

## **False Memories in Healthy Older Adults**

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*Some day you will be old enough to start reading fairy tales again.*

C.S. Lewis

### **Abstract**

The aim of this paper is to discuss the literature about the effect of aging on false memories and explain the retrieval model as an underlying factor. Therefore, it is a mini review which focused on ten related papers in terms of their hypotheses, designs, used methodologies and findings. Although this paper does provide evidence from the literature that indicates the effect of the retrieval processes on false memories in older adults, it will also examine contradictory papers which claim the importance of encoding over the retrieval process. It has also been mentioned about a widely accepted explanation on false memories; the source monitoring framework (SMF) which is a mechanism used to distinguish between real past events and imagined ones.

Keywords: False memories, retrieval model, adults, healthy older adults.

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## Introduction

Memories are our precious treasures because they preserve many of life experiences, excitements and essential knowledge. Unfortunately, they become faded, forgotten or remembered in a totally different way over the years. This phenomenon has a specific name as a branch of neuropsychology which examines these memory impairments: 'false memories'. Other terms, such as 'illusory memories' (Norman & Schacter, 1997), 'recovered memories' (Loftus & Davis, 2006) or 'confabulation' (Schacter *et al.*, 1995; Barba *et al.*, 2010) are also used and all these designations refer to deficits in memory and it is known from broad range of studies that these deficits increase with age (Norman & Schacter, 1997; Barba *et al.*, 2010; Attali & Barba, 2013).

Since the term 'confabulation' will sometimes be used instead of 'false memory' throughout this paper, it will be useful to mention definitions and give a brief background of it. Confabulation was described by Moscovitch (1995) as "honest lying" because confabulators do not produce false memories intentionally. According to Dalla Barba (1993), confabulation is "the production of statements or actions that are unintentionally incongruous to the subject's history, background, present and future situation". In addition, confabulations were separated into two categories by Kopelman and Baddeley (1989) as "spontaneous" confabulation and "provoked" confabulation. Spontaneous confabulation refers to contradictory and disjointed remembering while provoked confabulation describes normal reactions to false memories.

It is vital to differentiate between real past events or future planned events in order to remember them completely (Mitchell & Johnson, 2009). Although it might seem simple to deal with this discrepancy, it is not. Hence, it needs two processes; retrieval success and retrieval monitoring (McDonough & Gallo, 2013) and both of these processes might be impaired with age. According to these authors, retrieval success refers to the recall of related features of events whilst retrieval monitoring describes hunting for and determining whether the required events are accurate or not. Although some researchers have claimed that the encoding and storage processes outweigh the production of false memories and that there is no effect of the retrieval process (Attali & Barba, 2013; Attali *et al.*, 2009), there are a broad range of studies that have shown precisely the opposite of their claims (Watson *et al.*, 2004; McDonough & Gallo 2013).

Moreover, in accordance with one of the aims of this paper, it will be also helpful to refer to source monitoring since it will examine the importance of the retrieval process which includes the source monitoring framework which is also mentioned in some of the studies referred to throughout this paper. The source monitoring framework (SMF) is a mechanism used to distinguish between real past events and imagined ones and also to reverse the source of memories (Lindsay & Johnson, 2000). For instance, people can remember the place at which events occurred and who was involved in them by using source monitoring. However, this mechanism is impaired with age and older adults might infer the source of the events or the reality of them (McDonough & Gallo, 2013).

It will also be helpful to refer briefly to the DRM paradigm which has been used by many researchers to investigate false recall and will be discussed as a method used in some studies which will be considered in the discussion section. The Deese/Roediger-McDermott (DRM) paradigm is a technique which was devised by James Deese in the 1950s and subsequently improved by Henry L. Roediger and Kathleen McDermott (Gallo, 2010). Researchers use a word list which contains related words (bed, tired, snooze, rest and so on) in this paradigm and then ask the participants to

recall as many of these words as they can. It is observed that the subjects would recall a ‘critical lure’ which is a non-presented word (sleep). However, there is a debate about the reliability of the DRM paradigm since some researchers claim that the laboratory findings which are made using this paradigm cannot be generalized to real life because there is no relationship between words and events (DePrince *et al.*, 2004). Nevertheless, in parallel with the aim of this paper, those studies which have used the DRM paradigm have found that older adults are more vulnerable to recalling these lures (Dehon & Bredat, 2004).

