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The Use of Distraction to Improve Episodic Memory in Ageing: A Review of Methods and Theoretical Implications

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Healthy ageing is characterized by changes in several cognitive functions, including episodic memory and inhibition. While the age-related decrease in the ability to inhibit irrelevant stimuli is often associated with lower performance, especially in episodic memory, some studies have highlighted the boosting effect of distraction in several tasks in older adults, including episodic memory tasks related to recollection. The aim of this article is to review and compare previous studies according to specific study features and to consider the results in light of the dual-process model of recollection and familiarity that were used by the authors of the reviewed articles. This work led to the identification of two major points of comparison between the studies: the timeline of the distraction intervention and the implicit nature of the processes at play, which both allowed for different implications to the relationship with recollection. The use of distraction in memory tasks can enhance episodic memory, and especially recollective processes, due to specific actions at encoding and retrieval. These findings open the door to further investigations but also raise several questions concerning the role of implicit processes and the negative impact of distraction, for example.

Public Significance Statement

The process of ageing comes with many changes that may cause people to experience decreased cognitive abilities. Nonetheless, studies have shown that some age-related characteristics can lead older adults to have as good a performance as younger adults. Here, we consider the sensitivity to distractors that can promote better encoding in memory, especially in older people. Our review describes characteristics that need to be studied and included into larger cognitive theories in order to reach a better understanding of ageing processes and develop relevant intervention programmes.

Keywords: episodic memory, inhibition, distraction, ageing, cognition

Ageing is accompanied by several cognitive changes (for a review, see Drag & Bieliauskas, 2010), mainly affecting memory and executive functions. In the memory field, while episodic memory (memory for personal events) shows an age-related decrease (Koen & Yonelinas, 2014), other types of memory, for instance semantic memory (memory for facts), are better preserved (Drag & Bieliauskas, 2010). However, even among the components of episodic memory, some specific substages and processes decline less than others. Specifically, the age-related decline in episodic memory seems to depend on the type of task administered. For instance, it is greater in free recall tasks than recognition tasks (Rhodes et al., 2019), in associative memory than item memory (Old & Naveh-Benjamin, 2008), and in intentional than incidental encoding (Old & Naveh-Benjamin, 2008). These different age-related memory issues can be explained by dual-process memory models, among others (for review, see Bastin et al., 2019; Yonelinas, 2002). Although some single-process theories such as signal detection theory (for a summary of evidence for both theories, see Hayes et al., 2017; Rotello, 2017) may account for this phenomenon, authors of the reviewed articles typically relied on dual-process theory when they hypothesized about the mechanisms at play, which is why we will also use this theoretical framework to discuss the results.

According to these models, information in episodic memory can be retrieved via two distinct processes: recollection (i.e., recall of specific details from the encoding episode) and familiarity (i.e., knowing of previous encounter without explicitly remembering the context of encoding). Ageing is accompanied by a significant decrease in recollection, whereas familiarity is better preserved (Friedman, 2013), even though a decrease can also affect familiarity under certain methodological conditions (for a review, see Koen & Yonelinas, 2014). Rhodes et al. (2019) interpreted the different patterns of age-related differences in recognition and recall as due to decreased recollection but mostly intact familiarity,

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which can support recognition memory alone. Similarly, Old and Naveh-Benjamin (2008) argued that item recognition memory might require only familiarity, while associative memory tasks also require recollection.

Memory is not the only cognitive domain that is affected by age. A decrease in executive functions is also observed in ageing (Campbell et al., 2020; Drag & Bieliauskas, 2010). Each executive function has its specific characteristics and is differentially impacted by age. Decline in one function is especially prominent and of particular interest here: inhibition, including deletion of distracting information. Lustig et al. (2006) showed that older adults performed slower and more variably in attentional tasks in a condition with high distraction than in a nondistracting condition, while no such difference was observed in younger adults. They explained the effect as being due to difficulty inhibiting irrelevant information. In general, reducing distraction enhances performance in a wide variety of cognitive tasks (for a review, see Amer et al., 2016). According to a recent review by (Campbell et al. 2020), although they can be moderated by various factors (e.g., motivation and time of testing), age-related differences in inhibition are now well-established.

Following MacLeod's (2007) taxonomy pointing out that the term « inhibition » can refer to two different concepts—that is, the behavioural inability to retrieve information versus a cognitive process used to ignore irrelevant elements from the stream of information (Anderson, 2003)—here, inhibition should be understood as a cognitive process rather than a pattern of results.

We argue that irrelevant stimuli lead to interference more in healthy older adults (HOAs) than in younger ones, as a consequence of a decrease in cognitive control (i.e., inhibition). However, surprisingly, there may be situations in which the decrease in inhibition skills can help, support, and even enhance other cognitive functions. According to Weeks and Hasher (2014), the positive or negative effects of distractors might depend on the congruence of the distractors with the task to be performed. Indeed, distractors might have a facilitating effect on memory performance in ageing when they are congruent with the target material and a debilitating effect when they are incongruent and thus create interference. By congruent, the authors mean a semantic link between the distractor item and the background information that is the focus of the task, which could be the word "animal" superimposed on a picture of a lion, for example. Conversely, an incongruent situation would be the word "spoon" being superimposed on a picture of a car. Campbell et al. (2020) describe this effect as due to age-related differences in the "deletion" component of inhibition, which enables people to inhibit irrelevant information and no longer relevant information. Since age brings about a decrease in the ability to use deletion, distractors affect older adults more than younger ones and thus can be used more easily in subsequent tasks. Importantly, some reviews have tackled the role of distraction when evaluating episodic memory. For example, Amer et al. (2016) described cognitive control as a "double-edged sword" in ageing, since reduced cognitive control leads to greater attention to distractions in the environment and can enhance performance when distractors are relevant (see also Brédart, 2019). Along those lines, several studies have explicitly investigated the impact of relevant distractors on memory performance and have provided evidence of the specific boosting effects of distraction on cognition (Campbell et al., 2020).

Still, the interpretation of some key empirical findings is unclear and need to be clarified. For instance, the implications of the methodological choices and theoretical frameworks of the studies that used distraction as a mean to enhance episodic memory should be considered, as they may affect the validity of their results. Moreover, if a lack of inhibitory control has a beneficial effect on memory for associations, it contradicts the associative deficit hypothesis (Naveh-Benjamin, 2000). However, if verified, perspectives for intervention programmes, whether in healthy ageing or in cognitively impaired patients could be built on this model. Hence, this article reviews studies conducted in the past few years that used distractors as future targets to be evaluated for memorization in a population of older adults. More specifically, our goal is to provide an overview of the methods used, the main results obtained, and the implications these studies may have. Indeed, at the theoretical level, there is a need to understand the processes underlying previous findings and link them to memory models to provide a solid background for the phenomenon and extrapolate its applicability to larger populations.

Methodology

Research Question

The aim of this targeted nonsystematic review is to determine whether the use of distraction in episodic memory is effective to boost recollection and to reduce forgetting in older adults (healthy, mild cognitive impairement [MCI], and Alzheimer disease [AD]). Given that few studies examined this link directly, our broader research question was what is the impact of tasks using distractors as memory targets (i.e., items that need to be suppressed from processing to perform a given task because they may act as an interference) on episodic memory processes?

Search Strategy

The database search was processed in November 2020. The literature was browsed through three databases: PsycINFO, MEDLINE, and Scopus for articles published until November 2020. These databases were searched using specific keywords. The keywords were chosen based on two criteria. First, we determined the required keywords from the research question (memory or episodic memory or associative memory or associative learning or recollect* or forget* and distract* or inhibition and Alzheimer or Mild Cognitive Impairment or aging or older adult*, i.e., adults aged 65 and older). Second, some keywords were identified based on existing literature on the subject (hyper-binding). These keywords were encoded into the database using text words only for Scopus and a mix between text words and controlled vocabulary for MEDLINE and PsycINFO (for details about our research strategy, see the Appendix). Additionally, we examined the articles cited in the selected articles.

