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FALSE RECOGNITION AND SOURCE ATTRIBUTION FOR ACTIONS OF AN EMOTIONAL EVENT IN OLDER AND YOUNGER ADULTS

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In two experiments recognition of actions of a robbery presented in a video was examined in older and younger adults. In both experiments older adults had more false alarms and showed less accurate recognition than younger adults. In addition, when participants were asked in Experiment 1 to indicate Remember/Know/Guess judgments for actions they considered true, older adults accepted more false actions with Remember judgments. And when participants were asked in Experiment 2 to attribute the source (i.e., perpetrator), the older adults were less able to attribute actions that occurred during the robbery to their correct sources. Furthermore, we found a robust positive correlation between source attribution ability and recognition accuracy. Thus, source-memory deficits may contribute to older adults' false memories in real-life eyewitness situations.

Older adults are usually more likely than younger adults to accept false information, showing a higher probability for errors in recognition tasks. This age-related susceptibility to false recognition has

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been found in memory for word-lists (e.g., Balota, Burgess, Cortese, & Adams, 2002; Pierce, Gallo, & Schacter, 2004; Tun, Wingfield, Rosen, & Blanchard, 1998), sentences (e.g., Bayen, 1999), fragments of prose (Reder, Wible, & Martin, 1986), drawings (e.g., Koutstaal, 2003; Koutstaal & Schacter, 1997), photographs (Schacter, Koutstaal, Johnson, Gross, & Angell, 1997a), faces (Memon, Bartlett, Rose, & Gray, 2003), complex scenes (e.g., Gutchess, Welsh, Hedden, Bangert, Minear, Liu, & Park, 2005), and TV news (Frieske & Park, 1999). When witnessing a simulated or live event, people use to focus their attention basically on the key actions of the event (Aizpurua, Garcia-Bajos, & Migueles, 2009; Woolnough & MacLeod, 2001). Although participants usually show a good episodic recall for the actions of an event, recognition of these contents is less accurate because people also tend to accept false actions congruent with the event (e.g., Migueles & Garcia-Bajos, 1999). Previous studies that have systematically examined adult age-related differences have found that older adults are relatively more likely to accept false information as true when recognizing the different contents of an eyewitnessed event (Aizpurua et al., 2009; List, 1986; Loftus, Levidow, & Duensing, 1992).

Mechanisms proposed to underlie increased false recognition in older adults include an overreliance on semantic gist (e.g., Balota et al., 2002; Koutstaal & Schacter, 1997; Reder et al., 1986; Tun et al., 1998), and deficits in memory for item-specific information (La Voie & Faulkner, 2000), such as poor memory for the source (for reviews, see Balota, Dolan, & Duchek, 2000; Schacter, Koutstaal, & Norman, 1997b). Source memory refers to the origin of an experience, such as the precise details of who said a particular statement, when and where a particular face was encountered, or whether an object was perceived or only imagined (Johnson, Hashtroudi, & Lindsay, 1993). Neuropsychological studies have revealed that source memory ability is related to prefrontal cortex and medial temporal lobes, and that these areas are affected by normal aging (for a review, see Mitchell & Johnson, 2009). Research on standard source attribution tasks, in which words or sentences are presented by two or more sources and participants are tested on the origin of each word or sentence, has found that older adults show a relatively lower ability to determine who presented the information (e.g., Bayen, 1999; Brown, Jones, & Davis, 1995; Rahhal, May, & Hasher, 2002). For example, they are less accurate at remembering which of two speakers said something earlier (e.g., Simons, Dodson, Bell, & Schacter, 2004), whether an event was witnessed in a videotape or only seen in a photograph (e.g., Schacter et al., 1997a),

whether an item was seen earlier or imagined (e.g., Henkel, Johnson, & Leonardis, 1998), whether an item was thought about or spoken aloud (e.g., Hashtroudi, Johnson, & Chrosniak, 1989), or whether a piece of information was perceived or suggested by the experimenter (e.g., Mitchell, Johnson, & Mather, 2003).

