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Bias of Script-Driven Processing on Eyewitness Memory in Young and Older Adults

ELVIRA GARCÍA-BAJOS*, MALEN MIGUELES and ALAITZ AIZPURUA

Faculty of Psychology, University of the Basque Country UPV/EHU, San Sebastián, Spain

Summary: We investigated the effects of script-driven processing on eyewitness memory in young (aged 19 to 27) and older (aged 57 to 73) adults. Participants viewed a bank robbery video including high-typicality and low-typicality actions to examine the effects of the bank robbery script on recall and on immediate and 1-week recognition. There were no differences between young and older adults in recalling high-typicality actions, but recall of low-typicality actions was poorer for older adults. In recognition, participants produced more hits and false alarms, adopted a more lenient response bias, and exhibited greater confidence for high-typicality than low-typicality actions, showing the script-driven processing of the event, even in the long term, because the recognition interval only deteriorated performance for low-typicality contents. Older adults had a higher proportion of false alarms, more lenient response bias, and higher confidence than younger adults, showing that bias of script-driven processing is more evident in the elderly.

INTRODUCTION

The present study is a cognitive approach to understanding the positive and negative effects of previous knowledge on eyewitness memory in young and older adults. The primary aim is to determine whether older adults make use of their prior knowledge to a greater extent than younger adults when remembering a crime. Despite the increasing aging population and the number of elderly persons potentially falling victim to crime or witnessing different types of offences, research into memory capabilities of aging eyewitnesses and script-driven processing has received scant attention. Relatively recent research shows that half of eyewitness experts (Kassin, Tubb, Hosch, & Memon, 2001) and over half of police officers (Wright & Holliday, 2005) perceive the elderly as less accurate witnesses than younger adults. Moreover, the perceived credibility of older adults as witnesses can be predicted by aging stereotypes (Mueller-Johnson, Toglia, Sweeney, & Ceci, 2007).

The various studies published on eyewitness memory in older adults indicate that eyewitness memory is worse in older than in younger adults (Adams-Price, 1992; Aizpurua, García-Bajos, & Migueles, 2009; Coxon & Valentine, 1997; List, 1986; Loftus, Levidow, & Duensing, 1992; Scogin, Calhoon, & D'Errico, 1994; Yarmey & Kent, 1980). For example, Aizpurua et al. (2009) examined recall and recognition for a robbery and found that older adults recalled fewer items than younger adults and were less accurate in a recognition task owing to a higher rate of false alarms. But even more important, older adults strongly believed in the accuracy of their false memories. These deficits are attributed to an age-related decline in the ability among older adults to process episodic memory, whereas implicit and semantic memory functions are preserved or even facilitated (Hedden, Lautenschlager, & Park, 2005; Luo & Craik, 2009; Park et al., 2002). For instance, older people are cognitively slower, have fewer cognitive resources, and process information in a more general and automatic manner than the young, leading to relatively good memory for thematic knowledge but poor memory for specific facts. Nevertheless, the cognitive system may develop different strategies to compensate for processing limitations (Park & Reuter-Lorenz, 2009), such as a greater tendency in older adults to base their recognition decisions on general or schematic knowledge (e.g., Castel, 2005; Koutstaal, 2006; Mather, Johnson, & De Leonardis, 1999), and on the plausibility of the information (e.g., Aizpurua et al., 2009; Reder, Wible, & Martin, 1986). From the perspective of fuzzy-trace theory (e.g., Brainerd & Reyna, 1990), older people may have limitations in retaining literal information and be more inclined than younger adults to depend on gist (Aizpurua & Koutstaal, 2010; Koutstaal et al., 2003; Tun, Wingfield, Rosen, & Blanchard, 1998).

Although the typicality of information is a relevant factor in modulating eyewitness testimony, little is known about aging effects on script-driven processing in eyewitness memory situations. People have prior knowledge about the characteristics of most common crimes (Smith, 1991, 1993), and there is broad consensus on the actions involved in such crimes (García-Bajos & Migueles, 2003; Greenberg, Westcott, & Bailey, 1998; Holst & Pezdek, 1992; Migueles & García-Bajos, 2004; Tuckey & Brewer, 2003a). Although no normative data for crime scripts have been published for older adults, content and production frequency may be similar to data obtained for younger adults. For example, Light and Anderson (1983) found no differences between young and older adults in generic knowledge or unique items contained in scripts generated for routine daily activities such as grocery shopping. And, using a subjective rating task, neither did List (1986) find differences between young and older adults in objects or actions expectations concerning shopliftings.