Selection Criteria

All titles, abstracts, and articles were read and selected by the first author (Manon Demonty) and checked again by Marie Geurten using her own research strategy. Thus, the articles were not analyzed using double-blind methods. Only peer-reviewed articles were included. Other types of documents were excluded (e.g., books, dissertations). The articles that included any other type of population than the one of interest (i.e., older adults with or without MCI or AD) or that addressed any other type of memory than episodic memory (e.g., working memory) were also excluded. After that, the abstracts were read, and the articles were selected if they took the form of an experiment (reviews or meta-analyses were excluded), if they addressed episodic memory and the appropriate population and if they actually used distractors as future targets in their design. Finally, articles that measured the effect of distraction on memory, but did not evaluate memory performance for the items that were used as distractors were also excluded. In sum, we followed all steps of a systematic review except that we did not use double-blind methods for articles screening and data extraction and only included studies conducted in normal ageing or in MCI or AD patients, making our article a target review (Page et al., 2021).

Search Results

The result of our screening and selection procedure is illustrated in Figure 1. In total, the whole search process yielded 15 articles. Thirteen of them were found through our research strategy and two were added based on cited articles. All articles are summarized in Tables 1–3, and we will now discuss their findings.

Among the reviewed studies, we identified two different timelines for presenting a distraction task as part of a larger task: at encoding (i.e., the encoding phase takes the form of a distraction task) and after encoding (the distraction task happens after encoding, as an incident processing). To support a clearer understanding of the processes at play and the methodological challenges of such tasks, we considered these two classes of studies separately, as they would probably lead to different hypotheses about processes (e.g., the impact of distractions on the different stages of episodic memory, namely encoding and retrieval). Furthermore, in both categories, a distinction was made between studies that used implicit (e.g., incidental encoding and retrieval such as a lexical decision task) versus explicit memory tasks (e.g., explicit encoding and retrieval such as free recall and old/new recognition), or a mix of both. The next sections will describe the general conclusions that can be drawn from previous studies and the methodological aspects that need to be taken into account.

Figure 1

Number of Articles Returned at Every Step of the Research Strategy

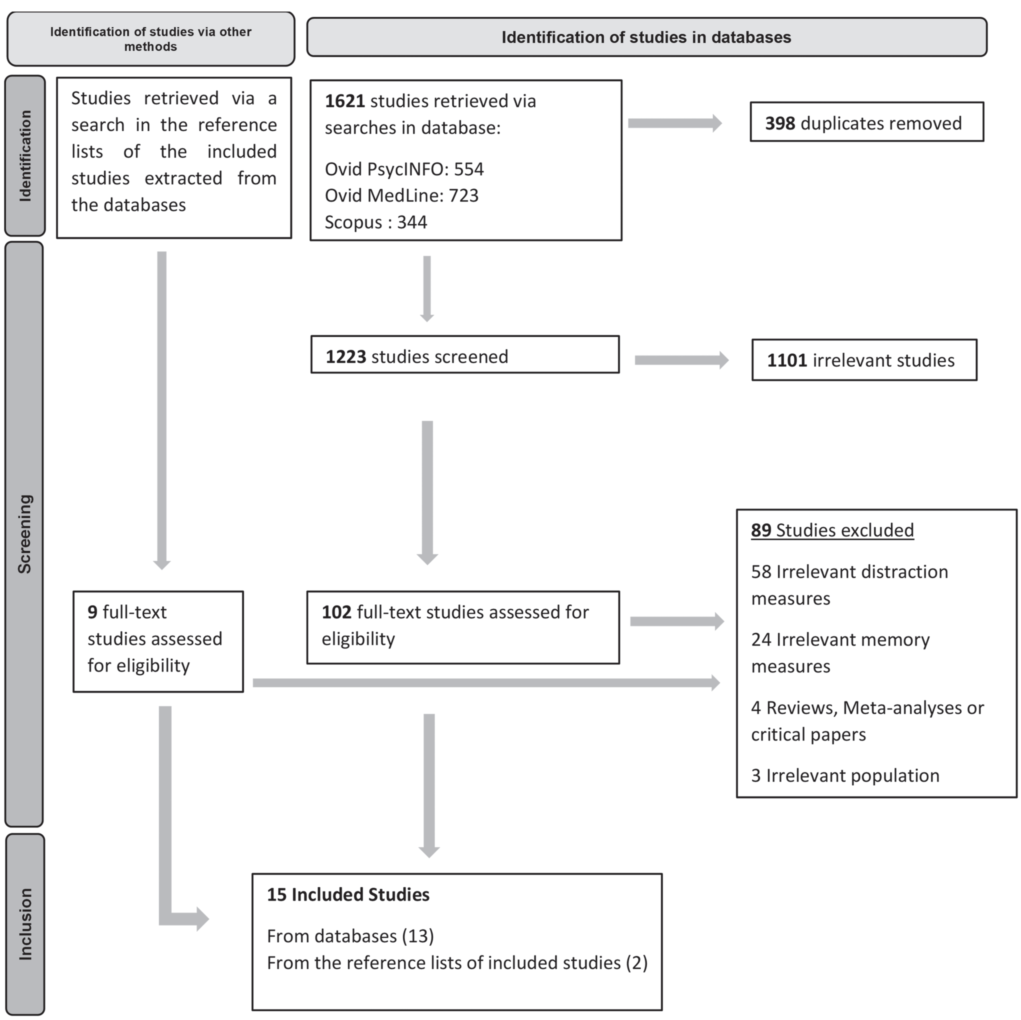


Table 1
Summary of Studies Using the Distracting Task as an Encoding Phase (With or Without Explicit Encoding) in One-Back Paradigms

