



# Diminished episodic memory awareness in older adults: Evidence from feeling-of-knowing and recollection

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## Abstract

The ability to reflect on and monitor memory processes is one of the most investigated metamemory functions, and one of the important ways consciousness interacts with memory. The feeling-of-knowing (FOK) is one task used to evaluate individual's capacity to monitor their memory. We examined this reflective function of metacognition in older adults. We explored the contribution of metacognition to episodic memory impairment, in relation to the idea that older adults show a reduction in memory awareness characteristic of episodic memory. A first experiment showed that age affects the accuracy of FOK when predictions are made on an episodic memory task but not on a semantic memory task, suggesting a particular role for episodic memory awareness in metacognitive evaluations. A second experiment showed that the age-difference in episodic FOK accuracy was removed if one took into account subjective reports of memory awareness, or recollection. We argue that the FOK deficit specific to episodic memory is based on a lack of memory awareness manifest as a recollection deficit.

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## 1. Introduction

Aging leads to a somewhat inevitable deterioration in episodic memory. One prevalent theory is that this memory dysfunction is connected to difficulties with the strategic regulation of memory, or metamemory (e.g. Shimamura, 1994). One such strategic activity is the awareness of memory function, or memory monitoring. The ability to monitor memory performance has considerable importance in everyday life and has been widely investigated previously (Berry, West, & Dennehey, 1989; Dixon & Hertzog, 1988; Perlmutter et al., 1987), especially with reference to age-related changes in episodic memory function (e.g. Connor, Dunlosky, & Hertzog, 1997; Souchay, Isingrini, & Espagnet, 2000). The rationale for such studies of metamemory is that

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episodic memory dysfunction is possibly caused, or at least contributed to, by a deficit in metamemory. A failure to monitor memory would mean that older adults were unable to compensate for their memory difficulties, or find it difficult to allocate cognitive resources efficiently to ensure adequate memory function.

In studies of aging, one of the often overlooked features of episodic memory is recollective experience, the subjective state or memory awareness that separates episodic ‘remembering’ from semantic ‘knowing’ (Tulving, 1985). Comparisons of remembering and knowing, two forms of memory awareness have been studied neuropsychologically as well as experimentally (Tulving, 1985; see Gardiner & Richardson-Klavehn, 2000, for a review) and are proposed to map on to episodic and semantic memory respectively. Recollective experience, or remembering occurs when a rememberer has a sense or feeling of the self in the past (according to Tulving’s (1985) view, ‘autoeotic consciousness’). Images (often visual), feelings, thoughts and verbal statements directly related to the recalled episode also often come to mind during recollective remembering.

A number of different models have been proposed which assume that retrieval in memory can be based on these two distinct forms of memory (see Yonelinas, 2002). (For an account of how these two states could be formed by differences in confidence, and thus rely on a single underlying memory process see Dunn (2004).) In the aging literature, findings from different paradigms provide converging evidence that aging disrupts recollection to a greater extent than familiarity (see, Yonelinas, 2002). For example, estimates from the process-dissociation procedure show that age leads to a decrease in recollection, but does not affect familiarity (Light, Prull, La Voie, & Healy, 2000; Yonelinas, 2002). Recent evidence from signal detection approaches, and in particular, receiver operating characteristic (ROC) curves also confirms that age affects the recollection to a greater extent than familiarity (Healy, Light, & Chung, 2005).

The same pattern of results has been observed using the Remember/Know procedure (e.g. Tulving, 1995) where participants report their subjective experience as either ‘remembering’ or ‘knowing,’ with the finding that older adults report less ‘remembering’ for items that they correctly recognise (e.g. Bastin & Van der Linden, 2003; Clarys, Isingrini, & Gana, 2002; Comblain, D’Argembeau, Van der Linden, & Aldenhoff, 2004; Parkin & Walter, 1992; Perfect & Dasgupta, 1997; Perfect, Williams, & Anderton-Brown, 1995). Our understanding of theory is that one can either be in a conscious state of remembering, or a state of knowing. Thus, our interpretation of this data is that when retrieving items from memory, older adults are less likely to be in the state of remembering. When we argue that memory awareness is diminished in aging, we therefore posit that older adults have fewer instances of recollection. Different types of information support these different remembering and knowing states. For example, ‘remember’ answers are associated with accurate retrieval of contextual information regarding the learning of the items, while this is not the case for knowing judgments (Perfect, Mayes, Downes, & Van Eijk, 1996). Thus, one might argue that older adults with a deficit in episodic memory show two simultaneous or accompanying deficits: a lack of the feeling of remembering, and a lack of contextual information produced at retrieval.

When examining episodic memory deficits in older adults, most studies overlook this central role of subjective experience when defining episodic function, focussing more on the more objective criteria of recently learned (in an earlier experimenter-initiated study phase), versus previously learned (e.g. tests of general knowledge) to differentiate episodic and semantic memory, and measuring memory performance quantitatively, not with subjective reports of the quality of memory. However, when considering metacognition, it is very common to ask participants for reports of subjective experience. Given that episodic memory and metacognition are so often studied in aging, it seems a logical step to examine states of awareness and metacognition in parallel. Thus, in this paper, two experiments examine the relationship between metacognitive monitoring (i.e., the capacity to predict one’s own memory performance) and memory with and without recollective experience. In the first experiment, we compared monitoring in semantic memory (where recollection or ‘remembering’ is not required) and episodic memory (where it is required). In the second experiment, we took a more direct approach, considering metacognitive monitoring and remembering in the same experiment.

The focus of this paper is Feeling-of-Knowing (FOK), in which predictions are made about the likelihood of subsequent recognition of currently non-recalled information (Hart, 1965; Nelson & Narens, 1990). In this procedure, participants are asked to estimate the likelihood that they will recognize a piece of information they have failed to recall earlier, either from long-term knowledge or semantic memory (Hart, 1965; Nelson & Narens, 1990), or from recently learned episodic memory information (Schacter, 1983; Souchay et al.,

2000). The implicit logic is to assume that the better one's knowledge is about one's memory, the more accurate the predictions are likely to be.