Crime scripts can guide the processing of eyewitnessed events and can activate automatic, fluid processing of typical information, saving cognitive resources and improving memory, particularly in older adults. However, script-driven processing can lead to worse performance for low-typicality contents or more specific facts that require attention. Scripts can also be an important source of error because they can mislead us into making wrong inferences and accepting typical but false information with high confidence

*Correspondence to: Elvira García-Bajos, Faculty of Psychology, University of the Basque Country, Avenida Tolosa, 70, 20018 San Sebastián, Spain.
E-mail: elvira.garcia@ehu.es

(García-Bajos & Migueles, 2003; Holst & Pezdek, 1992). In addition, older adults appear to have difficulties in attentional control processes, which can facilitate discrimination between memories of perceived events and inferences drawn during processing (Simons, Dodson, Bell, & Schacter, 2004). Bias of script-driven processing for crimes will be particularly significant in recognition because it requires the contents of the event to be differentiated from the contents of the script, and the magnitude of the bias will be greater for typical contents because they receive less specific processing than low-typicality contents (García-Bajos & Migueles, 2003; Migueles & García-Bajos, 2004).

Are older adults more prone to the bias of script-driven processing than younger adults? Memory performance depends on both remembering stored information and meta-memory monitoring of that information (Chua, Schacter, & Sperling, 2009). There is growing evidence that older adults exhibit higher rates of false recognition (Jacoby, Bishara, Hessels, & Toth, 2005; Norman & Schacter, 1997; Schacter, Koutstaal, & Norman, 1997) and show higher confidence in their false memories (Dodson, Bawa, & Krueger, 2007; Dodson & Krueger, 2006) than younger adults. This may be because in episodic tasks young and older adults base their confidence judgements on different sources of information—verbatim and gist information, respectively—in fuzzy-trace theory context. If the biases come from script-driven processing, response criteria and confidence will be higher for high-typicality information, which will be more easily accepted than low-typicality contents. Therefore, the overuse of typical semantic knowledge by older adults will affect both response bias and confidence.

An additional aim of this experiment is to study the effect of retention interval on recognition and confidence of high-typicality and low-typicality information and to determine whether the effects are different for young and older adults. The applied relevance of this aspect is evident because of the fact that victims and witnesses are usually called on to test their memories several times and often days or weeks after the occurrence of an event. Studies based on real cases show good long-term retention of information (e.g., Yuille & Cutshall, 1986). Even so, in a mugging event, García-Bajos and Migueles (2003) found poorer recognition in young adults at 1 week for low-typicality than for high-typicality information, and false alarms dropped for low-typicality actions while remaining constant for high-typicality information (also Greenberg et al., 1998). Therefore, long-term retention will require greater effort for low-typicality than for more generic script information, and retention interval will have a greater detrimental effect on older than younger adults for low-typicality contents.

To summarize, in this study, we examined how script knowledge can bias elderly eyewitness memory. In spite of the applied relevance of the effects of scripts on eyewitness memory in legal contexts, there are no normative studies involving the impact of scripts in older adults. Thus, normative data were obtained to determine the typicality of the actions for a bank robbery in young and older adults. We then selected a realistic video of a bank robbery, which included typical actions and low-typicality actions. Lastly, as is common in legal contexts, an immediate recall task and two recognition tasks for immediate and delayed evaluations were elaborated. We expected script-driven processing to produce better recall of high-typicality than low-typicality actions in both young and older adults. However, older adults should be particularly affected in the recall of low-typicality contents owing to age-related decline in processing ability. Although errors in recall are infrequent, script-driven processing should produce more high-typicality than low-typicality errors. Bias of script-driven processing in recognition may be greater in older adults because of their difficulties in discriminating between previous knowledge and actual actions in the event. That is, older adults may be less able to control false memories derived from automatic activation of the script. Finally, older adults will show greater confidence for their false recognition than younger adults.