Study (year)	Sample (size)	Type of distraction task	Memory task: Type	Memory task: Stimuli	Memory task: Tasks	Memory task: Measures	Results: Variable	Results: Effect size
Campbell et al. (2010), Experiment 1	Younger (n = 24), older (n = 24)	One-back	Associations (word–image)	27 images, 12 for memory and 15 for one-back only 52 words, 12 for memory and 40 for one-back only	Explicit encoding of associations/cued recall (immediate)	Number of recalled words according to age group (younger/older) and type of pairs (intact/rearranged/new)	Type Age × Type Older: type Younger: type	$\eta_p^2 = .15$ $\eta_p^2 = .07$ $\eta_p^2 = .29$ NS
Campbell et al. (2010), Experiment 2	Younger (n = 20), older (n = 20)	One-back	Associations (word–image)	34 images, 16 for memory and 18 for one-back only 34 words, 16 for memory and 18 for one-back only	Explicit encoding of associations/cued recall (immediate)	Number of recalled words according to age group (younger/older) and type of pairs (intact/rearranged)	Type Age × Type Older: type Younger: type	$\eta_p^2 = .20$ $\eta_p^2 = .11$ $\eta_p^2 = .38$ NS
Campbell et al. (2012)	Younger (n = 24), older (n = 24)	One-back (no explicit encoding, learning of statistical regularities)	Items (images)	30 images, six for practice, 24 critical, half red and half green, in fixed groups of three	Speeded detection task, images appearing in triplets as in the one-back, half attended colours and half unattended colours	Reaction times according to age group (younger/older), triplet position (first/second/third), and stream (attended/unattended)	Stream Stream × Triplet Position Age × Stream × Triplet Position	NS $\eta_p^2 = .06$ (NS) $\eta_p^2 = .06$ (NS)
Campbell and Hasher (2018), Experiment 1	Younger (n = 20), older (n = 20)	One-back	Associations (word–image)	34 images, 16 for memory and 18 for one-back only 34 words, 16 for memory and 18 for one-back only	Explicit encoding of associations/cued recall (immediate)	Number of recalled words according to age group (younger/older) and type of pairs (intact/rearranged)	Type Age × Type	$\eta_p^2 = .15$ $\eta_p^2 = .13$
Campbell and Hasher (2018), Experiment 2a	Younger (n = 20), older (n = 20)	One-back (aware of the connection with the one-back)	Associations (word–image)	34 images, 16 for memory and 18 for one-back only 34 words, 16 for memory and 18 for one-back only	Explicit encoding of associations/cued recall (immediate)	Number of recalled words according to age group (younger/older) and type of pairs (intact/rearranged)	Type Age × Type	NS NS
Gallant et al. (2020)	Younger (n = 55), older (n = 61)	One-back	Associations (word–image)	96 images 96 words (1/3 neutral, 1/3 negative, 1/3 positive) 96 pairs, 48 for memory and 48 for one-back only	Explicit encoding of associations/cued recall (immediate)	Number of recalled words according to age group (younger/older), valence of the words (negative/positive/neutral), and type of pairs (intact/rearranged)	Type Valence × Type Age × Valence × Type Neutral: Age × Type	$\eta_p^2 = .18$ $\eta_p^2 = .03$ $\eta_p^2 = .04$ $\eta_p^2 = .04$
Rowe et al. (2006)	Younger (n = 28), older (n = 32)	One-back	Items (words)	60 images for one-back 30 letter strings for one-back 20 words for one-back including 10 for word completion	Word-fragment completion task	Priming effect for critical words according to age group (younger/older) and time of testing (a.m./p.m.)	Age	$\eta_p^2 = .35$
Swirsky and Spaniol (2020)	Younger (n = 48), older (n = 48)	One-back with a control condition and a motivated condition (points to earn if correct answers)	Associations (face–name)	96 faces and names, including 16 critical pairs 96 trials divided into four blocks	Explicit encoding of face–name associations/cued recall (immediate)	Number of names recalled according to age group (younger/older), condition (control/motivated), and type of pairs (intact/rearranged)	Type Age × Condition × Type Older: Condition × Type Older, control: type Older, motivated: type	$\eta_p^2 = .07$ $\eta_p^2 = .13$ $\eta_p^2 = .19$ $\eta_p^2 = .52$ $\eta_p^2 < .01$

(*table continues*)

Table 1 (*continued*)

Study (year)	Sample (size)	Type of distraction task	Memory task: Type	Memory task: Stimuli	Memory task: Tasks	Memory task: Measures	Results: Variable	Results: Effect size
Weeks et al. (2016), Experiment 1a	Younger (n = 20), older (n = 20)	One-back	Associations (face–name)	34 younger faces and names, 34 older faces and names, each including 16 for memory, 18 for one-back only	Explicit encoding of face–name associations matching the participant's age range/ cued recall (immediate)	Number of names recalled according to age group (younger/older) and type of pairs (intact/rearranged)	Type Age × Type	NS $\eta_p^2 = .13$
Weeks et al. (2016), Experiment 2	Younger (n = 20), older (n = 20)	One-back	Associations (face–name)	16 younger faces and names, 16 older faces and names, each including eight for memory and eight for one-back only	Explicit encoding of face–name associations matching the participant's age range/ cued recall (immediate)	Number of names recalled according to age group (younger/older) and type of pairs (intact/rearranged)	Type Age × Type	$\eta_p^2 = .26$ $\eta_p^2 = .14$
Weeks et al. (2016), Experiment 3	Younger (n = 20), older (n = 20)	One-back	Associations (face–name)	16 younger faces and names, 16 older faces and names, each including eight for memory and eight for one-back only	Explicit encoding of face–name associations opposite to the participant's age range/ cued recall (immediate)	Number of names recalled according to age group (younger/older) and type of pairs (intact/rearranged)	Type Age × Type	$\eta_p^2 = .38$ $\eta_p^2 = .43$

Note. NS = Not Significant. Variables indicate the type of variable showing an effect, with "×" being a significant interaction between two variables, and ":" meaning an effect only for one parameter of the variable. "Type" indicates a difference in the type of tasks (implicit vs. explicit for most cases).

Distraction as an Encoding Phase

The studies considered in this section all have in common the fact that they used the distraction task as an implicit encoding phase whether or not it was later combined with an explicit study phase (see Figure 1). The stimuli used as distractors were irrelevant for the current task but would be relevant for the subsequent one. We will describe two main methods (one-back tasks and directed attention) and also mention studies using other original methods. Such timeline implies that some stimuli had to be ignored and suppressed from processing for the current task to be completed in the best possible manner (the "deletion" component of inhibition).

One-Back Tasks

In one-back tasks, participants saw a series of images and had to press a key whenever two identical images appeared consecutively. The distracting aspect of this task is the insertion of words superimposed over the images and the instruction to participants not to pay attention to those words. Nonetheless, the words or their associations with the images they appeared with would later be the subject of a memory task. Participants were not explicitly aware of the relationship between the one-back task and the main (memory) task. All the ageing studies that used this method and their results are summarized in Table 1.

In the case of associations, the efficiency of the one-back task to promote the encoding of pairs was measured by manipulating the matching of the pairs between the one-back task and the explicit encoding task. In general, half of the pairs to be studied were identical to those of the one-back task, and the other half were rearranged pairs composed of the individual items of the one-back task. A better memory for the intact pairs than the rearranged pairs was deemed to reflect an effect of the distraction task on associations (an example from Campbell et al., 2010, is shown in Figure 2). This task has been used in multiple studies with different types of materials (words and images, faces and names) and experimental manipulations. The main results indicated that, compared to young adults, older adults had a better memory for intact than for rearranged pairs (i.e., they performed better with pairs that were presented as distractors in the distraction task) at an implicit level, as in semantic judgement tasks (Davis et al., 2021), and at an explicit level in cued recall tasks (Campbell et al., 2020; Weeks et al., 2016). Alternatively, they sometimes showed a benefit at the item level in a subsequent task, such as a word-fragment completion task.

Studies that used one-back tasks as an opportunity to implicitly preencode associations supported the hyper-binding hypothesis in ageing (i.e., an emergent property of the loss of inhibition which would result in more information binding). According to Campbell et al. (2010), older adults implicitly created associations between the image (used as target for the one-back) and the word (used as distractor), most likely because of lower inhibitory control. Interestingly, hyper-binding is in opposition to the associative deficit hypothesis (Naveh-Benjamin, 2000), whereby older adults have trouble encoding and retrieving associations between items or between items and their context. The hyper-binding hypothesis suggests that associative memory per se is not compromised in ageing, given that older adults were able to encode associations in the one-back tasks, even without being aware of them. In a task using only images (half in red and half in green) in a one-back task,

Table 2

Summary of Studies Using the Distracting Task as an Encoding Phase in Paradigms Using Diverse Methods