There are several studies of FOK and aging, a typical finding being that younger and older adults do not differ in their ability to predict which items they will be able to recognise at least for semantic memory information (Allen-Burge & Storandt, 2000; Bäckman & Karlsson, 1985; Butterfield, Nelson, & Peck, 1988; Lachman, Lachman, & Thronesbery, 1979; Marquie & Huet, 2000). However, using an Episodic FOK metamemory task, Souchay et al. (2000) found a significant age effect on FOK accuracy for recently learned episodic information. Thus, as a whole, the data on FOK and aging suggest that an age-related decline in FOK accuracy may occur when judgments are made about episodic memory information but not when they are made about semantic memory information.

The question of interest concerns the age effect observed specifically for episodic FOK accuracy. This suggests that episodic and semantic FOK judgements may be based on different aspects of subjective experience. According to Koriat (1993), FOK judgments are based on an inferential process that uses a variety of mnemonic cues to determine the likelihood that the target is retained in memory and will be recognized in the future. Thus, when participants fail to recall an answer, their FOK judgments are based on partial information accessed during the search for the target. Furthermore, FOK accuracy is based on the quality of the partial information retrieved (Koriat, 1993). Our novel hypothesis is that in an episodic memory task, this 'partial information' is akin to the contextual information, feelings, and self awareness captured in Tulving's concept of autonoetic consciousness or the state of 'remembering,' and that a disruption of this state in older adults contributes to this particular deficit in monitoring episodic memory. This idea will be developed below, but we suggest that FOK judgments in older adults are particularly impaired in episodic memory tasks, because in these types of task, retrieval processes, guided by a state of 'remembering' are critical (see Conway, 2005). In a semantic memory task, one can assume that target item retrieval depends mainly on cues present in the person's general knowledge, and can be made fairly accurately on the basis of reading the cue alone.

Because it would be theoretically interesting if FOK was impaired for one form of memory but not the other, it seemed important to replicate the age deficit in episodic FOK, but more importantly, to demonstrate within the same group of participants that one form of monitoring is impaired, but another is intact. The purpose of the first experiment in this research was to investigate this hypothesis directly by testing the same group of participants with both an episodic and a semantic FOK task. In regards to the literature, we expected to observe an age effect only on the episodic FOK, but not semantic FOK. As will be discussed below, this would suggest that the two forms of FOK draw upon different cues, and the ability to monitor these cues is affected differentially by the aging process.

## 2. Experiment 1

The main aim of this experiment was to confirm the hypothesis that FOK accuracy is impaired in older adults for episodic but not semantic materials. This novel hypothesis was evaluated by directly comparing age effects on both Semantic FOK and Episodic FOK accuracy within the same individuals, with the same type of materials, and with comparable FOK judgment procedures. An additional feature of Experiment 1 was that, as far as possible, FOK responses were made for identical stimuli. That is, as well as FOK judgements being made by the same people across two tasks, the two tasks also used the same targets in the memory test in a counterbalanced manner. For example, in the semantic condition, people might be asked 'What is the subject of Magritte's famous surrealist painting, 'La Trahison'?' (Pipe). In the episodic condition, people studied the same target (Pipe), but with an episodic cue (unrelated to the word), e.g. Birthday—Pipe. This novel procedure ensured that the critical target for which the FOK judgement is made is the same in either condition. This is preferable since previous research has indicated that to some extent, the characteristics of the to-be-recalled target influence the magnitude of FOK judgement (e.g. Koriat, 1997). Thus, the design ensured that any differences in FOK accuracy were not due to differences between participants (the same participants took part in both tasks) and that the discrepancies between the semantic and episodic tasks were limited to the encoding conditions (pre-existing general knowledge or in a study phase) and the cue used at test (either general knowledge question, or episodic cue from the study phase).

## 2.1. Method

### 2.1.1. Participants

A total of 60 people living in a medium-sized metropolitan area served as participants. There were two groups: 40 older (7 men, 33 women; age range 64–91 years) and 20 non-student young adults (9 men, 11 women; age range 20–30 years). All participants were volunteers, and reported themselves to be in good physical and mental health, and free from medication known to affect the central nervous system. All participants in the older sample attained Dementia Rating Scale (DRS) (Mattis, 1976) scores over the cut-off of 137 points. Participants were also selected according to educational background and had at least 8 years of education. Table 1 shows that, on average, the younger adults had significantly more years of education than the older ones. However, the two groups did not differ on the Mill Hill Vocabulary Test (Raven, Court, & Raven, 1986).

### 2.1.2. Materials and procedure

**2.1.2.1. Feeling-of-knowing and memory assessment.** The FOK procedures used here were similar to those used previously to study Semantic FOK (Nelson & Narens, 1990) and Episodic FOK (Schacter, 1983). The most notable difference between the Episodic FOK and Semantic FOK procedures is that the former involves a study phase, so that FOK judgments are made on recently encountered material. The Semantic FOK procedure does not involve episodic learning, so FOK judgments are made about general information assumed to be already stored in memory. For this condition, participants are asked to answer general knowledge questions (cued recall). Following this, they are asked to make FOK judgments predicting whether they would or would not be able to recognize the correct answer if it were presented among some likely but incorrect choices. For the Episodic FOK condition, the cued recall test is preceded by a study phase in which participants have to learn cue-target pairs of words. The cued-recall phase is followed by FOK judgments similar to those in the semantic task. For both Semantic FOK and Episodic FOK, the FOK procedure is usually only assessed on the items the participants could not recall.

