportzis et al., 2017) or older adults with cognitive impairment. For example, Savulich et al. (2017) applied the Game Show to 21 older adults with MCI using a tablet and observed an improvement in episodic memory and visuospatial capacity, besides high levels of enjoyment and motivation. Chan et al. (2016) and Binder et al. (2016) also used a tablet to train cognitive functions of older adults, such as processing speed, visuospatial processing, attentional and mental control, episodic and working memory, and executive functions, and achieved an improvement in processing speed and episodic memory but no differences in mental control and visuospatial processing.

In turn, González-Palau et al. (2013) and Gonzá lez-Palau et al. (2014) used the GRADIOR software in a sample of older adults with MCI compared to healthy older adults to train perception, attention, episodic memory, and working memory. The users showed good usability and satisfaction with the intervention platform, improved verbal memory and attention, and reduced depressive symptomatology. In the same line, Fellman et al. (2020) used an internet-based platform to apply a Cognitive Training program focused on working memory in a sample of older adults with PD and verified improved working memory and reduced depression. Navarro et al. (2009) used the software How to Improve Your Mental Skills in healthy older adults to train memory and other cognitive functions and observed improved memory scores.

Other studies reinforce the use of Cognitive Training to address other cognitive domains of older adults at risk of cognitive decline. Maseda et al. (2013) developed a study on the efficacy of a Cognitive Training application (Telecognition) involving older adults with and without memory impairments. That application focused on memory, attention, language, calculation, abstract reasoning, perception, orientation and praxis. The results showed improvements in global cognitive, episodic memory, visuospatial, and verbal fluency skills on post-intervention patients without significant memory deficits. The same program was also used in older adults to address cognitive function and depressive symptomatology (Millán-Calenti et al., 2015), revealing improvement in overall cognitive functioning.

Several studies evaluated the BrainFitness program in older adults for the training of attention, working memory (Leung et al., 2015), executive function (Gooding et al., 2015) and processing speed (Smith et al., 2018; Valdés et al., 2019). Other computer-based training programs, such as CogniFit, SmartBrain, Cogmed, Lumosity, and COGPACK, have also been used to train the same cognitive functions (working memory, attention, memory and processing speed) in samples of healthy older adults (Gigler et al., 2013; Shatil, 2013) and older adults with PD (Paris et al., 2011), MCI (Belleville et al., 2006; Finn and McDonald, 2011; Vermeij et al., 2016), or subjective memory complaints (Frankenmolen et al., 2018).

Several studies applied Cognitive Training in older adults using several computerized tasks (examples are Borella et al., 2010; Wang et al., 2011; Zajac-Lamparska and Trempała, 2016; Bellander et al., 2017; Buitenweg et al., 2017; Golino et al., 2017; Grönholm-Nyman et al., 2017; Reijnders et al., 2017; Goghari and Lawlor-Savage, 2018; Withiel et al., 2019; Brum et al., 2020). Also, the results of a randomized controlled trial that included both behavioral interventions and computerized tasks—the ACTIVE Study (some examples: Ball et al., 2002; Margrett and Willis, 2006; Willis et al., 2006; Wolinsky et al., 2006; Wolinsky et al., 2009; Ball et al., 2010; Gross et al., 2011; Jones et al., 2013; Rebok et al., 2013; Sisco et al., 2013; Rebok et al., 2014; Ross et al., 2016; Ross et al., 2017; Ross et al., 2018) revealed that successful performance in daily tasks depends on executive function (Gross et al., 2011).

On the other hand, several studies applied Cognitive Training with paper and pencil or non-computerized tasks in older-adult samples with or without cognitive impairment. Some studied the Cognitive Training effects on global cognitive function in healthy older adults, which is often measured by tests that assess multiple cognitive domains (Park et al., 2009; Kwok et al., 2013; Chen et al., 2018; Rizkalla, 2018), while others focused on specific cognitive functions such as attention, working memory, language, executive functions, reasoning and visuospatial construction (Irigaray et al., 2011; Cheng et al., 2012; Irigaray et al., 2012; Jackson et al., 2012; Carretti et al., 2013; Netto et al., 2013; Feng et al., 2014; Li et al., 2016; Lopes and Argimon, 2016; Nouchi et al., 2016; Cantarella et al., 2017; Kuo et al., 2018; Rizkalla, 2018; Tagliabue et al., 2018). Regarding older adults with MCI, interventions not using computerized tasks were also focused either on global cognitive functioning (Rojas et al., 2013; Cohen-Mansfield et al., 2015; Sukontapol et al., 2018) or specific cognitive domains such as attention, memory (Cohen-Mansfield et al., 2015), language (Yan et al., 2016) and executive functions (López-Higes et al., 2018a; López-Higes et al., 2018b; López-Higes et al., 2018). In the same line,