However, when source memory ability is examined for emotionally charged information, some studies have found that older and younger adults have similar source memory (e.g., May, Rahhal, Berry, & Leighton, 2005; Rahhal et al., 2002), whereas other studies report typical age-related declines in source memory. For example, some studies using the misinformation paradigm have found that older adults accept more false information than younger adults (e.g., Mitchell et al., 2003). Thus, one aim of this research was to examine these contradictory findings and to analyze differences between older and younger adults in the ability to recollect the specific source of the actions involved in an emotional event. In order to do this, an experimental procedure was designed to examine participants' ability to indicate who carried out a specific action in a robbery.

Prior research on aging and memory has revealed that older adults have more intrusions and memory errors than younger adults in a variety of tasks and situations. However, not all memory distorsions would be considered as false memories. As Schacter and Curran (2000) point out, the term 'false memory' is reserved for memory errors that are subjectively held as true memories. Individuals are thought to be able to report on their subjective experience of remembering and distinguish it from the experience of familiarity (Gardiner, Ramponi, & Richardson-Klavehn, 2002; Tulving, 1985). Subjective memory experiences have been operationalized in a widely used method known as the Remember/Know paradigm (Tulving, 1985). In the Remember/Know paradigm, a Remember judgment is required when participants recall specific details that enable them to visualize or mentally relive the information, and a Know judgment is requested when the information generates feelings of familiarity, but participants are unable to recall any specific details. In previous research, it was found that young participants may claim to remember details of not-presented information in witnessed events (Migueles & Garcia-Bajos, 2002) and visual scenes (Miller & Gazzaniga, 1998), and that older adults assign Remember judgments to commission errors more often than younger adults with photographs (Schacter et al., 1997a) and words (Norman & Schacter, 1997). An important practical question therefore is whether older adults were more vulnerable than younger adults to false memory

effects in memory for a witnessed event, that is, for material that reflects the vibrancy of real-life situations more than static pictures or slides. We expected aging to produce an increase in the rate of false remember responses for false recognition in older adults compared to younger adults.

Another advantage of analyzing event memory using a recognition test is that it also allows us to examine the effects of response criterion adopted in the memory task. Although the relevance of response criterion to understand the effects of aging has been previously noted (e.g., Multhaup, De Leonardis, & Johnson, 1999), further research is needed to ascertain whether older people adopt a more lenient criterion than younger adults with event memory. In the current study, Signal detection theory was applied to examine the differences between older and younger adults in response bias and accuracy in event memory. The B''_D scores (Donaldson, 1992) represent the response criterion used by participants when they complete a recognition task. A' (Snodgrass & Corwin, 1988) is a nonparametric index that represents recognition accuracy. Both measures take into account the rate of hits and false alarms and therefore give more objective measurements of recognition performance.

To recapitulate, older adults have been found more prone not only to falsely recognize similar items (e.g., Koutstaal & Schacter, 1997), but also to accompany these errors with remember judgements (e.g., Norman & Schacter, 1997) and to make high-confidence memory errors (e.g., Dodson & Krueger, 2006). In addition, older adults generally show poorer performance when source memory capacity is examined (see Mitchell & Johnson, 2009). However, to our knowledge, there is not any research in which both phenomenological and source aspects are simultaneously examined in memory for a complex witnessed event that happens quickly and which involves multiple characters with different roles. It should be noted that when interviewing victims and witnesses in real-life circumstances, the ability to correctly remember what happened in an event and attribute specific actions to the perpetrators are relevant questions. Thus we undertook a comparison between subjective responses of retrieval experience (Remember/Know/Guess) and objective responses of source attribution (*who* performed an action) in an eyewitness situation. Finally, this study allows us to examine from a different perspective controversial results reported in the literature, such as the preservation or deterioration of source memory for emotionally charged information in older adults (e.g., May et al., 2005; Mitchell et al., 2003), the effects of response bias applying the signal detection theory, or the effects of aging in the subjective experience of retrieval.

Taking these aims into account, we designed two experiments. In addition to recognition decisions, participants in both experiments were asked to give a second memory judgment for the actions considered true in the event. Specifically, participants in Experiment 1 were asked to indicate Remember, Know, or Guess judgments in order to analyze age-related differences in the nature of subjective experience of memory. The presented event was expected to cause an increase in the rate of false Remember responses in older adults compared to younger adults. In order to examine age-related differences in the objective ability to recollect the specific source of the actions of the event, participants in Experiment 2 were asked to attribute the actions they considered true to the perpetrator. In this case, we expected older adults to show a relatively lower rate of correct attributions than younger adults.