In this study, for the Semantic FOK task, 80 general-information questions were chosen from the pool of French questions specifically created for the Semantic FOK task by Izaute, Laroche, Morency, and Tiberghien (1996). The questions tapped information about a variety of topics including sport, animals, medicine, and general knowledge. Each question was printed on a separate index card. The Episodic FOK procedure involved low- to moderately-associated pairs of words. The stimulus list was constructed with the 80 response words used in the Semantic FOK task. To determine the association level between these words and the cue words in the cued-target word pairs, we asked 76 adult participants (age range: 18–89 years) (who did not take part in the critical experiment) to produce the first word that came to mind when each target

Table 1  
Characteristics of participants and experimental measures, Experiment 1

	Younger ( <i>n</i> = 20)	Older ( <i>n</i> = 40)
<i>Characteristics of participants in the two groups (means and standard deviations)</i>		
Age (years)	24.25 (3.29)	74.05 (7.74)
Education (years)	14.05 (2.01)	9.80 (1.82)
Mill Hill vocabulary	33.50 (3.92)	31.92 (5.01)
<i>Feeling-of-knowing measures (means and standard deviations)</i>		
Gamma Episodic	.57 (.21)	.24 (.37)
Gamma Semantic	.35 (.21)	.46 (.34)
<i>Memory measures (means and standard deviations)</i>		
Cued recall		
Episodic	.36 (.19)	.16 (.11)
Semantic	.47 (.15)	.31 (.17)
Recognition		
Episodic	.86 (.11)	.71 (.13)
Semantic	.80 (.08)	.68 (.15)

word was presented. Only weakly associated words (1–3 occurrences out of 76) were selected to compose the 80 critical word pairs used in the Episodic FOK task. Consequently, the target material was identical in the Episodic FOK and Semantic FOK tasks. Each critical word had a corresponding question in the Semantic FOK task and a moderately associated cue word in the Episodic FOK task. The list of 80 target words was divided into two subsets of 40 items. To control for list effects, the sets were balanced across FOK tasks so that each critical target word was presented equally often in each experimental condition (Episodic vs. Semantic). Finally, the order of FOK tasks was controlled in this study so that half of the participants started with the episodic task and the other half with the semantic task.

*2.1.2.2. Episodic feeling-of-knowing.* All participants were tested individually. The procedure included a study phase, a cued-recall phase, an FOK judgment phase, and a recognition phase.

*Study.* In the study phase, all participants were presented with the 40 critical cue-target word pairs and were told that their memory for the target word would be tested later with the presentation of the corresponding cue from the list. The pairs were presented in a booklet on a 16 × 16 cm white sheet of paper, at a rate of 5 seconds per item. The cue word was printed in lowercase letters directly above the target word, which was printed in capital letters.

*Recall and feeling-of-knowing.* After the study phase, participants were instructed about the cued-recall phase. They were asked to recall the target word that corresponded to a given cue. Each cue was presented on a 16 × 16 cm white sheet and printed in lowercase letters. Participants were given 15 s to recall the target for a given cue. At the end of the 15-s period, the experimenter asked the participants to make their feeling-of-knowing predictions. They were allowed 5 s to do so. Feeling-of-knowing predictions were made for all items, not just the non-recalled ones. This procedure was necessary because participants did not know whether the items they had written down on the cued-recall test were in fact correct. However, only the predictions for non-recalled items (omissions errors) were included in the analysis of feeling-of-knowing accuracy. The FOK judgment response was either “yes” or “no”: when participants thought they would be able to recognize a target, they made a “yes” prediction, and when they thought they would not be able to recognize a target, they made a “no” prediction. The recognition test followed immediately after the FOK phase.

*Recognition.* A five-alternative, forced-choice recognition task was administered for each of the 40 word pairs (recalled and non-recalled). Participants were shown the 40 cue words, each one accompanied by five alternative response-words, the correct one plus four non-semantically related distracters. Each cue word and its response words were presented in a booklet on a 16 × 16 cm white sheet of paper. Participants performed this task at their own pace. They had to underline the words seen earlier. In both recognition tasks (episodic and semantic), the list of alternative response-words was taken from Izaute et al. (1996).

*2.1.2.3. Semantic feeling-of-knowing.* The procedure included a cued-recall phase, a FOK judgment phase, and a recognition phase.

*Recall and feeling-of-knowing.* The cued-recall phase was similar to the one used for Episodic FOK except that the participants were asked to answer 40 general-information questions. Each question was presented on a white sheet of paper (16 × 16 cm). The feeling-of-knowing prediction phase was strictly the same as in the Episodic FOK procedure.

*Recognition.* The recognition phase was similar to that used in the Episodic FOK procedure except that participants were shown the 40 initial questions, each accompanied by the five alternative response-words.

*2.1.2.4. Metamemory and memory accuracy.* In the FOK paradigm (Hart, 1965; Nelson, 1984), accuracy is generally assessed by calculating the Goodman–Kruskal Gamma correlation between the FOK judgment and recognition performance (Nelson, 1984; Wright, 1996); a Gamma correlation is calculated for each participant, and is then used as a dependent variable in a factorial design. Gamma is a continuous variable that ranges from –1 to +1. A large positive value means a high degree of accuracy, a value of zero means chance-level accuracy, and a negative value means less than chance-level accuracy. Note that for the calculation of Gamma, the measure is undefined when, two of the four possible outcome rates used to compute the Gamma scores (1, correct recognition of “yes” prediction; 2, incorrect recognition of “yes” prediction; 3, correct recognition of “no” prediction; 4, incorrect recognition of “no” prediction) are equal to 0. Thus, following Snodgrass and



Corwin's (1988) recommendations (see Souchay, Isingrini, Pillon, & Gil, 2003), we corrected the raw data by adding 0.5 to each frequency and then dividing by  $N + 1$  (where  $N$  is the number of judgments).

## 2.2. Results and discussion

Our main focus here was to examine the age differences on metamemory and memory measures. The data on FOK (episodic and semantic) and memory tasks (episodic and semantic cued recall and recognition) are summarized in Table 1.