Moreover, it might be useful to keep mind these two questions throughout the review

“Does ageing directly increase vulnerability to false memories?”

“Do false memories in the elderly arise from failures of retrieval or of monitoring?”

Although there is broad range of studies on this phenomenon, there is still no certainty about the effects of ageing on vulnerability to false memories. Therefore, the research will be conducted to explore this vulnerability to these confabulations in healthy older adults through the light of ten papers which will be discussed presently.

## **Discussion**

As stated in the previous part, retrieval success and retrieval monitoring are two essential processes to recall autobiographical events from the past or to realize the discrepancies between real past events and imagined future events, which is referred to as ‘source misattribution’. McDonough and Gallo (2013) examined the age-related deficits of retrieval monitoring while manipulating the retrieval success by giving an elaboration task. They conducted two experiments which each had two phases: for the first phase of experiment 1, participants were asked to generate a real event from their past without details, a detailed future event and a future event without details (elaborative and non-elaborative conditions, respectively). For experiment 2, they asked participants to generate a detailed real past event, a non-detailed real past event (elaborative and non-elaborative past conditions, respectively) and a future event without details. After 24 hours delay, in the second phases, the researchers gave a recollection test which asked the participants to differentiate the previously-generated future and real past events in their memory. The results were parallel with their hypothesis that older adults are more vulnerable than younger adults to confusing real (past) and imagined (future) events. Even though additional features, elaborative conditions, supported the recall of more details for both groups, the older adults did not benefit from elaboration, as expected. Contrarily, according to cross-test analyses, only the younger adults benefitted from detailed features to decrease the source misattributions. However, these results might have been affected by the complicated research design, since the events which the researchers asked the older adults to generate could have been made clearer. For instance, the non-elaborative past events and elaborative past events could be blended during the retrieval process. It could also have been necessary to support the older adults with cue-words and give them directions explicitly. To conclude, the study would have been more persuasive if the researchers had considered the effect of complicated design. Nevertheless, that study is substantial in terms of indicating the vulnerability of older adults to confabulations and importance of retrieval model as an underlying factor.

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One of the underlying factors which lead to confabulation is the interference effect of over-learned information (Barba *et al.*, 2010). Barba *et al.* examined that phenomenon in older adults and the results were parallel with their hypothesis that older adults are more vulnerable than younger adults to confabulate and they claimed that over-learned information is the key factor for this false memory issue. They studied twenty young and twenty older participants whose mean ages were 25.8 and 76.4 respectively. The task which they used was story recall, which is the same task that will be employed in the proposed study. There were three stories used, one of which was an unknown story, another was *Sleeping Beauty*, which is a well-known fairy tale, and the third was a modified version of *Little Red Riding Hood* in which, unlike the well-known version, the wolf does not eat Little Riding Hood at the end. The method of the study was briefly as follows. The researchers read the stories loudly to the subjects, and because it was a within-subject design, all the participants were read all three tales, and then the researchers asked both the young and old adults to recall 35 specific elements. The results were as expected; the older adults remembered many more false elements than the younger adults and the most misremembered story was the modified fairy tale. Moreover, their confabulations involved details from the original Little Riding Hood story, which can be interpreted as the interference of vigorously-represented knowledge (over-learned information) with new information (Little Riding Hood was not eaten by the wolf).