EXPERIMENT 1

Methods

Participants

Thirty older adults (age range = 56–79 years) enrolled in specific courses organized by the University of the Basque Country, and 35 younger adults (age range = 18–24 years) from the University volunteered to participate. Table 1 shows demographic characteristics for all participants. Overall cognitive ability was assessed by examining performance on the Forward (FDS) and Backward Digit Span (BDS) subtests from the Wechsler Adult Intelligence Scale (WAIS-III; Wechsler, 1981/1996), and on the Verbal Understanding task taken

Table 1. Participants' characteristics

	Age	Years of education	Forward Digit Span[a]	Backward Digit Span[a]	Verbal understanding[b]
Experiment 1					
Older	65.20 (5.24)	14.43 (2.47)	5.90 (2.09)	4.83 (2.07)	28.83 (8.89)
Younger	20.26 (1.74)	14.71 (1.20)	6.03 (1.01)	5.23 (1.55)	26.90 (5.56)
Experiment 2					
Older	60.57 (4.52)	14.70 (2.75)	6.10 (1.18)	4.57 (1.33)	30.63 (6.59)
Younger	21.92 (4.70)	15.16 (1.82)	6.00 (1.25)	5.11 (1.22)	26.76 (6.12)

Note. Values are means, with standard deviations (in parentheses).

[a]Subtest of the Wechsler Adult Intelligence Scale-III.

[b]Subtest of the Primary Mental Aptitude Test.

from the battery of Primary Mental Aptitude Test (Thurstone, 1938/1996).

As seen in Table 1, there were no differences in the Digit Span test. In the Verbal Understanding test, older adults identified slightly more synonyms than younger adults, although the results were not significant, $t(63) = 1.98$, $SEM = 1.61$, $p = .052$. There was no correlation between scores in these tests and major measures in the recognition task (i.e., hits, false alarms, accuracy, or response criterion).

Materials

The event, presented on a 3 min 30 s video, showed the robbery of a lottery outlet. One of the robbers pretends to be a customer while his two accomplices, wearing balaclavas, break in through a back door and make their way to the front where the employees are. The ringleader points a revolver at the head of one of the employees and tells her to hand over the key to the cabinet where the money is kept. When she refuses, he smacks her in the face. She gives the money to one of the robbers, who puts it in a bag and runs out to the getaway car. The other two robbers threaten the customers and then leave. When they see that their accomplices have abandoned them, they steal a motorcycle at gunpoint and flee the scene.

Using 7-point Likert scales ranging from 1 (low) to 7 (high), the participants assessed the event as emotional ($M = 5.79$), violent ($M = 5.47$), and causing an impact on them ($M = 4.79$). The event proved to cause greater impact on the older adults than on their younger counterparts ($M = 5.20$ vs. 4.37, $U = 1484.5$, $p = .033$), with no differences being found between the two groups in relation to emotion or violence. All these values differed significantly from the mean value of 4 on the scale ($p < .001$), and failed to correlate with any of the recognition measures examined in the experiment.

Two independent judges analyzed the actions associated with the event. To obtain equivalent true and false actions for the recognition test, they identified 16 perceptively clear true actions and constructed 16 false actions compatible with the event. In order to assess the probability of occurrence of these 32 actions, a prior study was conducted involving 15 participants (7 women and 8 men) aged between 26 and 48 ($M = 32.20$ years, $SD = 7.07$). These participants were not the same as the ones who took part in the main experiment. After viewing the video of the event, they were asked to rate the probability of occurrence of each action for this type of event on a 7-point Likert scale ranging from 1 (low) to 7 (high). A mean probability value was obtained for the occurrence of each action, and the judges selected 12 true and 12 false actions, discarding any items with extreme mean

probability of occurrence values. Furthermore, an effort was made to ensure that the mean probability of the set of true and false actions was approximately in the range of 4–5 on the scale.