Petrelli et al. (2014) and Petrelli et al. (2015) tested the NEUROvitalis program and Peña et al. (2014) the REHACOP Cognitive Training program in older adults with PD, and both found evidence of benefits in terms of memory.

Studies on Cognitive Training have significantly increased the possibility of delaying, improving, or reversing physiological changes related to the aging process (Lustig et al., 2009; Brinke et al., 2018). However, the results of Cognitive Training are controversial, as they differ in terms of transfer effects to ADL and gains in QoL and wellbeing. Gains in the global cognitive functioning are polemic and differ with the type of population studied. However, the transfer effect seems to depend on the training time (over 30 min), its frequency (limited to one to three times a week) (Lampit et al., 2015), the age of the participants and the type of tasks (attention and working memory) (Zajac-Lamparska and Trempała, 2016). Cognitive Training may become more efficient or effective when other components satisfy compensatory function needs (Kim and Kim, 2014), as it is not always enough on its own for older adults.

Enrichment

Some studies report the positive effect of an active lifestyle on improving overall cognitive functioning (Küster et al., 2016) in older adults without cognitive impairment or with MCI (Park and Park, 2018) and subjective memory impairments (McEwen et al., 2018). Enrichment refers to all activities (e.g., activity/cognitive, social, and physical stimulation) with a positive impact on cognitive functioning that enhance cognitive enrichment. It also comprises the implementation of motor, sensory, and cognitive stimuli in the person's environment (Hertzog et al., 2008; Steinerman, 2010; Patel, 2012).

Different Enrichment methods are described in the literature. Linde and Alfermann (2014) developed an Enrichment intervention combining physical activity and cognitive intervention in healthy older adults. Brinke et al. (2018) applied the Fit Brains Program to older adults who received fit cognitive training, exercise and a combination of both. In the same line, Eggenberger et al. (2015) implemented a multicomponent physical exercise with simultaneous cognitive training of executive functions, episodic memory and processing speed in older adults. In turn, Best et al. (2018) combined physical, social, and cognitive enrichment using the Lumosity training program to improve cognitive function in chronic stroke. Candela et al. (2015) also applied physical activity together with the training of long-term memory and selective attention. Finally, Kalbe et al. (2018) used a specific approach involving cognitive training and physical activity with group counseling.

Enrichment can be implemented as a potential treatment for neurodegenerative diseases (Patel, 2012), after stroke (Best et al., 2018), or after traumatic brain injury (Bondi et al., 2014). Because this approach provides cognitive and physical stimulation at home, it favors an enriching environment for patients, benefiting their recovery. The older adults' individual cognitively enriched behaviors (cognitive activity, physical exercise, among others) significantly impact their cognitive functioning improvement (Hertzog et al., 2008; Schmiedek et al., 2010).

Cognitive Stimulation

Another technique that prevents cognitive decline is Cognitive Stimulation, which involves engaging in activities (e.g., puzzles) to improve general and social cognitive functioning (Woods et al., 2012). This approach includes multiple group activities under a social environment and multisensory stimulation (Clare and Woods, 2004; Eckroth-Bucher and Siberski, 2009; Mowszowski et al., 2010; Steinerman, 2010; Gates and Sachdev, 2014; Kim and Kim, 2014; Kueider et al., 2014).