First, Barba *et al.* discoursed the “reduced attentional resources”, which refers to the lack of a pool of cognition to carry out a specific task. However, because this theory was described as “vague” by Balota *et al.*, (2000), they did not explain the results with this paradigm. Instead, they claimed that the reason underlying this interference was the effect of the “frontal/executive dysfunction” theory (Johnson, 1991, Moscovitch, 1989). According to this approach, the reason for confabulations is the lack of inhibition about the inappropriate information. Normally, the brain should repress unrelated information and expose the related-desired information (Balota *et al.*, 2000). Barba *et al.* suggested that the older adults failed to recall true elements because they failed to repress the unrelated information which included the original story elements. So when the older participants were asked to recall the modified version of the story, even though it had been read clearly shortly before, they recalled the original story that had been over-learned and was semantically similar to the modified version. In terms of the method they used, it can be said that the study was well conducted and that the participants and tasks were valid. Since, they used story recall task (which is more similar to the real life tasks, e.g. reading newspaper) instead of word list remembering task. However, the study conducted by Barba *et al.* would have been more persuasive if the researchers had considered the effect of retrieval process. Nevertheless, their study was substantial in terms of indicating the vulnerability of older adults to confabulations.

In another recent study conducted by Attali and Barba (2013), the researchers examined whether the encoding or the retrieval processes affected the amount of confabulation in older adults. It was hypothesised that over-learning causes the confabulations because former knowledge could interfere with new information, especially when it is semantically similar. The researchers found that poor encoding increased the confabulations whilst, surprisingly, the retrieval process did not have any effect on the confabulations. However, it is known from previous studies (for example, McDonough & Gallo, 2013; Watson *et al.*, 2004) that ageing does impair the retrieval process, especially retrieval monitoring, and that it causes the production of false memories. There are other studies that have shown the importance of retrieval accounting for confabulations (Dehon & Bredat, 2004; Fandakova *et al.*, 2013). The method of Attali and Barba’s study which is the subject of this paragraph was similar; they compared twenty younger adults with a mean age of 25.8 and twenty older adults with a mean age of 76.4 in terms of producing confabulations from nine stories: three

new stories, three well-known stories (*Sleeping Beauty*, *Snow White* and *The Three Little Pigs*) and three modified well-known stories (*Little Red Riding Hood*, *Tom Thumb* and *Cinderella*). The researchers presented all the participants with three conditions: free encoding and free retrieval; divided attention (DA) in encoding and free retrieval; and free encoding and DA in retrieval.

The explanation of these conditions is as follows. For free encoding and free retrieval, the researchers read aloud the stories and asked the participants to recall as many of the elements as they could. For DA in encoding and free retrieval, they read aloud the stories while the participants were doing a Reaction Time test on the computer (so their attention was divided during the encoding process) and then asked them to recall as many elements from the stories as they could. For the free encoding and DA in retrieval process, the researchers read the stories aloud while the participants were undiverted and then asked them to recall elements from stories while they were doing the Reaction Time test on the computer (so their attention was divided during the retrieval process). The logic behind this research design is that people might produce more confabulations when they are given a second task during the encoding process than when they are given an additional task during the retrieval process (Barba, 2002). The researchers' main hypothesis was that over-learned information would interfere with the new information during the encoding process.

In parallel with their hypotheses, the results indicated that divided attention during the encoding process caused more confabulations than divided attention during the retrieval process (actually, no effect was seen in the retrieval process in terms of producing confabulations), which could be interpreted as that the encoding process is essential for true recalling whereas the retrieval process is not. The reason underlying this result could be the familiarization of the participants. Since, when it is compared with Barba *et al.*'s previous study in 2010, the section which introduced the participants exactly matches that in the later study in terms of the participants' mean ages, age ranges, education levels and education ranges. To conclude, the study would have been more persuasive if the researchers had considered the effect of adaptation. Nevertheless, the study is substantial in terms of showing another explanation, encoding, for false memories.

In a study conducted by Gras *et al.* (2011), the researchers hypothesised that the modality of presentation (visual or auditory) would affect the production of false memories and they examined the differences between old and young adults in terms of producing false memories. Although they preferred to use short texts instead of word lists because the word lists in the DRM paradigm do not reflect real-life tasks (Wilkinson & Hyman, 1998), the abstract of their study did mention the DRM paradigm. Thus it might be said that the abstract confused readers.