In the recognition test, the actions were expressed with a subject (e.g., "the first robber tells the customers to shut up"), and next to a true/false option the three possible types of subjective experience (Remember/Know/Guess) that could accompany recognition were given.

Procedure

Older and younger adults were tested separately in small groups ($n \leq 10$). Participants first viewed the video and were instructed to pay attention as their memory for the event would be evaluated afterwards. The video sequence was projected on a 2×1.5-m screen. After watching the video, all participants filled in a sheet with their personal details, rated the level of emotion, violence, and impact associated with the event, and completed the Digit Memory test and the Verbal Comprehension test. These two tests had the twofold purpose of a distracter task and a way of measuring participants' cognitive skills. The duration of the delay between the encoding and test phases was about 15 min for all the participants. Lastly, the participants had unlimited time to complete the recognition task, indicating whether each of the 24 actions stated were true or false. For the actions they considered to be true, the participants were asked to provide a second memory judgment depending on the type of subjective experience accompanying retrieval. Participants were presented with detailed oral instructions (adapted from Rajaram, 1993) and illustrative examples to ensure that they understood the difference between the three options. Specifically, they were asked to give a Remember judgment if they had specific details that enabled them to visualize or mentally relive the information, a Know judgment if the element generated feelings of familiarity but they were unable to recall any specific details, and a Guess judgment when they considered the statement to be true even in the absence of any memory experience. The Guess judgment option prevents participants from giving Know judgments when they are, in fact, merely guessing (see Gardiner et al., 2002).

Results and Discussion

The main goal of this experiment was to analyze differences between older and younger adults as regards recognition and Remember/Know/Guess judgments for the actions of a robbery, and determine

whether older adults were relatively more likely than younger adults to show false recognition and produce false Remember judgments for the actions of the event. As expected, the eyewitnessed event was assessed by the participants as an emotional and violent event, and caused an impact on them event.

Recognition Task

Four one-way analyses of variance (ANOVAs) with Group (older or younger) as a between-subjects factor were applied for analyzing hits, false alarms, accuracy, and response criterion. Results are shown in Table 2.

Hits

The Group factor was not significant ($M = .69$ for older and $M = .65$ for younger). No differences in the proportion of hits are usually observed between older and younger adults when using standard recognition tests (e.g., Balota et al., 2002; Pierce et al., 2004; Tun et al., 1998, Experiments 1 and 2).

False Alarms

The Group factor was found to be significant ($F(1, 64) = 25.29$, $MSE = .02$, $p < .001$), with older adults having a higher proportion of false alarms than their younger counterparts ($M = .60$ vs. $M = .42$). In light of previous findings (e.g., Aizpurua et al., 2009; Schacter et al., 1997a), this was the expected result. In fact, older

Table 2. Mean proportions of hits and false alarms, mean A' and B''_D scores, and mean proportions and percentages of Remember, Know, and Guess judgments of hits and false alarms in Experiment 1

	Older adults		Younger adults	
	Proportions	**Percentages**	**Proportions**	**Percentages**
Hits	.69 (.12)		.65 (.14)	
Remember	.48 (.19)	70	.43 (.21)	66
Know	.14 (.15)	20	.13 (.16)	20
Guess	.07 (.09)	10	.09 (.10)	14
False alarms	.59 (.16)		.40 (.15)	
Remember	.33 (.17)	56	.17 (.11)	42
Know	.16 (.14)	27	.09 (.10)	23
Guess	.10 (.15)	17	.14 (.14)	35
A'	.57 (.13)		.67 (.14)	
B''_D	−.46 (.30)		−.12 (.41)	

Note. Standard deviations in parenthesis.

adults may have been more inclined than younger adults to depend on gist (e.g., Koutstaal et al., 2003; Tun et al., 1998).

A′ *Scores*

The A' scores (Snodgrass & Corwin, 1988) represent recognition accuracy. The values from this nonparametric index range from 0 to 1. Scores of .5 indicate chance performance, and higher scores reflect better discrimination and greater accuracy. In all cases accuracy was higher than the level expected from random chance ($p < .001$). The Group factor was found to be significant ($F(1, 64) = 6.85$, $MSE = .02$, $p = .011$), revealing that older adults were less accurate than younger ones (.56 vs. .65). This finding is consistent with the limited amount of results available on older adults' memory for events (Aizpurua et al., 2009; List, 1986; Loftus et al., 1992). This result was due to the fact that the older adults committed more false alarms than the young people, because no differences were found with regard to the number of hits.