Study (year)	Sample	Type of distraction task	Memory task: Type	Memory task: Stimuli	Memory task: Tasks	Memory task: Measures	Results: Variable	Results: Effect size
Davis et al. (2021), Experiment 1	Younger (n = 30), older (n = 30)	Semantic judgement	Associations (word–image)	76 images, four for practice, 72 divided into three groups for each condition (full binding of image and word, some binding with the word to be ignored, no binding without word) 72 words	Semantic judgement: "drawer fitting" of both the image and the word, some pairs intact, some rearranged, and some new when there was no word at encoding	Reaction times according to age group (younger/older), condition (no-binding/some binding/full binding), and pair type (intact/rearranged)	Pair type Condition × Pair Type Age × Pair Type Age × Condition × Pair Type	η_p^2 = .23 η_p^2 = .04 (NS) η_p^2 = .11 η_p^2 = .14
Davis et al. (2021), Experiment 2	Younger (n = 45), older (n = 45)	Semantic judgement	Associations (word–image)	76 images, four for practice, 72 divided into three groups for each condition (full binding of image and word, some binding with the word to be ignored, no binding without word) 72 words	Semantic judgement: "drawer fitting" of both the image and the word, some pairs intact, some rearranged, and some new when there was no word at encoding)	Reaction times according to age group (younger/older), condition (no-binding/some binding/full binding), and pair type (intact/rearranged)	Pair type Condition × Pair Type Age × Pair Type Age × Condition × Pair Type	η_p^2 = .03 (NS) η_p^2 = .04 η_p^2 = .03 (NS) η_p^2 = .04
James et al. (2016)	Younger (n = 22), older (n = 21)	Directed attention	Associations (images)	432 images, 288 at encoding and 144 as lures at retrieval Two associates (context items) with each image (colour and scene)	Recognition of individual images and of each context items, one attended to and one unattended	Context accuracy according to age group (younger/older), type of context (attended/unattended), and accuracy of the other feature (correct/incorrect)	Type Age × Type Age × Other Older adults: other Older adults: type	η_p^2 = .77 η_p^2 = .25 η_p^2 = .06 (NS) η_p^2 = .2 η_p^2 = .63
Kim et al. (2007)	Younger (n = 26), older (n = 26)	Text reading while ignoring italic words	Items (words)	Five texts Two sets of 16 words, half target (to be ignored) and half control (new)	Remote associates task (RAT)	Percentage of RAT problems solved according to age group (younger/older) and item type (target/control)	Age × Type Older: type Younger: type	η_p^2 = .1 η_p^2 = .22 NS
Powell et al. (2018)	Younger (n = 22), older (n = 21)	Directed attention	Associations (images)	432 images, 288 at encoding and 144 as lures at retrieval Two associates (context items) with each image (colour and scene)	Recognition of individual images and of each context item, one attended to and one unattended	Conditional context accuracy according to age group (younger/older) and target context probability (p [target correct/distractor correct]/p[target correct/distractor incorrect])	Probability Age × Probability	η_p^2 = .05 (NS) η_p^2 = .03 (NS)

Note. NS = Not Significant.

Table 3
Summary of Studies Using the Distracting Task as a Rehearsal of Preencoded Items/Associations in One-Back Paradigms

Study (year)	Sample	Type of distraction task	Memory task: Type	Memory task: Stimuli	Memory task: Tasks	Memory task: Measures	Results: Variable	Results: Effect size
Biss et al. (2013), Experiment 1a	Younger (n = 38), older (n = 40)	One-back	Items (words)	42 images for one-back 24 nonwords for one-back 28 words, 20 for memory and 8 for one-back only	Explicit encoding of words/immediate recall/delayed recall after one-back	Number of recalled words according to age group (younger/older), time of testing (immediate/delayed), and type of words (repeated/unrepeated)	Age × Time × Type Older: Time × Type Younger: Time × Type	$\eta_p^2 = .05$ $\eta_p^2 = .18$ NS
Biss et al. (2013), Experiment 2	Younger (n = 30), older (n = 30)	One-back with answers to every trial	Items (words)	42 images for one-back 24 nonwords for one-back 28 words, 20 for memory and 8 for one-back only	Explicit encoding of words/immediate recall/delayed recall after one-back	Number of recalled words according to age group (younger/older), time of testing (immediate/delayed), and type of words (repeated/unrepeated)	Age × Time × Type Older: Time × Type Younger: Time × Type	$\eta_p^2 = .09$ $\eta_p^2 = .15$ NS
Biss et al. (2013), Experiment 3	Younger (n = 36), older (n = 28)	One-back as the last step of the distracting interval	Items (words)	42 images for one-back 24 nonwords for one-back 28 words, 20 for memory and 8 for one-back only	Explicit encoding of words/immediate recall/delayed recall after one-back	Number of recalled words according to age group (younger/older), time of testing (immediate/delayed), and type of words (repeated/unrepeated)	Age × Time × Type Older: Time × Type Younger: Time × Type	$\eta_p^2 = .05$ (NS) $\eta_p^2 = .31$ $\eta_p^2 = .08$ (NS)
Biss et al. (2018)	Younger (n = 25), older (n = 32)	One-back	Associations (face–name)	56 faces, 24 for memory and 32 for one-back only 44 names, 24 for memory and 20 for one-back only 10 words and 10 nonwords for one-back	Explicit encoding of face–name associations/immediate cued recall/delayed cued recall after one-back/recognition (R/K)	Number of words recalled according to age group (younger/older), time (immediate/delayed of testing), and type of pair (repeated/unrepeated) Hits and false alarms R and K proportions	Recall—Age × Time × Type Older: delayed recall—type Younger: delayed recall—type Recollection—Age × Type Older: recollection—type Younger: recollection—type	$\eta_p^2 = .09$ $\eta_p^2 = .06$ NS NS $\eta_p^2 = .04$ NS
Biss et al. (2020)	Older (n = 18), aMCI (n = 18)	One-back	Associations (face–name)	56 faces, 24 for memory and 32 for one-back only 44 names, 24 for memory and 20 for one-back only 10 words and 10 nonwords for one-back only	Explicit encoding of face–name associations/immediate cued recall/delayed cued recall after one-back/recognition (R/K)	Number of words recalled according to group (HOA/aMCI), time of testing (immediate/delayed), and type of pair (repeated/unrepeated) Hits and false alarms R and K proportions	Recall—type Recall—Time × Type Recall—Group × Time × Type Recollection—type Recollection—Group × Type	$\eta_p^2 = .13$ $\eta_p^2 = .40$ NS $\eta_p^2 = .17$ NS

(table continues)

Table 3 (*continued*)

Study (year)	Sample	Type of distraction task	Memory task: Type	Stimuli	Tasks	Measures	Results: Variable	Effect size
Lourenço and Maylor (2015)	Younger (n = 57), older (n = 59)	One-back as encoding and rehearsal of prospective instruction	Items (words)	129 images for one-back, including two critical trials (prospective answer) 60 words for one-back including four critical lures (related to the prospective answer) 90 letter strings for one-back 120 words for lexical decision (4 critical lures and 4 words from one-back) 120 nonwords for lexical decision	Prospective memory (PM) task (in one-back) Lexical decision task (LD)	Proportion of correct responses to target pictures for the PM instruction according to age group (younger/older) and presence of critical lures (present/absent) Reaction times to the LD task according to age group (younger/older), presence of critical lures (present/absent) and word type (critical lure/one-back words)	PM: lures PM: Age × Lures LD: lures, type, interactions	$\eta_p^2 = .1$ NS NS

Note. NS = Not Significant; aMCI = amnesic mild cognitive impairment; HOA = Healthy older adult.

in which participants were asked to process only one of the two colours, Campbell et al. (2012) provided further evidence that older adults learned the statistical regularities (i.e., images always presented in groups of three) of the stimuli they were instructed to ignore (the nontarget colour) without showing negative effects on the stimuli they were to attend to (the target colour).

The hyper-binding effect has been replicated many times, but some studies showed that, under some circumstances, this effect may be reduced. For instance, Swirsky and Spaniol (2020) added a motivational condition (points to earn for right answers in the one-back task) to this task using face–name associations; this led to a reduction of the hyper-binding effect, suggesting a relationship between motivation and inhibitory control. Gallant et al. (2020) created words that were of positive, negative, or neutral valence and showed that the age-related hyper-binding effect only appeared for neutral pairs. The authors concluded that emotional distractors made the age-related hyper-binding effect smaller, likely because older adults are able to inhibit irrelevant emotional stimuli more than neutral words. Finally, Campbell and Hasher (2018, Experiment 2) showed that, when older adults were informed before the explicit encoding phase that some of the pairs had been presented in the one-back task, their memory performance for rearranged pairs was better and therefore there was a smaller hyper-binding effect (as measured by the difference between intact and rearranged pairs).