In brief, the independent variables of the research were: 1) the predictive inference effect, which refers to the expectations of the text-readers and their predictions about what will happen next; and 2) the presentation modality, which involved both visual presentation and auditory presentation. To test the predictive inference effect, they used four texts: predictive (which steered participants to make predictions at the end of the text), explicit (they could clearly see what happened next), contradictory (what happened next could be predicted by the participants in two different ways) and control text (the outcome could not be expected by any predictive inference). Using a control text was an innovation. Additionally, the texts were read to half of the participants (the auditory condition) whereas the other half were allowed to read it themselves (the visual condition). The hypothesis was that the older adults would produce more confabulations than the younger adults because the inference effect would be higher for them.

Moreover, it was claimed in the introduction that all the participants would perform better with the visual condition in terms of producing fewer confabulations than they would in the auditory condition. It is clearly seen that their methods was well-conducted. Since, the participants

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(especially the older ones) were tested for cognitive deficits (Mini Mental State Examination), depression levels (Geriatric Depression Scale) and both younger and older adults were measured for their vocabulary level. It was mentioned in the methods section that they tested the older adults in terms of depression levels because there is evidence which shows positive correlations between confabulations and false memories (Schacter *et al.*, 2002). Furthermore, it is easy to follow the results since they were presented in separate sections for each independent and for other variables that could be important (for example, confidence ratings). It is interesting that according to the results of the Reading Span Test (Daneman & Carpenter, 1980), which measures the working memory capacity, the scores of the older adults were found to be significantly lower than those of the younger adults. It is known from the findings of Peters *et al.* (2007), however, that poor working memory causes the production of many more false memories. Although this was a weakness of the study, its probable effect it was not mentioned. According to the results, the older adults produced more false memories than the younger adults, which supported the main argument of the paper.

However, in Experiment 2, they found no significant effect of presentation modality on confabulation, so perhaps both older and younger adults produced the same amount of false memories from both the visual and the auditory presentations. To conclude, the study would have been more persuasive if the researchers had considered the effect of working memory capacity. Nevertheless, this study is substantial in indicating the difference between older and younger adults in terms of producing confabulations, which is also harmonises with the aim of this paper.

Memory situations do not always get worse for older adults. For instance, Umanath and Marsh (2012) found that older adults are better than younger adults in terms of semantic memory and suggested that older adults would produce fewer semantic false memories because of their ability to detect the paradox between what they read and what they already know. However, this is just a supposition because they cited no research to support the hypothesis that older people are better at detecting contradictions. Instead, they used MacKay *et al.*'s (1999) study as evidence that there is no difference between younger and older adults in terms of finding errors. Another inappropriate study which they cited to support their claims was that of Madden and Mitroff (2010) which claimed that older adults are better than younger adults at detecting visual shifts. These unrelated evidences are weaknesses of the study. In addition, as a natural consequence, the results of this study showed that there was no significant difference between older and younger adults in terms of contradictory detection. To describe the study's methodology briefly, the researchers used 79 university students and 50 older adults as participants. However, no mention was made of their education levels, depression levels, general knowledge or even their mean ages, all of which are vital in terms of the validity of the research (Schacter, 2002). They gave the participants two 1200-word stories each; one third of the stories involved true facts, one third of them included false information to mislead the subjects, and remaining third contained neutral information. Half of the participants (the detection group) were asked to read and listen and after each sentence, if they thought that it contained incorrect information, they had to click one button but if they thought that the whole sentence was correct they had to click a different button. The other half of the participants (the control group) were asked to click the next button even if they thought that there was misinformation. At the end of the test, the researchers gave the participants a general knowledge test to measure the effects of misleading with false information and of the detection process. The results showed that the older adults produced fewer false memories than the younger adults in the general knowledge test although there was no significant difference between the groups in detecting errors in the stories. Even though the researchers tried to mislead the older adults with incorrect information throughout the stories, they were more successful in the general