B''_D *Scores*

The B''_D scores (Donaldson, 1992) represent the response criterion used by participants when they complete a recognition task. The values range from -1 to $+1$. Zero scores indicate a neutral response criterion, negative values, a more lenient criterion (tendency to respond *true*) criterion, and positive scores, a more stringent criterion (tendency to respond *false*). All B''_D scores were significantly different from 0, which indicates a neutral response criterion ($p < .001$). The Group factor was significant ($F(1, 64) = 19.33$, $MSE = .13$, $p < .001$), with older adults adopting a more lenient response criterion than younger participants ($-.46$ vs. $-.12$). In other words, compared to younger adults, older adults showed a greater tendency to choose the *true* option, regardless of the veracity of the information, a result consistent with previous studies using words and pictures (e.g., Balota et al., 2002; Koutstaal & Schacter, 1997). Moreover, this finding may indicate that access to gist information is maintained with aging and therefore older adults may adopt a more liberal response criterion than younger adults at the time of retrieval.

Remember, Know, and Guess Judgments

In order to examine phenomenological judgments, two global ANOVAs (Group $\times$ Judgments) were carried out, one for hits and the other for false alarms. Complementarily, the Remember, Know, and Guess judgments were analyzed separately for hits and false alarms using two single-factor ANOVAs (Group). The results are shown in Table 2. Note that in addition to proportions of hits,

false alarms, and Remember/Know/Guess responses for hits and false alarms, percentages indicating each response option are also reported in Table 2.

Remember, Know, Guess judgments for hits. Only the Judgments factor was significant ($F(1, 63) = 127.94$, $MSE = .04$, $p < .001$), with hits receiving more Remember judgments than Know or Guess judgments (.45 vs. .14 and .08, $p < .001$), and more Know judgments than Guess judgments (.14 vs. .08, $p = .011$). Most of the hits for photographs (Schacter et al., 1997a) and actions (Migueles & Garcia-Bajos, 2002) also receive Remember judgments. In this study, as in Norman and Schacter (1997), no differences were found between older and younger adults as regards the judgments accompanying correct recognition (for an exception, see Schacter et al., 1997a).

Remember, Know, Guess judgments for false alarms. The Judgments factor was significant ($F(1, 63) = 14.24$, $MSE = .03$, $p < .001$). Participants accompanied more false alarms with Remember judgments than with Know or Guess judgments (.25 vs. .12 and .12, $p < .001$), with no differences found between Know and Guess responses. Thus, participants accompanied the acceptance of false information with the same subjective experience with which they recognized true information. The false recognition of nonpresented photographs (Schacter et al., 1997a) and actions (Migueles & Garcia-Bajos, 2002) is also mainly assigned Remember judgments. As expected, the significant Group $\times$ Judgments interaction ($F(1, 63) = 5.92$, $MSE = .03$, $p = .003$) indicated that older adults assigned almost twice as many Remember judgments to false alarms as their younger counterparts (.33 vs. .17, $p < .001$), and also more Know judgments (.16 vs. .09, $p = .041$), although no differences were found as regards Guess responses (.10 & .14). This significant interaction is consistent with results obtained by Schacter and his colleagues (Norman & Schacter, 1997; Schacter et al., 1997a), and shows that in relation to the actions of an event, older adults are more likely than young people to accompany false recognition with a subjective memory experience similar to the retrieval of real contents.

EXPERIMENT 2

Experiment 1 produced two key findings. First, older adults were less accurate at recognizing the event actions, because they had a greater proportion of false alarms than did the younger adults, although no differences were found in the hit rate. They also adopted a relatively

more liberal criterion when responding to the recognition task. Second, the older adults assigned Remember judgments to their false alarms much more often than their younger counterparts, indicating that they were more likely to experience false memories for the actions of the event. Thus, Experiment 1 established that the witnessed event produced increased false recognition responses (i.e., false alarm rate) and enhanced false memory effects (i.e., Remember judgments for false alarms) in older adults compared to younger adults for the actions of the robbery.