While Cognitive Training focuses on specific cognitive domains, Cognitive Stimulation consists of engaging patients in non-specific activities to produce improvements in general mental functioning (Miranda-Castillo et al., 2012; Bahar-Fuchs et al., 2013; Herrera et al., 2017). For example, in a population with AD, the first method aims to improve, or at least maintain, cognitive and social function, while the second tries to reduce cognitive impairment (Clare and Woods, 2004; Mowszowski et al., 2010; Kueider et al., 2014). In terms of results, a meta-analysis (Liang et al., 2019) confirmed that Cognitive Training is the ideal cognitive intervention to reduce cognitive decline in people with AD, while another meta-analysis (Lin et al., 2013) concluded that Cognitive Stimulation improves the global cognitive functioning in 6–12 months in people with mild cognitive deficit or dementia.

Cognitive stimulation is applied using both computer-based and other cognitively stimulating activities (e.g., museum visits). The literature shows the usefulness of mobile applications like iBeni (Martínez-Alcalá et al., 2018), the tablet application Stim'Art (Yasini and Marchand, 2016), or video game devices such as Actively Station (Ordonez et al., 2017) and Wizard-of-Woz (Dethlefs et al., 2017) in older adults. For persons with mild to moderate cognitive impairment, the Cognitive Stimulation KODRO software can be useful to train global cognitive function, executive functions, language, working memory, processing speed, and attention (Malvy, 2016; Djabelkhir et al., 2017; Djabelkhir-Jemmi et al., 2018). Other examples using this type of intervention are the Bike Labyrinth interactive virtual bike tours, used by Karssemeijer et al. (2019) in older adults with dementia, or the Road Sign Test computer training focused on processing speed in people with MCI (Valdés et al., 2019).

In turn, most Cognitive stimulation studies that did not include computerized tasks found gains on several cognitive domains in healthy older adults (Tranter and Koutstaal, 2008; Ferná ndez-Prado et al., 2012; De Oliveira et al., 2014; Suzuki et al., 2014; Zimmermann et al., 2014; Zon et al., 2016; Grimaud et al., 2017; Herrera et al., 2017; Young, 2020) and older adults with mild to moderate dementia (Spector et al., 2003; Woods et al., 2006; Moro et al., 2012; Yamanaka et al., 2013; Moro et al., 2015; Capotosto et al., 2017; Piras et al., 2017; Stewart et al., 2017; Young et al., 2019). This intervention has also been proved to reduce cognitive decline in people with AD (Vidovich et al., 2011; Miranda-Castillo et al., 2012). Other improvements were observed in apathy and depression symptomatology (Niu et al., 2010) and conversation and communication skills (Spector et al., 2010).

Cognitive Stimulation has also been combined with physical activity. Dannhauser et al. (2014) found that this combination benefited the working memory, physical health, and fitness of older adults with MCI. Thiel et al. (2012) demonstrated that

Cognitive Stimulation and physical activity might prevent age-related cognitive decline.

These positive results can be explained by the fact that Cognitive Stimulation has excellent adherence and completion rates, reasonable costs and high experiential relevance to participants, as confirmed by Alves et al. (2014) in a study involving older adults with cognitive impairment. However, Cognitive Stimulation components are controversial among authors. On one hand, Kim and Kim (2014) reported that Cognitive Stimulation includes visual, sensory, auditory, motor or social, and deep brain stimulation. On the other hand, other authors (Clare and Woods, 2004; Mowszowski et al., 2010; Steinerman, 2010; Kueider et al., 2014) describe it as involving social activities aimed to reduce cognitive decline (Newson and Kemps, 2006), improving cognitive functioning, health and well-being (Tranter and Koutstaal, 2008; Yuill and Hollis, 2011; Woods et al., 2012; Toh et al., 2016; Castel et al., 2017). Others yet report that Cognitive Stimulation can facilitate the preservation of cognitive functions, improve them with a purpose (e.g., improving attention to improve driving), or reduce the effects of aging in neurological patients (Bigand and Tillmann, 2015; Capotosto et al., 2017; Djabelkhir et al., 2017; Martínez-Alcalá et al., 2018; Rosell, 2018). This intervention also provides a non-pharmacological approach for the recovery of brain and motor functions after a disease or brain injury (Bigand and Tillmann, 2015).

Brain Training

Brain Training is usually based on repeatedly using programs ("brain games") focused on performance in cognitive tasks over a period of time to improve cognitive deficits. This type of intervention should include ADL such as video games, music, computerized training, or physical exercise (Rabipour and Raz, 2012; Heugten et al., 2016; Simons et al., 2016).