knowledge test. These findings can be explained by Barba's (2010) study which is mentioned in the first paragraph of this paper. According to that study, when the researchers asked the older participants to recall the modified version of the story, even though it had been read to them shortly before, they nevertheless recalled the original story that had been over-learned and was semantically similar to the modified version. In parallel with this study, older adults might produce fewer false memories because of the effect of over-learning. To conclude, the study would have been more persuasive if the researchers had considered the effect of various features of the participants. Nevertheless, the study is substantial in terms of indicating the resistance of the older adults to misleading information because of their strongly-represented prior knowledge and also this study presents contrary argument which is older adults are better in terms of semantic memory.

As was explained in the introduction, the DRM paradigm might be used to examine false memories in older adults. Gallo and Roediger (2003) used this paradigm to investigate whether the length of word lists and the modality of presentation would affect false recognition in younger and older adults. According to their activation/monitoring theory, when the participants were studying the word lists, they activated the other related words which did not exist in the list (Roediger *et al.*, 2001). Subsequently, this activation would be recalled or recognized as a result of erroneous monitoring. Moreover, the researchers expected that when the participants were given a long list, which meant more activation and association with related-non-existing words, the number of false memories would increase. They therefore used word lists of three different lengths, five, ten and fifteen words. They also considered the effects of source attribution on false memories. Thus, each participant was given nine auditory and nine visual tests and then asked to remember which word belonged to which source. At the end of the experiment, the results were analysed and the findings showed that longer lists caused more false memories in both older and younger adults. Thus, older adults had no greater impairment in terms of the length effect. Furthermore, the results indicated that older adults produced more false memories and made more mistakes in terms of source judgments than younger adults. These findings might be considered to be in line with activation/monitoring theory. However, the study would have been more persuasive if the researchers had considered retrieval monitoring theory. Since it is known from the literature that source monitoring might impair recall in older adults, it would cause the source misattributions identified in this study (McDonough & Gallo, 2013; Watson *et al.*, 2004). Nevertheless, the study was substantial in terms of supporting the claims for the vulnerability of older adults to false memories which also harmonises with the aims of this paper.

As stated in the introduction part, source monitoring is an important process to discriminate between real and imaginary memory in both younger and older adults. Furthermore, the studies described in the literature indicate that older adults have more difficulties in source monitoring tasks (Spencer & Raz, 1995; McDonough & Gallo, 2013). In parallel with those studies, Dehon and Bredat (2004) examined the source monitoring process by comparing younger and older adults using the DRM paradigm. Following this paradigm, participants were given a word list and then asked to recall or recognize words in the list. However, there was the usual trick with this list: the words in the list were semantically connected with each other and all the words were strongly associated with a non-presented (critical) word. Thus, participants tended to produce false recall/recognition by producing these critical words because of this association. In the first part of Dehon and Bredat's (2004) study, the researchers used six DRM lists for each participant and then asked them to recall the words in the lists and also required them to rate their confidence about these recalled words by using a scale of 1 to 5. By this means the researchers investigated the differences between older and younger adults in terms of source monitoring by analysing the false

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recall and also the proportions of confidence in both age groups. The findings showed that the older adults produced more critical words compared with the younger adults and the confidence levels of the older participants for both presented words and critical words were higher than those of the younger adults, which might be explained by the difficulties over differentiating between real and false memories in older adults (Schacter *et al.*, 1998). In the second part of the study, the researchers investigated the effects of warning on producing false recall, which means investigating whether the participants would avoid remembering critical words as a result of warnings given before the presentation of the word lists. The results showed that while younger adults reduced their false recall of critical words as a result of the warning, older adults did not benefit from the warnings. The ineffectiveness of the warning effects in older adults was explained by researchers by Norman and Schacter's (1997) claims that deficits in monitoring in older adults might not be the result of increased false memory. However, this explanation is not clear enough in terms of understanding the reasons that underlie the ineffective warning factors in older adults. Nevertheless, this study is important because the results indicated the importance of the impairment in the source monitoring process for older adults by demonstrating the false recall increment.