Deficits in memory for source information can explain, at least in part, older adults' impairments in episodic tasks (e.g., Balota et al., 2000; Schacter et al., 1997b). It is known that when memory for words and sentences and for simple visual actions is examined, older adults have greater difficulty than younger adults at source attribution (e.g., Kersten, Earles, Curtayne, & Lane, 2008; Simons et al., 2004). For example, in a recent study, Kersten et al. (2008) found that older adults had greater difficulty than young adults at determining which person performed each of the actions (e.g., peel a banana, flutter a flag). Although the stimuli used in Kersten et al. (2008) also involved actors performing different actions, it is worth noting that three important differences exist between the present study and that reported by Kersten et al. (2008). First, the current stimulus involves a more complex event, with multiple actors who take on different roles in a robbery of a lottery outlet; second, the event is longer and also much more emotionally charged; and finally, the procedure for selecting which actor performed a particular action is more attuned to actual police procedure. Thus, the event presented in the current study more closely resembles real-life eyewitness situations.

In addition, results are mixed when source memory for emotionally charged information is analyzed (May et al., 2005; Mitchell, et al., 2003; Rahhal et al., 2002). To address this issue, differences between older and younger adults in their ability to attribute correctly recognized actions to their source (i.e., perpetrator) were analyzed in Experiment 2. We expected the proportion of correct source attributions to be less in older adults for actions pertaining to the witnessed emotional event.

Methods

Participants

Thirty older adults (age range = 56–75 years) enrolled in specific courses organized by the University of the Basque Country, and 37 younger adults (age range = 18–33 years) from the University

volunteered to participate. Table 1 shows demographic characteristics for all participants. We examined participants' performance on the same subtests used in Experiment 1. There were no differences in the FDS or in the BDS tests, but in the Verbal test older adults identified significantly more synonyms than younger adults, $t(65) = -2.49$, $SEM = 1.56$, $p = .015$. However, there was no correlation between scores in these tests and major measures in the recognition task (i.e., hits, false alarms, accuracy, or response criterion).

Materials

The same event used in Experiment 1 was presented. The event was assessed as emotional ($M = 6.12$), violent ($M = 6.09$), and causing an impact on the participants ($M = 5.07$), and no differences were found between the two groups in relation to the assessment of these aspects. Although these values were slightly higher than in Experiment 1, it should be noted that a very similar trend was observed in both studies. The recognition test included the same 24 actions (12 true and 12 false) as Experiment 1. All of the actions were carried out by a single perpetrator. However, the number of possible perpetrators was controlled. Half of the actions, whether true or false, had only one possible perpetrator ("kept reading the paper during the robbery" can only be attributed to the driver), and the other half, two possible perpetrators ("came in shouting 'this is a stick up!'" could be attributed to either of the two robbers who entered the premises just as the robbery began). In the recognition task the actions were expressed without a subject (e.g., "to tell customers to shut up"), and were accompanied by a true/false option and a list of six possible subjects (the first robber, the driver, the ringleader, the girl, the owner, and the shop assistant).

Procedure

The procedure was identical to Experiment 1, except that participants were asked to indicate who they believed had carried out the action in the event. After making sure they knew who each character was (e.g., the oldest shop assistant was the owner), they received specific instructions to select only one person from among the six possible alternatives given.

Results and Discussion

Recognition Task

In order to examine the recognition data, four one-way analyses of variance (ANOVA) with Group (older or younger) as a

Table 3. Mean proportions of hits and false alarms, mean A' and B''_D scores, and source memory score in Experiment 2

	Older adults	Younger adults
Hits	.69 (.13)	.66 (.15)
False alarms	.62 (.18)	.44 (.16)
A'	.54 (.16)	.64 (.16)
B''_D	−.47 (.34)	−.18 (.40)
Source memory[a]	.61 (.26)	.72 (.19)

Note. Standard deviations in parenthesis.

[a]Total number of old items attributed to the correct source/total number of old items correctly identified as old (hits).

between-subject factor were conducted for analyzing hits, false alarms, accuracy, and response criterion. Results are shown in Table 3.

Hits

No effects of the Group factor were observed ($M = .66$ for older and $M = .69$ for younger).