*Memory.* A 2 (age group)  $\times$  2 (task—episodic vs. semantic) repeated measures ANOVA conducted on memory performance (proportion correct) yielded the expected main effect of age, [ $F(1,58) = 32.72, p < .001$ ] showing reduced performance in the older group. A significant main effect of task type was also observed, [ $F(1, 58) = 22.37, p < .001$ ] showing greater performance in semantic recall, but there was no interaction between age group and task, [ $F(1,58) < 1$ ]. These results suggest a similar effect of aging on both episodic and semantic recall. A similar analysis on the recognition data, yielded a significant age effect, [ $F(1,58) = 22.93, p < .001$ ], an effect of task type that approached significance, [ $F(1,58) = 4.00, p < .06$ ], and no interaction between age group and recognition measure type, [ $F(1,58) > 1$ ].<sup>1</sup>

To control for a possible educational background effect, analyses of covariance were conducted on each memory measure. Before doing so, we tested that the two statistical assumptions to conduct an analysis of covariance were met (i.e., linearity and homogeneity of regressions). For the recall measures, the analysis indicated that the age effect on episodic recall remained significant when educational background was partialled out, [ $F(1,57) = 11.29, p < .01$ ], however, it was reduced for semantic recall and turned out non reliable (however, approaching significance) [ $F(1,57) = 3.46, p < .07$ ]. A further analysis on semantic recall showed that without partialling out educational background the effect size was large (Cohen's  $d = .93$ ), while when controlling the educational background the effect size turned out to be medium (Cohen's  $d = .45$ ). Finally, for the recognition measures, an analysis of covariance showed that the age effect on episodic recognition memory remained reliable after partialling out educational background, [ $F(1,57) = 10.70, p < .01$ ] but not on semantic recognition, [ $F(1,57) = 1.18$ ].

*Feeling-of-knowing accuracy.* Our main focus was the comparison of episodic and semantic FOK. First, it should be noted that the two FOK measures, for the two groups, were all reliably above the chance level. One-sample  $t$ -tests demonstrated that Gammas were reliably non-zero ( $p < .001$ ). A 2 (age group)  $\times$  2 (task—episodic vs. semantic) repeated measures analysis of variance (ANOVA) was conducted on the Gamma correlations. This analysis yielded a significant main effect of age [ $F(1, 58) = 4.35, p < .05$ ] showing reduced accuracy in the older group. There was no main effect of task [ $F(1, 58) < 1$ ]. As hypothesized, there was, however, a significant interaction between age group and FOK measure type, [ $F(1, 58) = 10.57, p < .01$ ]. The means (Table 2), show that whereas the younger adults have higher Gammas for the episodic task, the older adults actually outperform the younger adults on the semantic task. For further consideration of this interaction, two separate one-way ANOVAs were conducted on each FOK measure. These indicated a significant age group effect on Episodic FOK accuracy clearly revealing reduced performance with age, [ $F(1,58) = 13.37, p < .001$ ], but not on Semantic FOK accuracy [ $F(1,58) < 1$ ]. Because the assumption of linearity between the FOK Gamma correlations and the educational background measure was violated, educational background was not used as a covariate. There is a clear pattern of results: there are no group differences in semantic FOK (and, if anything, the older adults are actually more accurate than young people on this task), and a highly significant impairment in FOK accuracy for the older adults on the episodic task. Altogether, these observations support the hypothesis that only Episodic FOK accuracy is affected by age group.

The main goal of this experiment was to confirm the differential effect of aging on Episodic FOK and Semantic FOK accuracy. The major new finding was that a dissociation was observed with the same individuals and using the same target words for the two FOK tests. The finding that an age-linked change may appear

<sup>1</sup> The fact that semantic memory is affected in this manner is of interest, since although older adults cannot recall information as well as younger people, they are nonetheless able to recognise it. This lack of accessibility is not unlike difficulties with TOT which are more frequent in older adults.

Table 2  
 Characteristics of participants and experimental measures, Experiment 2

	Younger ( $n = 20$ )	Older ( $n = 36$ )
<i>Characteristics of participants in the two groups (means and standard deviations)</i>		
Age (years)	26.55 (3.67)	72.41 (8.94)
Education (years)	12.10 (0.71)	10.22 (1.35)
Mill Hill vocabulary	36.85 (2.74)	37.50 (5.22)
<i>Feeling-of-knowing task (means and standard deviations)</i>		
Memory measures		
Cued recall	20.95 (7.43)	10.08 (6.38)
Recognition: hits	36.95 (2.32)	30.25 (4.29)
FOK accuracy		
Gamma	.54 (.36)	.36 (.23)
<i>Remember-know task (means and standard deviations)</i>		
R/K measures		
R	.59 (.24)	.31 (.31)
K	.03 (.40)	.05 (.30)
Memory measures		
Recognition: hits	29.65 (3.77)	23.86 (5.92)
Recognition: false alarms	5.75 (4.11)	7.94 (4.72)

on a FOK task where episodic memory is involved, but not semantic memory, demonstrates, at least in certain conditions, that metamemory monitoring is affected by aging. As a whole, our results are consistent with previous studies where aging effects on Episodic FOK and Semantic FOK accuracy were analyzed in separate experiments (Allen-Burge & Storandt, 2000; Bäckman & Karlsson, 1985; Butterfield et al., 1988; Lachman et al., 1979; Marquie & Huet, 2000; Souchay et al., 2000). To recapitulate, the fact that age affects only the FOK for an episodic memory task and not a semantic task suggests that these may be functionally different. Our view is that the difference between episodic and semantic memory, especially for such tasks assessing subjective experience, or cognitive feelings such as FOK, must be the subjective state at the time of retrieval, or the state of awareness, and the availability of contextual details and other information.

According to Koriat (1993), when participants fail to retrieve targets from memory, FOK judgments are based on the partial information accessed during the search for the target. Early work on partial recall comes from the tip-of-the tongue (TOT) literature (e.g. Schwartz, 2002). Indeed, TOT and semantic FOK paradigms are very similar. In TOT, participants are asked to retrieve a word in response to a definition and are either asked to signal if they are in a TOT state or are asked to predict their later recognition of the non-recalled word. TOT studies and Semantic FOK studies show that participants can successfully retrieve either structural–phonological partial information, such as the initial letter, or semantic related information, such as the connotative meaning (e.g. Eysenck, 1979; Schwartz, 2002). In the same way, studies using an episodic memory task to assess the FOK, have shown that participants can retrieve some structural–phonological partial information (Blake, 1973; Koriat, 1993) or some semantic related information (Koriat, 1993; Koriat, Levy-Sadot, Edry, & de Marcas, 2003; Schacter & Worling, 1985).