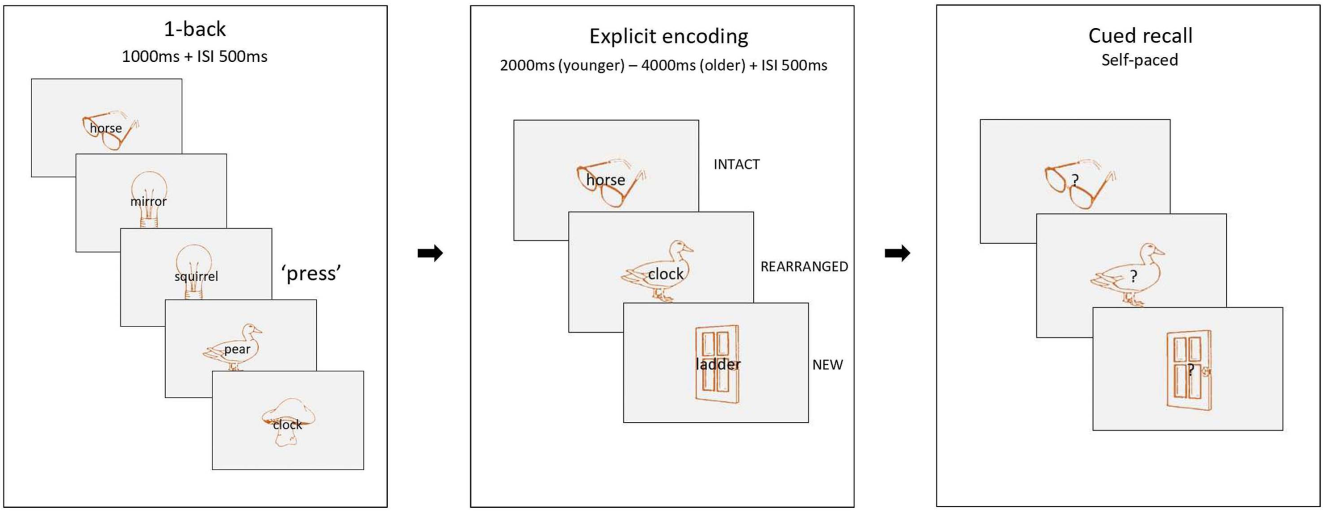
Directed Attention Tasks

Another task also based on the deletion component of inhibition was used in several studies (James et al., 2016; Powell et al., 2018), which are summarized in Table 2. In this task, participants were presented with a main item and two context items (a colour and a scene). Participants' attention was drawn to one of the two context items while they were instructed to ignore the other one. The encoding instructions took the form of a judgement of likeliness regarding the main item and one of the context items (determining whether the object and the context item were likely to appear together) while the other was ignored. At retrieval, each main object appeared with its two possible context items. First, an "old/new" judgement had to be made about the main object. If the answer was "old," participants were asked to judge, on a scale from 1 to 4, whether the presented colour and scene matched with the object; the two context items were judged separately. The results showed that both younger and older adults remembered attended context items better than those they had ignored, which provides evidence that older adults have a preserved general ability to focus their attention on a stimulus. However, older adults were more likely to correctly identify a context item if the other one was correct as well, which suggested a hyper-binding effect. The authors interpreted this finding as a sign that older adults formed associations between the two context items, even though it did not boost their memory for the unattended items.

Other Methodologies

Finally, some studies used a variety of different methods, which are summarized in Table 2. For example, Kim et al. (2007) used a task that required participants to read stories in which distracting words were intermingled. They were then asked to perform a

Figure 2
N-Back Protocol Used by Biss et al. (2013, 2018) to Engage Learning by Distraction



Note. In this case, it shows incident learning as the items were previously presented before the explicit encoding (distraction as incident processing would consist in the *N*-back task taking place after the explicit encoding). Distraction occurs as participants are instructed to ignore the superimposed words in the one-back task. See the online article for the color version of this figure.

Remote Associates Task (RAT) in which three words were presented, and the task was to find a fourth word that linked the other three, some of which could be solved with the to-be-ignored words from the reading task. The results indicated that older adults benefited from the presence of to-be-ignored words to solve the RAT problems, and even performed better at that task than young adults, without causing major impairments to their reading performance. In another study, Davis et al. (2021) used a task requiring participants to make semantic judgments (whether objects would fit into a drawer) about images while either ignoring letter strings or words or taking the words into account. After a delay, participants were asked to perform the same task, but now had to take into account both the image and the word. Some pairs were intact from the initial task and others were rearranged. Their results showed faster semantic decisions for intact image/word pairs (i.e., hyper-binding), which was present when participants were not required to pay attention to the word, and in older adults only. The authors interpreted their results as showing that older adults learned the associations between attended to images and to-be-ignored words.

Summary and Methodological Implications

To summarize, presenting distractors at encoding (or before an explicit encoding phase) seemed to elicit hyper-binding between the item to be attended to and the one to be ignored. In healthy ageing, this effect, in some cases, enhanced memory for pairs that were presented in the same form as in the distracting phase. For example, the use of a one-back task at encoding, whether it was followed by an explicit encoding phase (Campbell et al., 2010) or not (Rowe et al., 2006), seemed to enhance memory for distractors and, even more so, for the attended items associated with the distractors. The benefit was particularly prominent for associative memory tasks and was not limited to only one of the items from the associations since memory was better after the distracting phase for learned associations than for rearranged pairs. In some cases, the effect of distraction enabled older adults to perform as well as younger adults (Swirsky & Spaniol, 2020; Weeks et al., 2016). However, the hyper-binding effect due to sensitivity to distraction did not always take the form of a memory enhancement: In the studies conducted by Powell et al. (2018) and James et al. (2016), it showed in the older adults' greater dependence on the congruency between the attended items and the unattended ones to make memory judgements.

The results depicted here raise the question of the implicit nature of the "hyper-binding" processes involved. First, we need to clarify the distinction between explicit and implicit processes. We consider that a distraction phase containing relevant stimuli that must be ignored acts as an implicit encoding phase, since the instructions do not require that these stimuli be memorized. However, the test phase is either explicit (i.e., it requires participants to recall or recognize an item through an explicit reference to the encoding phase) or implicit (i.e., it does not mention an encoding phase, but the trials can be related to the prior presentation of the stimuli, as a sort of priming). Some studies (Davis et al., 2021; Kim et al., 2007; Rowe et al., 2006) used fully implicit designs and found positive effects of distraction, leading to a boost in performance in the presence of relevant distractors. However, the implicit nature of the evaluation they used (e.g., RAT, semantic judgement, word-fragment completion) provides no information about the actual effect of distraction on explicit memory and, more importantly, on functions that seem to decrease with age. Indeed, there is evidence that semantic memory is relatively preserved in ageing (Drag & Bieliauskas, 2010); therefore, the efficiency of the task in tasks that do not require explicit memorization accounts for the fact that some enhancement is possible (Kim et al., 2007), but there is no link with declarative episodic memory.

Nevertheless, the fact that the task also works in designs that require explicit memory for associations is very important as a decline in such processes is typical in ageing. Furthermore, the processes that take place (supposedly implicitly) during the distracting phase produce an effect in subsequent explicit encoding and retrieval. Indeed, not only are associations created and thus encoded better but they are also better recalled. Finally, some authors claim that, for this effect to happen, participants should not be aware of the relationship between the distracting phase and the other tasks; at least, their awareness should not be measurable by retrospective questionnaires. For instance, Campbell and Hasher (2018) indicated that the age-related hyper-binding effect did not appear when participants were explicitly informed of the relationship between the one-back task and the explicit encoding.