False Alarms

In this case, the Group factor ($F(1, 66) = 21.37$, $MSE = .64$, $p < .001$) was found to be significant. Thus, older adults committed a greater number of false alarms than their younger counterparts (.62 vs. .44).

A′ *Scores*

All scores differed significantly from the .5 value, which indicates chance performance ($p < .01$). The Group factor was found to be significant ($F(1, 66) = 8.93$, $MSE = .27$, $p = .004$). Due to the high proportion of false alarms committed by older adults, young people showed greater accuracy in the recognition task (.64 vs. .54).

B''_D *Scores*

All B''_D scores were significantly different from 0, which indicates a neutral response criterion ($p < .001$). The effects of the Group factor were significant ($F(1, 66) = 10.26$, $MSE = .15$, $p = .002$), revealing that older adults adopted a more liberal criterion than their younger counterparts (−.18 vs. −.47).

All of these results in Experiment 2 replicated the main findings in Experiment 1.

Source Memory

Source memory score was calculated by dividing the total number of old items attributed to the correct source by the total number of old items correctly identified as old (Murnane & Bayen, 1998; see, for example, May et al., 2005). In general, the proportion of correct attributions was higher than the proportion of wrong ones (.68 vs. .32, $t(66) = 6.38$, $SEM = .055$, $p < .001$), indicating that participants were able to attribute event actions to their source. No differences were found in relation to number of possible perpetrators of the actions. As expected, the Group factor was significant in the source memory score ($F(1, 65) = 4.67$, $MSE = .05$, $p = .034$), indicating that older adults had fewer correct attributions than their younger counterparts (.61 vs. .72). These results coincide with those obtained by many other researchers who have observed that older adults are less able to determine which person presented certain information or performed a specific action (e.g., Brown et al., 1995; Kersten et al., 2008; Simons et al., 2004). Thus, the present results suggest that the deficiencies presented by older adults as regards to the specific processes of source attribution extend to robbery situations in the field of event eyewitness memory. In addition, in the recognition task, recognition accuracy was significantly negatively correlated with age, $r(67) = -.34$, $p < .01$, and positively correlated with source memory score, $r(67) = .48$, $p < .001$. More importantly, when we conducted a simultaneous multiple regression including age and source memory score as predictors in order to determine their relative contribution to recognition accuracy, the strongest and only significant predictor was source memory score, $\beta = .42$, $t(66) = 3.72$, $p < .001$; the contribution of age to recognition accuracy was not significant, $\beta = .20$, $t(69) = -1.82$, $p = .07$.

GENERAL DISCUSSION

The present study provides a comparison of healthy older and younger adults on recognition and source attribution of actions of a witnessed event. In forensic settings such as real-life eyewitness situations, specific memory for source is especially relevant because individuals are usually asked to remember precise features or details associated with the witnessed event. In two experiments, a material validated for emotion, violence, and impact was employed to examine differences between older and younger adults in the subjective experience of retrieval, and in the ability to attribute event actions to their correct source. The current investigation also allowed us to analyze

mixed results reported in previous research regarding the preservation or deterioration of source memory for emotionally charged information in older adults (e.g., May et al., 2005; Mitchell et al., 2003), the contribution of the source memory ability to recognition accuracy in older and younger adults, and the effects of aging on response bias using the signal detection theory.

One of the most consistent and best-studied findings in the field of episodic memory and aging is older adults' greater susceptibility to false recognition. In the research presented here, recognition of the actions of a robbery was analyzed in older and younger adults. Both true and false actions examined had the same probability of occurrence in the presented event. In line with results from previous studies using similar events that are close to real situations (Aizpurua et al., 2009; List, 1986; Loftus et al., 1992), it was found that compared to younger adults, older adults systematically showed a greater tendency to accept false actions as real, demonstrating a less accurate recognition of event information.