However, despite these similarities, we also suggest some important differences. Here, we make a novel suggestion: recollection-mediated retrieval processes are critical in an episodic FOK task but not in a semantic FOK task. In particular, we suggest that, unlike in an episodic FOK task, in a semantic FOK task, the participant need not retrieve event-specific information about encoding conditions, and the relationship to the cue. In the episodic task, to make an evaluation of FOK, even if participants can use structural or semantic related partial information, they might also need to access information based on retrieval of the specific study episode of the materials in question. Thus, episodic FOK tasks involve another kind of partial information regarding how and where the information was acquired and it is this reliance on these auto-noetic partial cues that makes these episodic judgements particularly difficult for the older adults. Thus, the differential use of retrieval cues may explain the dissociations observed in all these population between a preserved semantic FOK and an impaired episodic FOK. We return to this idea in more detail below.

Finally, the procedure used in this study also gave us the opportunity to analyze age-related effects on both episodic and semantic memory for recall and recognition tasks. The data indicated a reliable age-related effect for episodic recall and recognition tasks. However, as demonstrated by analysis of covariance and effect sizes, the age-group effect on the semantic memory cued recall and recognition tasks appeared to be somewhat accounted for by the cohort educational difference between younger and older participants. These findings seem to be consistent with the claim that increasing age is associated with a significant decline in episodic memory whereas semantic memory is relatively preserved (Balota, Dolan, & Duchek, 2000), again converging on the idea that older adults are disproportionately disadvantaged on tasks requiring recollection of previous episodes.

### 3. Experiment 2

The first experiment confirmed that age affects the accuracy of FOK predictions when made on an episodic memory task. Of interest is determining why age seems to affect only the FOK accuracy in episodic memory. According to Koriat and Levy-Sadot (2001) FOK judgments can be based on two different types of retrieval processes: an automatic one and an effortful one (similar to the distinction made by Tulving (1985) referring to knowing—more automatic, and remembering—more effortful). This idea relies mainly on the model proposed by Jacoby (Jacoby, 1991) which suggests that memory judgments can be made on the assessment of processing fluency (i.e. familiarity) or on the recovery of the context and elaboration given to an item when it was initially studied (recollection—sometimes synonymous with autonoetic consciousness). In support of these ideas, in a recent study on young adults, Hicks and Marsh (2002) showed that high FOK predictions were associated to more remember judgments in a recognition tasks. In other words, a high level of confidence in future retrieval of a currently non retrievable stimulus was associated with remembering the item at retrieval. This suggests that the feeling of ‘knowing’<sup>2</sup> experienced during a failed recall attempt occurs alongside items being later recognised on the basis of a feeling of remembering. We propose that both these cognitive feelings stem from states of memory awareness which operate alongside memory processes.

Thus, the retrieval of contextual information, supported by feelings of recollection is critical for accurate FOK predictions, and we suggest that this retrieval is lacking in older adults. There exists a considerable evidence that older adults fail to retrieve contextual information available to older adults during tests of episodic memory (see Craik & Jennings, 1992), but to date no-one has used this evaluation of retrieval processes to consider the basis of metamemory failure in older adults, nor suggested a diminished subjective experience.

More germane to the current study, most research into the contextual information available to older adults in tests of episodic memory derives from research considering the differences in recollection and familiarity. Older adults have a memory performance characterised by a lack of recollection, and also fail to retrieve contextual information. This has great relevance to the question of the age effect on the FOK where it is based on the retrieval of episodically-based partial cues. However, despite the clear conceptual similarity between these research themes, no study has assessed how the age effect on recollective experience may explain the age effect observed in an episodic FOK task. We make the novel suggestion that the age effect on the FOK in episodic tasks is related to these retrieval (contextual) deficits in older participants. That is, when an older adult is faced with the task of assessing future performance in an episodic FOK task, they lack sufficient contextual material to act as a cue in order to predict accurately subsequent recognition. We conceptualise this as a reflecting diminished memory awareness and the information available when retrieval fails.

Thus, in a second experiment, we aimed to unite these two different research themes in the aging literature: FOK and recollective experience. In the light of the foregoing arguments we hypothesized that recognition performance in older adults is characterized by a lack of contextual information available at test—a failure in autonoetic consciousness manifested empirically as a lack of ‘remembering’. In turn, we suggest that FOK judgments in older adults are inaccurate because the important contextual information necessary to make accurate FOK judgements is lacking: thus older adults rely more on ‘knowing’ than younger adults

<sup>2</sup> The term ‘knowing’ here is somewhat misleading, since we are arguing that this particular feeling is based on autonoetic consciousness, usually conceptualised as feelings of remembering. However, we have used the term ‘knowing,’ because the measure of subjective experience taken at this point is ubiquitously referred to as a ‘feeling of knowing.’



and that this is the reason why older adults are found to be less accurate at predicting their recognition performance. Thus, our main aim was to extend the research on examining the quality of the subjective experience accompanying FOK judgements in older adults by using the remember/know distinction (Gardiner & Java, 1991; Tulving, 1985).

According to Koriat (1993), the efficacy of metamemory processes stems from the quality of memory processes themselves. FOK accuracy may thus depend on the overall accuracy of the partial information (Koriat, 1993). Thus, we predicted that FOK accuracy might be more related to Remember responses than to Know responses. To assess this hypothesis, participants were given a classic episodic FOK task and a separate Remember-Know task. The link between FOK accuracy and Remember-Know was determined using a between-subjects correlation analysis between RK responses and FOK accuracy, with the prediction that those people reporting higher levels of remembering would make more accurate FOK predictions. Finally, we suggested that older adults' inaccuracy in predicting their performance in the recognition task may be related to the fact that older adults rely more on familiarity process in retrieval. Thus, by using a multiple regression analysis we predicted that the age effect on the Remember responses may explain the age effect on FOK accuracy.