Some studies used Lumosity, a Brain Training platform, for the training of several cognitive domains. Ballesteros et al. (2015) and Ballesteros et al. (2017) conducted two studies focused on the effects of video games on the training of a set of cognitive functions in healthy older adults and observed improvements in the trained group in attention, working memory, processing speed, visual recognition memory, and well-being, compared to a control group. Mayas et al. (2014) also used Lumosity with older adults to train problem-solving, mental calculation, working memory, attention and confirmed the game training effects on reducing distraction and improving alertness. In turn, Nouchi et al. (2012) covered the effects of video game training with Brain Age and Tetris on executive functions and processing speed in a sample of older adults, and their results indicated transfer effects of the Brain Training game in the same cognitive domains.

Van de Ven et al. (2017) used several computerized tasks in older adults with cognitive impairment targeting executive functions, attention, reasoning, and psychomotor speed (www.braingymmer.com). Two other studies have used the Nintendo DS video games in older adults as a Brain Training method (Power et al., 2011; McDougall et al., 2012).

For some authors (McDougall and House, 2012), the older adults who benefit from Brain Training show improved perception of their cognitive functioning and QoL. However, even though there is evidence that Brain Training plays an important role in the improvement of cognitive functions, this intervention alone has no potential to achieve rehabilitation goals (namely, in functional terms) and should only be offered in combination with neuropsychological rehabilitation programs (Heugten et al., 2016).

Throughout our review, we found that the concept of Brain Training seems to be used more commercially and some researchers call it "cognitive training" (e.g., Buitenweg et al., 2017).

Cognitive Rehabilitation

Cognitive Rehabilitation is defined as a systematic and multidisciplinary process oriented to therapeutic activities. It can follow different approaches, namely: reinforcement and reestablishment of behavior patterns; creation of new patterns of cognitive activity through the compensation of neurological deficit mechanisms, and training of compensation strategies involving the learning of cognitive skills, memory techniques, problem-solving, concentration, and critical thinking; establishment of external compensation mechanisms or environmental structuring; and adaptation and understanding of current cognitive deficits (Cicerone et al., 2000).

This intervention is an individualized approach, i.e., developed based on each user's goals, with a comprehensive view of individual difficulties (cognitive deficits, functional and behavioral problems, and real life). The planning and implementation of Cognitive Rehabilitation involve the person with the cognitive deficit, their family members, and a team of health professionals (Cicerone et al., 2000; Wilson, 2002; Clare et al., 2003; Mowszowski et al., 2010; Steinerman, 2010; Bahar-Fuchs et al., 2013; Kueider et al., 2014).

Cognitive Rehabilitation can be focused on several cognitive domains, namely attention, concentration, memory, perception, communication, reasoning, and planning (Cicerone et al., 2000; Stuss et al., 2007). It can be computer-based or administered in a paper and pencil format (LoPresti et al., 2004; Maggio et al., 2018). Cognitive Rehabilitation has different general objectives than Cognitive Training, despite having the same approach (e.g., teaching problem-solving strategies). Specifically, Cognitive Rehabilitation uses a compensatory approach, adjusted to each person's goals, with an intervention aiming to improve cognitive and everyday life functioning both functional and behavioral.

Cognitive Rehabilitation has been applied in a very wide range of populations, such as patients with acquired brain injury for remediation of cognitive deficits (Cicerone et al., 2000; Cicerone et al., 2005; Gordon et al., 2006; Rees et al., 2007; Rohling et al., 2009), older adults with AD (Loewenstein et al., 2004), older adults with mild cognitive deficits (Mansbach et al., 2017), and older adults with dementia (Clare et al., 2019).