The subjective experience of memory constitutes an important aspect of episodic retrieval, because in many cases, such as eyewitness memory situations, it is crucial to distinguish between true and false memories. However, it is quite clear that memory experience is prone to error, with individuals claiming to vividly "remember" nonpresented information (e.g., Migueles & Garcia-Bajos, 2002; Miller & Gazzaniga, 1998). In fact, although different brain regions are activated with true and false recognition, this differential activity seems to be inaccessible to the conscious mind (Slotnick & Schacter, 2004). In Experiment 1, the Remember/Know procedure (Gardiner et al., 2002; Tulving, 1985) showed that there were no differences between older and younger adults in the proportion of Remember responses for hits, whereas for false alarms it was higher in older adults. Specifically, older adults accepted twice as many false actions with Remember judgments than their younger counterparts, suggesting an important age-related increase in the likelihood to experience false memories (Schacter & Curran, 2000) for actions of the event. Not having a literal memory for the information presented, older adults may be more inclined than younger adults to base their recognition decisions on gist information (Koutstaal et al., 2003; Tun et al., 1998) or on the plausibility of the information (Reder et al., 1986), which would explain their susceptibility to false memories.

Different details of real events may be remembered as part of a similar event that, in fact, has not been witnessed (Lyle & Johnson, 2006). Thus, the sense of familiarity generated by the false information, which is both likely and compatible with what actually

happened, motivates participants to search for perceptive details that corroborate their memory. As a result, these details are borrowed from the actually presented event and are added to the false memory trace (Lampinen, Neuschatz, & Payne, 1999), and these characteristics may be used by individuals to make source attributions and determine the origin of a memory (e.g., Meade & Roediger, 2009). This phenomenon is known as *importation* (Lyle & Johnson, 2006). Even if older adults could encode perceptual details of an event, they may not be able to spontaneously use this information at the time of retrieval and, as a result, they may have a perceptively less detailed memory representation than younger adults (e.g., Koutstaal, 2003; Multhaup, 1995). By this logic, the above-mentioned *importation* would be more likely to occur in older than in younger adults.

In the study reported here, we investigate the ability of older and younger adults to attribute correctly recognized actions to their perpetrator, a source memory capacity that is critical in eyewitness situations. In Experiment 2, we found that older adults had a lower proportion of correct attributions than their younger counterparts, reflecting a lesser source attribution capacity among older adults. This result suggests that for the actions correctly recognized as part of the event, older adults were not as effective as younger adults in differentiating between actions carried out by different actors in the original event. Therefore, the well-documented deficits in older adults' source memory (e.g., Brown et al., 1995; Kersten et al., 2008; Rahhal et al., 2002; Simons et al., 2004) could be expected with emotionally laden events that closely resemble potential real-life eyewitness situations, such as actions of a robbery. When source memory ability is examined with emotionally charged information, typical age-related declines in source memory are not present (e.g., May et al., 2005). However, older adults do not show the same memory benefits as young adults for negative emotional information. For example, their ability for source memory is significantly diminished when a slide showing a person with a gun is presented (e.g., Charles, Mather, & Carstensen, 2003). Moreover, accurate memory for an action requires not only remembering both the action and the perpetrator, but also remembering which person performed a particular action (i.e., source attribution ability); in other words, it requires binding actors and actions correctly (Kersten et al., 2008). Older adults are less able than young adults to spontaneously process the relationship between an element and its context (e.g., Lyle, Bloise, & Johnson, 2006), which would make them more likely to make errors in the source attribution task.

In addition, we found that the ability to perform well on the source attribution task correlated with recognition accuracy, such that individuals who scored higher on source memory showed greater accuracy in the recognition task. Finally, and more importantly, when simultaneously including each of the possible contributors, source memory capability constituted the main and only significant predictor of recognition accuracy in both older and younger adults. This suggests that, independently of the age, the ability to attribute event actions to their correct source substantially contributes to the ability to accurately recognize the eyewitnessed event.

In conclusion, this work has shown that recognition of the actions of a robbery resulted in very convincing false memories for both older and younger adults. Consistent with previous research, older adults persistently falsely recognized actions and claimed more often than younger people that they had a subjective experience of remembering a false (i.e., not presented) action. In addition, when asked to provide specific details of a given event, older adults were relatively less able to correctly determine the perpetrator of the action. More importantly, we found a significant positive correlation between the ability to determine the source of an action and the capacity to accurately recognize the event actions. Thus, older adults were more likely to make errors on the recognition test probably due to impaired source attribution ability.

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