In general, these findings suggest that there is an important link between attention/executive processes and episodic memory, and that the mere presence of distractors can influence episodic memory. We must not forget that distraction is an issue in ageing and can lead to interference and impair cognitive performance; thus, any study (whether experimental or clinical) should keep in mind the difference between congruent/relevant distractors and incongruent/irrelevant ones (Weeks & Hasher, 2014). However, some surprising findings have been described, suggesting that older adults are not bothered as much by incongruent distractors as they are helped by congruent ones. In fact, this might be an artefact and a limit of the methodologies described above: Some studies do not take account of the fact that the benefit of distraction for intact pairs might be overestimated because older adults' memory is impaired for rearranged pairs. Campbell et al. (2010, Experiment 1) tackled this by comparing a condition where the encoded pairs they used were new versus rearranged from the distracting phase and found that rearranged pairs created a disadvantage compared with new pairs, for older adults only. However, Weeks et al. (2016, Experiment 1b) addressed the issue by comparing their first sample to a new one that was only given the associative learning task without the distraction task. They found that both samples performed equally well on rearranged pairs, but that the first sample performed better on intact ones. This indicates that using distraction provides a benefit for items that appear identical as distractors and later targets, but there is no obvious disadvantage caused by those that do not appear identically.

Distraction as Incident Processing

While to-be-ignored items seem to enhance memory when presented at encoding, other studies have attempted to use distractors as a means for older adults to process already learned information. These studies are summarized in Table 3. Such tasks posited that, once a material was learned, presenting it as a distractor to older adults in a subsequent task could serve as incident processing, whether in an item memory task (Biss et al., 2013; Lourenço & Maylor, 2015) or an associative memory task (Biss et al., 2018, 2020). In those studies, the distractors were to be ignored when performing the task administered but could in some cases be relevant to process the material that was learned beforehand, without the participant being aware of the relationship at the time of distraction.

One-Back Tasks

Biss's team created the following task: Participants studied a list of stimuli (pairs or items) and recalled them, and then performed a one-back task in which some of the studied stimuli appeared (incident processing), and then had to recall the stimuli after a 15-min delay. The first study was conducted by Biss et al. (2013) with three experiments using memory for items (words). They concluded that older adults were more easily distracted by words in the one-back task that were relevant to the memory task (Biss et al., 2013, Experiment 2), but that the presence of relevant words in the one-back task boosted the recall of those words (Biss et al., 2013, Experiment 1), such that their performance for those words was equal to that of young adults. The team replicated their results with a face–name associative memory task (Biss et al., 2018). In this study, older adults even showed better memory for repeated names after the one-back task (15 min after encoding) compared to their performance immediately after encoding. The researchers also included a recognition task and observed an effect of repetition on recollection, but not familiarity, whereby repeated items led to more "remember" answers than unrepeated ones.

Lourenço and Maylor (2015) used a one-back task as a mean to process a prospective memory instruction (pressing a key when animal images came up in the one-back, when some of the to-be-ignored words were animal words). The results indicated better prospective memory performance when animal words appeared as distractors, especially for older adults. However, this manipulation did not lead to better lexical decision performance for the one-back words. This study is described here because its implications differ from those of the studies presented in the previous section. First, there was no explicit encoding phase, and the retrieval was implicit, as in Rowe et al.'s (2006) study. However, unlike Rowe et al.'s findings, implicit performance was not significantly better for the words presented as distractors in the one-back. This difference can be discussed in light of the number of critical items and the nature of the implicit task. Second, the fact that the presence of intention-related words boosted prospective memory performance indicates that, here, the distractors served as an incident processing of a previous instruction that had to be encoded in episodic memory (note that there was a delay between the instructions and the one-back task).

Summary and Methodological Implications

To sum up, using distraction to incidentally process learned information seems to be effective at improving episodic memory in older adults, whether through free recall, cued recall, or recognition memory. When using a recognition task, the reported benefit appeared to be related to recollection and not familiarity and therefore did not lead to common familiarity mistakes such as false alarms. Nevertheless, further research is needed to confirm the efficiency of the use of distractors for that purpose.

As for the negative impact of distractors, Biss's team made efforts to examine the effect of processing learned items on other items (learned items that are not repeated and repeated items that are not learned). Biss et al. (2013, Experiment 1b) compared the performance of participants given repeated and unrepeated words to that of participants who were given only unrepeated words and reported that the forgetting rate was equal in both groups for unrepeated pairs, suggesting that repeating some words does not impair the memory for unrepeated ones. Furthermore, Biss et al. (2013, Experiment 2) observed participants' reaction times when the item was or was not congruent in their one-back task and concluded that older adults' responses were slower for trials that happened to contain a repeated item, indicating that distractors were harder to ignore when they were relevant. An interpretation could be that all distractors, whether congruent or incongruent, attract attention but the incongruent ones are more rapidly deemed irrelevant; thus, older adults' inhibitory control enables them to ignore incongruent distractors more easily and prevents them from interfering significantly with the task. Finally, Biss et al. (2018) reported that incongruent repeated items are not identified as false alarms more often than any other item in their forced-choice recognition memory task. These arguments account for the fact that distractors used as an incident processing provide an effective means of boosting memory for learned items without significantly impairing responses to unrepeated items or leading to interference from repeated unlearned items. The reasons for the phenomenon remain unclear, but the relationship posited between distraction and recollection (Biss et al., 2018) could be a valid explanation. Since recollection is, among other things, memory for context associated with the time of encoding, it seems logical that it should lead to correct remembering of associations (the two parts of the association are correctly remembered, and a rearranged association is correctly excluded). If the effects of distraction on familiarity were greater, however, certain errors could be more systematic, and the negative effects of distraction, such as interference, could have a larger impact.

As we mentioned earlier, when distraction is manipulated before encoding, its effects can be seen under implicit circumstances, as measured by Campbell and Hasher (2018). However, for tasks that use distraction as incident processing, the issue has not yet been investigated, to our knowledge. Furthermore, we might hypothesize that the studies using this method for associations may not entail purely implicit processing. Indeed, in these cases, one of the items of the pair must be attended to during the one-back (the image), even though participants are not instructed to memorize the images. If we consider this hypothesis and the fact that the task still works to enhance memory, a distinction should be made from studies using distraction before encoding that claimed that the conditions (distraction and link between the tasks) must be implicit. Either the lack of effect under explicit conditions is not very robust and Campbell and Hasher's results need to be put into perspective, or the processes involved during the two types of timelines are so different that expectations in one case cannot be extrapolated to the other. The differences between these two tasks and their underlying processes will be discussed more thoroughly below.

Discussion

Our aim with this work was to provide an overview of the articles that were published on the subject of distractors as episodic memory targets in normal and pathological ageing (it is worth noting that only one study investigating participants with possible cognitive impairment, MCI, was found using our search methodology). We aimed for a clearer understanding of the methodological variables underlying each effect, the theoretical framework that was used in such literature, and the way it interacted with clinical outcomes. We were able to classify articles according to two timelines of distraction intervention and will now integrate them together to include the phenomenon into a larger theoretical framework.

Overall, older adults' lesser ability to inhibit distractor processing can be used as a way to boost their memory for distractor items and their associations with attended items, in different tasks. The examination of the different methodologies enabled us to formulate a first conclusion: There seem to be conditions in which distraction enables an enhancement in cognitive performance. Moreover, beyond methodological considerations, there is a great need to understand the processes at play and the reasons why this enhancement occurs. As we mentioned earlier, the task acts upon processes known to decline with age, and the effect needs to be put in perspective using the most recent memory models. A better understanding of how distractors can be inserted into such models could even lead to hypotheses regarding what could happen in various clinical populations, such as people with early dementia. Consequently, we will now discuss the implications, challenges, and perspectives of these tasks.