Regarding the population with cognitive deficits, Vanova et al. (2018) conducted a randomized controlled trial with follow-up involving adults with MCI and mild dementia who completed a computer and internet-based program (GRADIOR and ehcoBUTLER) and observed an improvement in cognition, mood, QoL, ADL, and quality of patient-career relationship. Jelcic et al. (2014) applied the same intervention adding teleconference technology (Skype) in older adults with AD

compared to a group that had face-to-face/conventional rehabilitation and a third control group that underwent face-to-face unstructured Cognitive Stimulation (e.g., practicing manual skills, reading the newspaper), and concluded that Cognitive Rehabilitation via teleconferencing improved the global cognitive functioning and language (phonemic and semantic) of people with AD. In turn, Mansbach et al. (2017) applied a computer-assisted online Cognitive Rehabilitation module (Memory Match) to 43 older adults with mild cognitive deficits and achieved an improvement in global cognition, attention, and memory in the intervention group. Another study by Kurz et al. (2009), involving older adults with MCI and AD, comprised diverse Cognitive Rehabilitation activities, namely relaxation techniques, activity planning, self-assertiveness training, stress management, external memory aids, memory training, and motor exercises.

Fasilis et al. (2018) applied a virtual environment (Main Tasks) to a group of older adults with mild dementia to train working memory, attention, problem solving, motivation, organization, impulsivity and found a relative improvement in cognitive variables. Another study by Maggio et al. (2018), with a sample of older adults with PD, used a semi-immersive therapy (virtual scenarios) system for motor and Cognitive Rehabilitation of patients with neurological diseases—BTS Nirvana—and achieved greater improvement at cognitive functioning, executive, and visuospatial abilities.

In the healthy population, Levine et al. (2007) applied a Goal Management Training program to simulate real-life tasks in healthy older adults, and the results showed an improvement in performance and self-rated executive. Craik et al. (2007) applied a program for memory training to healthy older adults that did not include computerized tasks, and there were no effects of training on working memory, primary memory, and recognition memory.

CONCLUSION

To our knowledge, this is the first study to identify the various existing definitions, methods, and procedures, as well as the overlapping information regarding the cognitive intervention known including their discrepancies. This literature review aimed to discuss and characterize different types of cognitive intervention in older adults commonly reported in the relevant literature and determines what main factors may contribute to their efficacy and inefficacy. We have also seen some weaknesses in this field. Most of the studies considered (**Supplementary Appendix S1**) using computer-based training interventions for both healthy and neurocognitive disorders older adults, mild to moderate cognitive impairment, AD, or dementia. However, several studies did not include computerized tasks in the interventions involving healthy older adults and older adults with AD, PD, neurocognitive disorders, mild to moderate dementia, or MCI.

We also concluded that the presented studies show heterogeneity of methods regarding sample size and characteristics, outcome domains, duration and content of the intervention, number of individual treatment sessions, control condition, and main intervention. Moreover, some studies confuse certain concepts; for example, use the concept of Cognitive Stimulation or Enrichment for Cognitive Training. This inconsistency does not allow a concrete definition of the most effective intervention, its durability and the best format for older adults. Thus, it is necessary to harmonize the methodology of intervention applied to the study population.

Our conclusions should be interpreted considering some limitations. Firstly, our research was restricted to electronic databases via EBSCO (although these are the most representative and significant in the field at hand). Secondly, our attempt to contact authors and experts to access some unavailable studies was not altogether successful, but we believe that this is unlikely to have determinatively influenced our findings. Lastly, due to rigorous research with strict inclusion/exclusion criteria, we gathered a restricted pool of analyzed papers (168 studies included from 641 full-text articles assessed for eligibility). Despite these limitations, the current review allows us to find some answers to our initial research questions.

We also consider that our main purpose was achieved since a conceptualization of cognitive interventions for healthy and older adults with several types of cognitive impairments was possible. Nevertheless, a few questions remain for additional research to further enhance this non-pharmacological approach involving the elderly. In future researches, we suggest a comprehensive view to discuss the methodology of each type of intervention presented in this research and subsequently demonstrate its results and efficacy (or not) in specific older-adult populations (e.g., healthy older adults, people with different levels of cognitive decline), comparing different approaches, namely computer-based interventions and applications without computerized tasks. We also cogitate that additional studies are further needed that highlight the durability of the observed gains (or not), the transfer effects for daily functioning and well-being, the probability and risk of developing cognitive morbidity.

AUTHOR CONTRIBUTIONS

LM and JO contributed to literature review and organized the database. LM wrote the first draft of the manuscript. LM, JO, FB, and MC-B contributed to manuscript revision, read, and approved the submitted version.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fragi.2022.844725/full#supplementary-material

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