### 3.1. Method

#### 3.1.1. Participants

A total of 20 young adults (age range, 20–30) and 36 older adults (age range, 60–91) served as participants in this experiment. Participants in Experiment 1 were not included in Experiment 2. The group of young adults consisted of 11 men and 9 women and the group of older adults consisted of 10 men and 26 women. All participants were volunteers and reported themselves to be in good physical and mental health and free from medication known to affect the central nervous system. For older adults a first screening was made on the basis of their overall score on the Mini Mental Status (MMSE, Folstein, Folstein, & McHugh, 1975), which identifies older adults who exhibit signs of the onset Alzheimer's disease. All participants in the older group gained MMSE scores over the cut-off of 27 points ( $M = 29.42$ ;  $SD = 0.72$ ). Participants were also selected according to educational background. All those who participated in the study had at least 8 years schooling. Descriptive statistics on age, education and vocabulary score (Mill Hill, Raven, Court & Raven, 1986) are shown in Table 2. There was a significant age effect in years of education, with younger adults having more years of education.

#### 3.1.2. Materials and procedure

All participants were tested individually on two separate tasks: an episodic FOK task and a R/K task. These two tasks were counterbalanced such that half of the participants in any one group were tested first on FOK and the other half on Remember/Know.

*3.1.2.1. Remember/know task.* The procedure included a study phase and a recognition phase. The words were selected from the Lieury, Iff, and Duris (1976) and Vazou and Isingrini (1994) associative norming lists. The mean normative frequency of the distracters chosen for the recognition phase was similar to that of the target items. In the study phase, all participants were presented a list of 36 items. The words in this list were taxonomically unrelated concrete nouns. Items were presented in a booklet on a 16 × 16 cm white sheet of paper, at a rate of 5 seconds per item. The participants were told to read the words and to remember them for a test to be given afterwards. The test list in the recognition phase consisted of the 36 target items and 36 unrelated distracters. Participants were instructed to underline the words if they recognized them from the list seen earlier. Immediately after making this recognition response, they made a Remember or Know judgement. For items identified as old, they evaluated whether this was a Remember (R) or Know (K) judgement. The Remember-Know instructions were based on those used by Gardiner (1988). Participants were told that they were to respond R only if they could remember some qualitative information about the study event. They were told that this could include such things as recollecting what they were thinking about when the word was presented. Moreover, they were instructed that they should respond R only if they could, if asked,

tell the experimenter what they recollected about the study event. Participants were told to respond K if they thought the item was studied but could not recollect any details about the study event.

*Memory measures and remember-know measures.* Memory was measured by two recognition scores: the number of correct hits and the number of false alarms. Recollection and familiarity were assessed by using an independent Remember/Know method suggested by Yonelinas and Jacoby (1995). Recollection is measured as a probability and is estimated by subtracting the proportion of false remember responses from the proportion of true remember responses then dividing by the opportunity to observe true remember responses. According to their measure, to determine the probability that an item is familiar, one must divide the proportion of know responses by the opportunity the participant has to make a know response (see Yonelinas & Jacoby, 1995; Yonelinas, Kroll, Dobbins, Lazzara, & Knight, 1998).

*3.1.2.2. Episodic feeling-of-knowing task.* The FOK task used in this second experiment was identical to Experiment 1.

### 3.2. Results and discussion

In this section, we firstly consider the FOK task, before turning our attention to the R/K task. In each, we consider objective memory performance before moving on to the subjective evaluation of memory. Finally, we take a between-subjects approach to consider the contribution of recollection to FOK. As recommended by Bryan and Luszcz (1996), the age-group variable was used rather than individual age in all hierarchical regression analyses. As participants were sampled from two age groups, age was not normally distributed in this study, and correlations involving variables with this type of distribution tend to be inflated because of over-estimation of the range of scores. Therefore, age was coded as a qualitative variable (*young* = 1, *old* = 2).

#### 3.2.1. Feeling-of-knowing task

*Memory performance.* In this task, a one way ANOVA revealed a significant Age effect on recall [ $F(1,51) = 33.14, p < .001$ ], such that older adults recalled fewer items (see Table 2 for means). A significant Age effect was also found for recognition [ $F(1,51) = 41.57, p < .001$ ] with older adults recognizing less target words. Because the assumptions to conduct an analysis of covariance were met, we included years of education as a covariate. The results showed that Age effect remained significant when educational background was included as a covariate on the recall task [ $F(1,53) = 10.76, p < .001$ ] and the recognition task [ $F(1,53) = 17.02, p < .001$ ].

*FOK accuracy.* The two FOK measures, for the two groups, were all reliably above chance, with the two FOK indexes were reliably non-zero [ $p < .001$ ]. As expected from Experiment 1, a *t*-test revealed a significant difference between younger and older adults on FOK Gamma [ $t = 2.48, p < .02$ ], replicating the finding that younger adults have higher FOK accuracy scores than older adults for episodic materials (see Table 2). In this study we thus confirm that age has an effect on FOK in episodic memory. Because no linear relationship between FOK Gamma correlation scores and Years of education measures was observed, no covariance analysis was conducted.

*3.2.1.1. Remember/know task. Memory performance.* First, a one way ANOVA revealed the expected significant age effect on recognition, older adults producing less hits than younger adults [ $F(1,51) = 3.02, p < .01$ ]. No age effect was found on the False Alarms scores in recognition.

*Remember-know responses.* This task also gave us the opportunity to examine the established recollection deficit in aging by comparing Remember and Know responses in older and younger adults. Table 2 gives the Remember and Know scores. First of all, a one way ANOVA on Remember scores showed a significant age effect [ $F(1,51) = 11.18, p < .01$ ] with older participants having less Remember responses than younger participants as reported previously in the literature. In contrast, no age effect was observed for the Know scores. Thus, we replicate previous findings reported in the literature insofar as the older adults' recognition is characterised by a lack of recollection. Again, because no linear relationship was been observed between years of education and any of the following dependant variables in this task (memory performance, or Remember-Know judgments), years of education has not been used as a covariate.

*Between subjects analysis.* Aging research on the Remember-Know paradigm suggests that memory retrieval in older participants is based more on familiarity than on the recollection of a more complete mental representation. This experiment aimed to determine whether this age effect on recollection affects FOK accuracy. By using a correlational analysis we assessed the relations between FOK accuracy and recollection (R/K answers). And finally, by using a regression analysis we examined whether the age effect on FOK accuracy was due to the age effect on recollection.