Theoretical Implications

Only a few studies have investigated the link between the dual-process model of recognition memory and distraction. They suggested a relationship between recollection and distraction: According to Biss et al. (2018), repeated pairs were recognized in a forced-choice task using recollection, and not familiarity. Similarly, in a study with Event Related Potentials (ERP) measures, James et al. (2016) suggested that younger and older adults used recollection to the same extent when recognizing attended and unattended items. In the other studies that we described, the link between memory performance and recollection is inferred from two facts: associative memory depends on recollection and free/cued recall is related to recollection.

Actually, the cognitive mechanisms underlying the results presented here are somewhat unclear. Whether taking a strand for dual-process theories or single-process theories (Yonelinas, 2002), there is still an uncertainty regarding which mechanisms can account for the increased performance of learning by distraction in older adults. We consider here several possibilities, which are not mutually exclusive.

First, reminding could account for the difference between older and younger adults. Indeed, if older participants failed to ignore the repeated items or pairs, this could trigger reminding of their prior occurrence, thus facilitating encoding and promoting future recollection. However, as shown by Garlitch and Wahlheim (2020), reminding occurs more often in younger subjects than in older adults. This does not mean that some of the learning by distraction effect could not be imputable to reminding, but it cannot explain the whole patterns of results that is generally extracted from the studies.

The repetition effect could also account for the pattern of results. Indeed, repeated pairs or items are better encoded both in semantic and episodic memory (Yonelinas, 2002). As older people tend to focus more on information when it is presented as distraction (Campbell et al., 2010), noticing their repetition would lead to better encoding.

In the case of associative memory (i.e., when information to be learned and included in the distractor phase are pairs of items), reminding and/or repetition may facilitate binding mechanisms in older people, potentially allowing them to overcome the typical associative deficit (Naveh-Benjamin, 2000). This is the idea behind the term "hyper-binding." Of note, hyper-binding can be demonstrated if the final recognition memory test shows increased hits and no effect or even a reduction for false alarms. Alternatively, a general increase of hits and false alarms would indicate enhanced memory for the items, but not the pairs, and/or a shift towards a more liberal response bias (Naveh-Benjamin, 2000).

A specific test of the hypothesis of changes in response bias can be found in Experiment 1b in Biss et al. (2013). The authors presented new participants with the same setting as Study 1a (which is similar to that shown in Figure 2), but with no repeated target pairs. To say it otherwise, they only presented nonstudied pairs in the one-back task to assess whether a response bias would exist. They found a higher hit rate of unrepeated items as in Study 1a, but the same forgetting rate in the two experiments.

In most studies presented, the distraction phase allowed more correct answers for target stimuli. However, only a few studies considered false alarms during the test phase. The most controlled in that matter is Biss et al. (2018) who reported better hits but no increase in intrusions from repeated words in cued recall and no increase in false alarms in recognition memory in older adults. This was also replicated in Biss et al. (2020), but with a forced-choice task only, which is not sensitive to response bias. James et al. (2016) took into account false alarms in a corrected recognition score (hit–false alarms) but did not study the difference between younger and older groups. However, the raw data show 6% false alarm rate for younger adults and 10% for older adults. Finally, Powell et al. (2018) also used a hit–false alarms recognition memory score but did not provide raw data nor did statistical analyses on false alarms alone. More studies are necessary to assess the effect of learning by distraction on different types of memory responses, notably to ensure that no change in response bias could account for the result. This would be necessary to confirm that the phenomenon of learning by distraction for pairs is lead to hyper-binding.

Different Timelines of Distraction Tasks: Which Processes Are Involved

Studies were distinguished by two timelines for the distraction intervention: before explicit encoding and after explicit encoding. Such manipulations necessarily have different impacts on the underlying processes. Indeed, from an episodic memory point of view, using distractors as a preencoding phase leads to a preactivation (Rowe et al., 2006, even talks about priming) of associations as a whole. Both attended and unattended items are encoded and, most interestingly, they are bonded together. Later, when the explicit encoding phase begins, intact pairs reinforce the preencoded associations and provide additional details essential to the recollective experience we mentioned earlier. In this case, we expect the effect on recollective processes to be due to reinforced encoding, which makes the episode richer because of the multiple presentations of the associations. This enables the associations to be bonded together to the point that they are considered as a full episode instead of two separate parts and therefore lead to enhanced cued recall performance. This explanation is also congruent with the results of James et al. (2016): The attention paid to both the attended and unattended items creates such robust associations between all the items from the full episode of encoding that they are hard to separate from one another at retrieval.

On the other hand, the use of distractors as incident processing of encoded items or associations allows for different conclusions. First, the distracting phase simultaneously acts as a sort of rehearsed encoding and adds to the richness of the episode through an association with an attended image (whether or not this image was studied before, i.e., whether for item or associative memory). Second, distractors used for incident processing enable a preretrieval practice to take place, acting as a covert reinstatement due to relational components (images associated with words), and leading participants toward subsequent conscious recollection at test. Third, at test, the reactivation is attributed to recollection based on the number of details recollected (due to multiple exposure) and on their quality (due to the association with an image that makes the episode unique).

Furthermore, in addition to affecting the memory processes at play in different ways, the two timelines have different impacts on inhibitory processes. On the one hand, when distractors are used before explicit encoding, older adults' decreased inhibitory control leads them to process unattended items, the activation of which leads to benefits at encoding. We refer to a sort of general unconscious processing of all distractors, which are later either encoded more strongly or counteracted by the rearranged pairs. Here, the explicit encoding phase remains prominent and influences the recollective experience more, preventing the preencoded associations from impacting the encoding of rearranged pairs. On the other hand, distractors used as incidental processing imply that some of the encoded items or pairs are repeated, but not all of them. Authors who use such tasks posit that there are no significant impacts on unrepeated items and on repeated unlearned items. This could mean that the distractors are generally deemed irrelevant by older adults, but that the ones that are relevant to the memory task attract their attention, even at an unconscious level, and are reinforced. Moreover, the phenomenon acts on the items that can benefit from it, but does not affect the memory of the other items. These phenomena can be more easily explained when taking the point of view of recollection. In Biss et al. (2013, 2018), we could hypothesize that filler words are not identified as false alarms because they do not undergo the combination of explicit encoding, retrieval practice, and incidental encoding (note that they always appear with a different image).

Implicit and Explicit Processes: Necessarily Separate?

As we have mentioned several times, some authors distinguish between explicit and implicit tasks. The use of distraction generally involves an implicit task, at least, on article. One could hypothesize that the use of a one-back task with superimposed words as distractors could lead to explicit contamination of processing. Even though participants may not be able to report the link between the tasks, they might have explicitly (which does not mean voluntarily) used the distractors as an incident processing opportunity for the studied items. The use of a graded awareness questionnaire to control contamination from implicit to explicit processes might not be a valid measure, as it requires memory of all the tasks and a good understanding of the questions on the questionnaire. We therefore believe that further research is needed to investigate that point.

Nonetheless, we could also challenge the idea that explicit contamination of the processing of distractors and the awareness of the relationship between the tasks, for example, in one-back settings, is much of an issue. As we mentioned, Campbell and Hasher (2018) found that the hyper-binding effect usually found in those contexts depended on the implicit nature of the processing. However, they manipulated awareness by telling participants during the explicit encoding that some of the pairs they had to study were identical to those in the one-back task. Participants who were aware of such relationship showed better performance for rearranged pairs compared to unaware participants, while there were no differences for intact pairs. The fact that this instruction impacted the results does not, in fact, mean that the distractors have no effect on memory when their relevance is highlighted. Quite the contrary, it means that participants were able to delete the preencoded associations from their memory which would have been used if the link had not been spoken of. In other words, explicit awareness of the relationship leads participants to counteract their initial processing of the associations (indicating that they were indeed preencoded) and minimize the hyper-binding effect. Thus, that article provides evidence not only that the hyper-binding effect happens under implicit conditions but also that the unattended items are still processed. Regarding the dual-process model, the better performance for rearranged pairs in Campbell and Hasher's study indicates that, in terms of metacognitive processes, participants might pay more attention at the encoding phase and try to inhibit the initial activation of the pairs. Therefore, the task allocates more resources to the rearranged pairs (which might trigger a feeling of fluency that now has an identifiable external source; Jacoby & Whitehouse, 1989) and adds more details to the encoding (by helping participants to realize that the pair was different, whereas this detail did not explicitly exist when the link was unknown to them). That study therefore accounts for the effect of distraction on recollection for the intact pairs but puts in perspective the lack of any negative effect of unconscious distraction on rearranged pairs highlighted by Weeks et al. (2016, Experiment 1b).