In parallel with the previous study, the effects of warning and the source monitoring process on false memories in older adults were also examined by Watson *et al.*, (2004) whose aims were: 1) to explore whether older adults would take advantage of the warnings without the repeated test trials to decrease the false recall; 2) whether the older adults would benefit from a combination of warnings and repeated test trials to reduce false memories; and 3) can old adults improve monitoring strategies when the presentation rate is slowed, and as a result of this can they reduce false recall? Watson *et al.* (2004) used the DRM paradigm throughout the experiment and the results showed that the older adults benefitted from slower presentation as expected, and thereby they produced less false recall compared with the faster presentation group. The practice effect was also examined and there was no significant effect of multiple test trials in older adults, because they could not reduce the amount of the false recall throughout five test trials, as opposed to younger adults who could. The reason for this ineffectiveness of practice might be age-related impairments in spontaneous source monitoring. Additionally, the older adults took just as much advantage from the warnings as the younger participants, which is the opposite of Dehon and Bredat's (2004) findings described in the previous paragraph. However, when the combination of repeated test trials and the warnings effects in older adults is considered, it can be seen that although older adults reduced their false recall as a result of slow presentation, they sustained this reduction throughout the five test trials. The strength of the study is number of participants; they used 72 older adults and 72 younger adults, which is very acceptable in terms of the validity of the research. On the other hand, the study would have been more persuasive if the researchers had used a more real-world research design, since it is known from the literature that the DRM paradigm does not fit every-day events (DePrince *et al.*, 2004). Nevertheless, this research is substantial in terms of providing evidence of the effect of source monitoring in false memories and also indicating age-related decreases in false memories, which also harmonises with the aim of this paper.

Repeated test effects were also examined by Skinner and Fernandez (2009) in a similar way to the previously discussed study (Watson *et al.*, 2004). Skinner and Fernandez (2009) repeated the tests and also examined the divided-attention effect on the encoding process, as Attali and Barba (2013) also did. Their aim was to determine whether older adults will decrease their false memories with repeated tests under the full-attention condition as efficiently as younger adults in the divided-attention condition at encoding. The DRM paradigm was also used by the researchers in this study. They used three groups of participants: younger adults in the free encoding, younger adults with

divided attention in the encoding process and older adults with free encoding. Although they attempted to understand which of the encoding or monitoring processes would have the greater effect on false memories in older adults, they simply manipulated the divided-attention condition with the encoding process in younger adults instead of incorporating divided attention with the monitoring process in both younger and older adults. This was the most important weakness of this study. The results indicated that the older adults showed similar performances to the younger adults who were tested under the divided-attention condition. In addition, the younger adults were better when the word lists were repeated three times compared with when they were given only once. In contrast, the older adults demonstrated more critical lure when they were given the word lists three times. These results are in line with results of the previously discussed study which showed that older adults did not benefit from repeated tests (Watson *et al.*, 2004). Moreover, the results are also similar to those of Attali and Barba (2013) that more false memories would be produced when the participant's attention is divided at the encoding process. Thus, both studies claimed that the encoding process is much more important in terms of false recalling compared with the retrieval process. However, this is not a valid conclusion –especially in this study – because they did not apply divided attention at the retrieval process and as a result of this their results do not give any evidence in terms of the effects of the retrieval process on false memories. To conclude, the study would have been more persuasive if the researchers had considered the effect of the retrieval process (monitoring), since, it is known from the literature that there is impairment in the monitoring process in older adults and that because of this impairment they might produce more false memories than younger adults (Dehon & Bredat, 2004; Gallo & Roediger, 2003). Nevertheless, this study is substantial because it indicated the poverty of older adults in terms of false memories compared with young adults, which also harmonises with the aim of this paper.