*Correlation analysis.* We predicted that high levels of FOK accuracy should be associated with higher levels of Remember responses than Know responses. Thus, a correlation was calculated between the Gamma scores and the Remember and Know scores. This revealed that the Gamma score was significantly correlated to the Remember scores [ $r = .29, p < .05$ ], but not to the Know scores [ $r = .003$ ]. Thus, those people who had higher levels of remembering in their recognition were also better able to predict their subsequent recognition performance in an FOK task. Correlations were also computed in each group separately. For the group of young participants, a significant correlation was obtained between the Gamma scores and the Remember scores [ $r = .52, p < .02$ ], but no correlation was noticed with the Know scores [ $r = .18, p > 1$ ]. In contrast, no significant correlations were observed in the group of older participants either for Know [ $r = .13, p > 1$ ] and Remember scores [ $r = .02, p > 1$ ].

*Regression analysis.* To answer the question of whether age-related differences in Recollection (Remember responses) mediate any age-related differences in FOK accuracy, we used a hierarchical regression procedure that allowed us to compare the amount of variance explained by age in the FOK measures with this amount when controlling for age-related difference in recollection (for a detailed discussion of this kind of regression analysis, see Salthouse, 1995). The hierarchical regression procedure showed that the total amount of variance associated with age on FOK was .30 ( $p < .02$ ). Partialling out the proportion of Remember responses measure reduced the age-related variance in the FOK index by 67% (i.e. ( $R^2$  with age alone— $R^2$  change)/ $R^2$  with age alone). Most importantly, the change in  $R^2$  for added age in the FOK was reduced to a non-significant .01. Thus, age related differences in recollection at test can explain the variance in age-related changes in FOK accuracy.

In summary, this second experiment gave us the opportunity to investigate the relation between recollective experience and FOK accuracy by determining whether participants who were able to make accurate FOK judgments were more likely to make R judgments for correctly recognized items. Correlational analysis gave support to our hypothesis by showing a clear relationship between FOK accuracy and Remember responses. No significant correlations were observed between FOK accuracy and Knowing responses. This second experiment was mainly aimed to assess whether older participants inability to make accurate FOK predictions was based on a lack of contextual information from the study episode being available at test. This prediction was borne out in that we demonstrated first that FOK accuracy score were not correlated to Remember scores and that in a regression analysis that the age effect on the FOK in one task was mainly explained by the age effect on the proportion of items given Remember responses at test in a different task. Given that we assume that R judgments are reflective of contextual detail available to the participant at retrieval, we suggest that this data supports our hypothesis, the accuracy of FOK predictions, is affected by recollective experience, and the deficit in FOK accuracy for older adults is likely to be due to a lack of this contextual information on which to base the FOK judgments.

Finally, in conducting this experiment we also again replicated a number of other established age deficits. Firstly, we confirmed a clear age effect on FOK accuracy with an episodic memory task (Souchay et al., 2000). Moreover, we demonstrated a clear episodic deficit, with older adults in two tasks demonstrating impaired cued-recall and recognition performance for verbal word-pairs. These results are in line with other research showing a clear age effect on both recall (Craig & McDowd, 1987; Whiting & Smith, 1997) and recognition (Bastin & Van der Linden, 2003) in episodic memory. Finally, we also demonstrated that older adults' correct recognition judgments were associated with fewer Remember responses, confirming that recognition in older participants is made more on the basis of familiarity, 'knowing,' rather than remembering (Parkin & Walter, 1992; Perfect et al., 1995).

#### 4. General discussion

The ability to monitor memory performance is probably one of the most investigated metamemory functions, especially because of its possible role in explaining memory difficulties. The Feeling-of-knowing

task is a common paradigm used to evaluate individual capacity to monitor or predict their memory performance. Previous research on FOK and aging suggested that an age-related decline in FOK accuracy might occur when predictions are made on an episodic memory task but not on a semantic memory task (e.g. Allen-Burge & Storandt, 2000; Souchay et al., 2000). Our hypothesis, based on the notion that it is states of memory awareness that separate episodic from semantic memory, was that older adults have impoverished cognitive feelings (i.e. a lack in the state of recollection) and this affects their ability to make metacognitive evaluations of episodic, but not semantic materials. We examined this first by comparing FOK in tasks which did (episodic FOK) and did not (semantic FOK) rely on the proficiency of recollection. The major new finding of this research was to confirm that age affects the accuracy of the FOK when predictions are made on an episodic memory task but not on a semantic task.

Following on from these results, using a correlational method, we conducted a second experiment in order to examine the relationship between FOK accuracy and the availability of contextual cues and partial information available at test as indexed by ‘remembering’. This second experiment showed that those individuals who made more accurate FOK predictions prior to the test phase, made more recognition judgments on the basis of remembering. Moreover, the age-difference in FOK accuracy was removed if one took into account measures of recollection: we argue that the FOK deficit specific to episodic memory tasks is based on a lack of a state of recollection, contextual information, or retrieval cues that are captured in asking participants to report their recollective experience.

Thus, it is a failure of metacognitive processes at retrieval, not encoding, that characterizes the aging deficit in metacognition (for evidence that metacognition is intact at encoding, see the judgement of learning literature, e.g. Connor et al., 1997). This resonates with the recollective experience literature. It is known that there is little correspondence between the introspective reports of contextual information and peripheral thoughts accessed at encoding and retrieval in memory tasks in older adults (Perfect & Dasgupta, 1997). Perfect and Dasgupta asked participants to ‘think aloud’ during encoding, and report what they were thinking during studying items for a future memory test. Then, at test, as well as make the usual remember/know judgements, participants made justifications on the basis of what they could remember thinking about during study. They found that when older adults justify their ‘remember’ responses, this has little bearing on what they were thinking or doing at encoding—they fail to retrieve the same comments about the item at study as at test. Again, we conceptualize this as a diminished subjective experience, a lack of appropriate recollection. By comparison, young participants make accurate reports of their introspections at study when prompted at retrieval. This lack of correspondence between contextual information at encoding, where the to-be-remembered item brings to mind one thought, and retrieval, where it seems to bring to mind another, is presumably behind the older adults’ difficulties in making accurate FOK judgments observed here.