Effect on Recollection: Remaining Questions and Limits

The theoretical framework we present here leaves a lot of room for discussion. We believe that the proposed effect on recollection needs to be confirmed and replicated. Furthermore, this overview did not use a quantitative method to measure the prevalence of each effect on each measure, and we believe that a future increase in the number of studies using such tasks will provide the opportunity to run meta-analyses. The questions that remain open are related to, first, the potential negative impact of distraction. The explanation of recollection we gave above enables us to understand why memory for some stimuli is reinforced but not, for example, why the memory of unrepeated stimuli remains intact (Biss et al., 2013, Experiment 1b). Moreover, a better understanding of the processes involved could be provided by measures of recollection and familiarity that are not self-reported, such as neuroimaging techniques; for example, James et al. (2016) used ERP measures in their study. Further research is needed to link this task more formally to recollection and familiarity and their underlying brain regions and to provide a better understanding of the methodological choices that lead to the effect on recollection, especially with a clinical perspective in mind.

Another potential confounding effect that may explain age-related differences could be that initial difference in memory performance may lead to less room for improvement in young than in older adults. We thus examined levels of memory performance in the reviewed studies. First, there was no ceiling effect for either groups or conditions in most studies using recall scores as index of performance (Biss et al., 2013; Campbell et al., 2010, 2012; Campbell & Hasher, 2018; Davis et al., 2021; Gallant et al., 2020; James et al., 2016; Kim et al., 2007; Lourenço & Maylor, 2015; Weeks et al., 2016). Nevertheless, one study showed recall in the younger group close to ceiling effect (Powell et al., 2018). In the studies in which no ceiling effect was reported (Biss et al., 2013; Campbell et al., 2010, 2012; Campbell & Hasher, 2018; Davis et al., 2021; Gallant et al., 2020; James et al., 2016; Kim et al., 2007; Lourenço & Maylor, 2015; Weeks et al., 2016), the room for improvement ranges usually from 70% to 40% depending on the difficulty of the task, and the difference between groups never exceeds about 20%. Considering this information, we feel that it is unlikely that the hyper-binding effect is confounded with an initial difference in performance.

It is worth noting that out of the 15 articles found for this review, 10 have been written by authors from the same research team and five by researchers with no apparent link to this team. We think that further replication by other research teams should benefit the topic and increase the scientific and clinical potential of this phenomenon. Especially, it could be interesting to conduct studies aiming at determining whether improvement in recollection can be transferred to everyday life, first in the field of healthy ageing (in methodological and clinical terms) but also by developing controlled trials to apply to a variety of patient populations.

Conclusion

There are still many questions to be answered, but the tasks described here open up various avenues for future research: both fundamental research on the link between distraction and memory (especially recollection and familiarity) and applied research. Biss et al. (2020) were among the first researchers to apply this kind of task to a population of patients with MCI characterized by a recollection deficit and showing some positive effects on cued recall and recollection, suggesting that the method could be used in a rehabilitation programme. The conclusions we were able to draw and the hypotheses presented here emphasize the necessity of comprehending the relationship between distraction (related to executive functions) and episodic memory as a complex and fine-grained one that is part of more integrated cognitive processes.

Résumé

Le vieillissement en santé se caractérise par des changements dans plusieurs fonctions cognitives, dont la mémoire épisodique et l'inhibition. Bien que la diminution de la capacité à inhiber les stimuli non pertinents liée au vieillissement soit souvent associée à une baisse de performance, en particulier de la mémoire épisodique, des études ont mis en relief l'effet stimulant de la distraction parmi les personnes âgées dans le cadre de plusieurs tâches, y compris des tâches de mémoire épisodique liées à remémoration. L'objectif du présent article est d'examiner et de comparer des études antérieures selon des caractéristiques précises et d'examiner les résultats à la lumière du modèle du double processus de la remémoration et de la familiarité, utilisés par les auteurs de ces études. Ce travail a mené à la détermination de deux principaux points de comparaison entre les études : le moment de la distraction et la nature implicite des processus en jeu, qui ont tous deux donné lieu à des répercussions différentes sur la relation avec la remémoration. L'usage de la distraction dans les tâches de mémoire peut améliorer la mémoire épisodique, et en particulier les processus de remémoration, en raison d'actions précises aux étapes de l'encodage et de la récupération. Ces résultats ouvrent la voie à d'autres recherches plus approfondies, tout en soulevant plusieurs questions au sujet du rôle des processus implicites et de l'effet négatif de la distraction, par exemple.

Mots-clés : mémoire épisodique, inhibition, distraction, vieillissement, cognition

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(*Appendix follows*)

Appendix

Summary of the Research Strategy Keywords and Boolean Processes in the Three Databases Examined

Step no.	Strategy/keywords	No. of results
	APA PsycINFO	
1.	Memory/	70,332
2.	Episodic Memory/	6,860
3.	Associative Memory/	1,148
4.	episodic memory.mp.	11,606
5.	associative memory.mp.	2,246
6.	associative learning.mp.	5,425
7.	Forgetting/	3,353
8.	forget*.mp.	11,002
9.	recollect*.mp.	8,485
10.	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9	98,289
11.	Distraction/	5,056
12.	Response Inhibition/	3,387
13.	inhibition.mp.	80,760
14.	distract*.mp.	27,634
15.	hyperbind*.mp.	11
16.	11 or 12 or 13 or 14 or 15	106,577
17.	Aging/	66,101
18.	aging.mp.	116,260
19.	Older Adulthood/	10,102
20.	older adult*.mp.	64,900
21.	Alzheimer's Disease/	52,155
22.	alzheimer.mp.	37,911
23.	Mild Cognitive Impairment/	8,561
24.	mild cognitive impairment.mp.	13,302
25.	17 or 18 or 19 or 20 or 21 or 22 or 23 or 24	196,224
26.	10 and 16 and 25	554
	Ovid MEDLINE	
1.	Memory/	71,452
2.	Memory, Episodic/	5,908
3.	Association Learning/	10,393
4.	episodic memory.mp.	10,211
5.	associative memory.mp.	2,405
6.	associative learning.mp.	5,225
7.	forget*.mp.	11,089
8.	recollect*.mp.	6,834
9.	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8	108,909
10.	distract*.mp.	34,883
11.	Inhibition, Psychological/	12,467
12.	inhibition.mp.	982,095
13.	hyperbind*.mp.	12
14.	10 or 11 or 12 or 13	1,015,420
15.	Aging/	244,993
16.	aging.mp.	391,262
17.	older adult*.mp.	104,193
18.	Alzheimer Disease/	109,799
19.	alzheimer.mp.	121,352
20.	mild cognitive impairment.mp.	21,562
21.	15 or 16 or 17 or 18 or 19 or 20	576,870
22.	9 and 14 and 21	723
	Scopus	
1.	TITLE-ABS-KEY (memor* OR episodic AND memory OR recollect* OR forget* OR associative AND memory OR associative AND learning AND inhibit* OR distract* OR hyperbind* AND aging OR older AND adult* OR alzheimer OR mild AND cognitive AND impairment)	344

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