Finally, a recent study Fandakova *et al.* (2013) examined the effects of memory monitoring deficits in older adults and their confidence level while they are producing false memories. The confidence levels of the younger and older adults were also compared in Dehon and Bredat's (2004) study described above, and the findings indicated that the older adults were more confident in their false responses than the younger adults. Similarly, Fandakova *et al.* also found that the confidence levels of the older participants were higher than those of the younger ones. Additionally, the researchers also examined the differences between young and old adults in terms of benefit from repeated test trials which was also examined in Watson *et al.*, (2004) study described above, and it was found that the older adults gained no benefit from repeated test trials. In parallel with the previously-described study, Fandakova *et al.* also found that older adults did not reduce their false memories throughout the repeated tests. In all these supporting findings, the researchers have also indicated the vulnerability of older adults in terms of the production of false memories. The researchers have explained this result by the retrieval monitoring account. According to them, the reason behind the increased false memory in older adults is deficits in the monitoring process. Unlike the other studies which have been discussed above, Fandakova *et al.* (2004) used a recognition task instead of a recall task. According to Kelley and Sahakyan (2003), recognition tasks force the participants to make a decision instead of having a choice such as 'I do not remember' in recall tasks. However, recognition tasks allow the production of much more memory whereas recall tasks limit the participants' choices (Kelley & Sahakyan, 2003). To conclude, this study would have been more persuasive if the researchers had used a more real-life research design since, as already observed, it is known from the literature that the DRM paradigm does not fit every-day events because of its lack of generalizability (DePrince *et al.*, 2004). Nevertheless, the study is substantial in that it supports the evidence for source monitoring in false memories and also shows the age-related decreases in false memories which is also in harmony with the aim of this paper.

## Conclusion

The aim of this paper is provide information about false memories, explain the retrieval model with a focus on source monitoring as an underlying factor and the effects of ageing on them. Additionally, it has focused on a discussion often related papers from the literature. It has also sought to create a correlation between these ten previous studies and the proposed future research study which will be planned to examine whether older adults are more vulnerable to false memories and investigate whether false memories increase because of failures of the retrieval process.

The DRM paradigm discussed in this paper has been used in the past to investigate false recall, but there is disagreement about its reliability and some scholars claim that findings made in academic studies using this paradigm cannot be generalized to real life because there is no relationship between words and events (DePrince *et al.*, 2004). Nevertheless, given the aim of this paper, the studies which have used the DRM paradigm have found that older adults are more vulnerable to recalling lures, and this is linked to false memories (Dehon & Bredat, 2004).

It is vital to differentiate between real and imagined past events or future planned events to remember them completely (Johnson & Mitchell, 2009). Although this paper has discussed evidence from the literature that indicates the effect of the retrieval processes on false memories in older adults, it has also examined other papers which claim the importance of encoding rather than the retrieval process.

Although the ten papers discussed here examined different aspects of false memories, some general results were also found. For instance, in nine of the ten research studies, older adults were found to be more vulnerable to producing false memories or recalls than younger adults (the single exception is Umanath & Marsh, 2012). However, this common finding was interpreted differently in different studies. Whereas Attali and Barba (2013) and Skinner and Fernandez (2009) claimed that the reason for this vulnerability in older adults is impairment of the encoding process, Dehon and Bredat (2004), McDonough and Gallo (2013), Watson *et al.*, (2004) and Fundakova *et al.*, (2013) all suggested that retrieval processes such as source monitoring or retrieval success are important to produce true memories.

Furthermore, the studies discussed here demonstrated that older adults have more confidence in their false memories than younger adults (Dehon & Bredat, 2004; Fundakova *et al.*, 2013), which might be explained by deficits in the source memory of older adults. Additionally, warning effects were also examined and it was found that older adults continued to produce false memories even though they had been warned of the possibility before the tests (Dehon & Bredat, 2004; Watson *et al.*, 2004).

To conclude, memories are sometimes unreliable, especially when people are getting older and could produce false memories unintentionally.

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