We conclude that older adults have particular difficulties in accessing or utilizing cues from retrieval attempts in order to accurately predict future recognition. We presume that on the basis of cognitive feelings of remembering, younger adults are guided to reproduce meaningful material at retrieval. Whilst not actually recalling the item itself, the presence of the experience of recollection is such that it permits the retrieval of other material related to study, and the individual’s experience of it, and is therefore predictive of future recognition.

This line of argument is largely correlational. One possible interpretation of our results is that those people who are generally more accurate at predicting recognition are also better at making introspections about their memory in general in the remember/know task. This alternative explanation is merely that the correlations are based on general metacognitive competence within a subset of older adults. Whereas this correlational evidence needs interpreting with some caution, we think this alternative is somewhat unlikely. Firstly, this ‘general’ account would not explain why older adults appear to be impaired specifically on episodic and not semantic tasks, and secondly, it is not thought that there is a general metacognitive ability or processor: various types of metacognitive abilities and measures very rarely correlate with each other in individual differences analyses (Kelemen, Frost, & Weaver, 2000; Souchay, Isingrini, Clarys, Taconnat, & Eustache, 2004). Finally, to explore further the relationship between FOK and Remembering, experiments including Remembering and Know judgments in the recognition task following the FOK judgments should be carried out.

It is of interest to note that this type of dissociation between episodic and semantic FOK has been already reported in the literature in other populations reinforcing the idea of different consciousness-based processes in



the two memory monitoring systems. For example, patients with frontal lobe lesions have been found to show impaired FOK accuracy for episodic tasks only (Janowsky, Shimamura, & Squire, 1989). The same pattern of results has also been observed in patients with Alzheimer's disease (AD). AD patients were found to have a preserved semantic FOK (Bäckman & Lipinska, 1993; Lipinska & Bäckman, 1996) and an impaired episodic FOK (Souchay et al., 2003).

Our finding that older adults have a specific deficit in FOK accuracy when asked to predict performance on non-recallable items in an episodic memory task is evidence for a specific form of metacognitive deficit. Our view is that this is related to the quality of memory in older adults, and their impoverished subjective experience, or the lack of cognitive feelings to moderate and guide memory performance. We suggest that older adults have a metacognitive monitoring deficit, only where metacognitive proficiency relies on retrieval processes and cues based on mnemonic factors (Koriat, 1997), conceptualized as recollection or Tulving's concept of 'autonoetic consciousness': 'Remembering'. Future research could assess this possibility further by considering the subjective experience of older adults as they retrieve information in detail. When retrieving events from their past life—what is the cognitive feeling of the older adult: are they remembering experiences, or do they just know them? Further, previous research has shown that it is possible to train older adults to retrieve information on the basis of recollection and not familiarity (Jennings & Jacoby, 2003), which results in increased memory performance. It would be interesting to see if such interventions can also influence metamemory accuracy, or the richness of people's experiential state.

This study suggests a strong line for future research study. Firstly, the replication of an age effect on episodic FOK accuracy clearly illustrates one area in which older adults do have a metacognitive impairment. Interestingly, this metacognitive deficit seems secondary to the memory deficit, not vice-versa. Older adults have metacognitive difficulties on the basis of impoverished retrieval mechanisms: they fail to make accurate predictions because they cannot retrieve sufficient contextual information on which to 'remember' an item rather than merely find it familiar, and in turn, they cannot accurately predict their future recognition. Further research could address this hypothesis further: does providing contextual information aid accurate FOK predictions in the same way as it has been demonstrated to aid memory performance (e.g. Naveh-Benjamin, Craik, & Lilach Ben-Shaul, 2002). In addition, further studies could address which partially retrieved information is available to participants, and whether it is related to FOK accuracy. For instance, if a participant can remember the colour of an item, or whether it was in upper or lower case, it would be interesting to see if this 'partial information' at retrieval supports accurate predictions, as would be hypothesised from our findings. Moreover, would the reinstatement of contextual information lead to an experience of remembering, a reinstatement of normal recollective feelings?

Finally, whilst the aims of this paper were not neuropsychological, it is interesting to consider the brain mechanisms implicated in the lack of autonoetic states in older adults. Neuroimaging studies exploring the brain correlates of metamemory have revealed a set of brain regions including the prefrontal lobes and the mediotemporal lobes (Kikyo, Ohki, & Miyashita, 2002; Kikyo & Miyashita, 2004; Maril, Simons, Mitchell, Schwartz, & Schacter, 2003; Schnyer, Nicholls, & Verfaellie, 2005). This network of brain regions, similar to the one described by Papez (1937, 1995), could be in fact implicated more generally in any subjective experience or self-referential processing (Chua, Schacter, Rand-Giovannetti, & Sperling, 2006). Neuroimaging techniques have showed that frontal lobe structures are particularly vulnerable to the effects of aging (Cabeza et al., 1997; Grady et al., 1995; Schacter, Savage, Alpert, Rauch, & Albert, 1996). Thus, the frontal lobes, and a network connected to them might be implicated in the lack of the subjective experience of recollection in older adults. Damage to this network of brain regions has been shown to lead to pathological states of memory awareness, such as *déjà vecu* or 'recollective confabulation' (Moulin, Conway, Thompson, James, & Jones, 2005), where patients have false memory based on 'remembering' events that are actually novel. In fact, perhaps it is subtle changes to this area of the brain in aging that leads to changes in the subjective experience of memory such as the finding that older adults are less likely to report *déjà vu* (Brown, 2003).

To sum up, the idea central to this paper, that metacognitive evaluations in FOK are reliant on the knowledge available to participants is not new: '...people have no privileged access to the contents of their memory over and above what they can retrieve from it'. Koriat demonstrated that FOK accuracy is related to the likelihood that general knowledge questions yield answers, and that those answers are correct. However, what this present study illustrates is a clear difference between FOK for episodic (impaired in older adults) and semantic



materials (not impaired in older adults). We suggest that this difference is due to the different nature of semantic and episodic materials, namely that in making subjective evaluations of memory, older adults often lack recollection. We suggest that memory and metacognitive difficulties in older adults are characterised by diminished states of memory awareness, and specifically, a lack of recollection.

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