METHOD

Participants

Ninety-six students from the University of the Basque Country, 50 young adults and 46 older adults, volunteered to take part in this experiment. The younger participants (age range: 19–27 years) were students of Psychology and Education. The older adults (age range: 57–73 years) were students of Human Sciences for seniors. The participants said they had no problems with visual or auditory acuity or that any such deficiencies had been corrected. Table 1 shows demographic characteristics for participants. There were no significant differences between the young and older adults in years of education or perceived health. The younger participants showed greater perceptual speed in the test on perception of differences (3 minutes), $t(94) = 11.83$, $p < .001$, $d = 3.14$, and greater phonemic fluency (letter p, 3 minutes) than the older adults, $t(94) = 5.35$, $p < .001$, $d = 1.09$. The older participants had higher scores than the young adults, $t(94) = 2.52$, $p < .05$, $d = 0.51$, in the verbal comprehension of 50 synonyms (3 minutes). Although the young adults scored higher in perceptual speed and phonemic fluency and the older participants were better at verbal comprehension,

Table 1. Participant characteristics (*SDs* in parentheses)

	Age	Years of education	Health[a]	Perceptual speed[b]	Phonemic fluency[c]	Verbal comprehension[d]
Young	21.98 (1.86)	16.92 (1.08)	4 (0.67)	49.99 (7.33)	36.46 (6.26)	28.08 (5.96)
Older	63.72 (4.20)	16.89 (3.47)	3.89 (0.53)	30.39 (8.81)	28.70 (7.92)	32.13 (9.54)

[a]Participants rated their health on a scale form 1 (*very bad*) to 5 (*very good*).
[b]Perception of differences (faces) (Thurstone & Yela, 1988).
[c]PMA fluency factor (Thurstone, 1938).
[d]PMA verbal factor (Thurstone, 1938).

none of these measures was significant as a covariate in recall or recognition.

Design

A 2 (age group: young adults, older adults) × 2 (typicality of the actions: high, low) × 2 (evaluation interval: immediate, one week) mixed-factorial design was used, with age group as the between-participants factor and typicality and interval as the within-participants factors. The participants were tested on their memory for the event with an immediate free recall task and an immediate and 1-week delayed recognition tasks. In the recall task, both correct recall and errors for high-typicality and low-typicality actions were evaluated. In recognition tasks, the hits, false alarms, accuracy, response bias, and response confidence were evaluated.

Material

A prior study was conducted to collect normative data for the typicality of the actions in a bank robbery. Another 135 students from the University of the Basque Country, 70 young adults and 65 older adults, participated voluntarily. The young adults, 51 women and 19 men (age range = 18–28 years, M_{age} = 19.60 years, *SD* = 1.61), were Psychology students. The older adults, 44 women and 21 men (age range = 55–76 years, M_{age} = 61.05 years, *SD* = 4.77), were students of Human Sciences for seniors. All of the participants were given 10 minutes to list in chronological order the most common or typical actions in a bank robbery. There were no significant differences in the number of actions produced by the young (range = 8–28 actions, *M* = 16.87, *SD* = 4.57) and the older adults (range = 7–26 actions, *M* = 15.77, *SD* = 4.59), $t(133) = 1.40$, $p > .05$, $d = 0.24$. Two judges encoded the actions according to frequency of production. Following the criteria put forth by Bower, Black, and Turner (1979) and adopted by other authors (e.g., García-Bajos & Migueles, 2003; García-Bajos, Migueles, & Anderson, 2009; Greenberg et al., 1998; Holst & Pezdek, 1992), high-typicality actions were defined as actions mentioned by over 25% of the participants. To discriminate from more fuzzy medium-typicality actions, low-typicality actions were those listed by less than 5% of the participants (see Appendix for examples). General actions (e.g., enter bank or exit bank) without more specific information of the event were not considered because they may be easily deduced in terms of schema-based reconstruction of the event.

From this normative study, we identified the typicality of the actions of the selected event and prepared a 1-minute 45-second bank robbery video. The video begins with two security guards walking into a bank carrying metal cash boxes. Suddenly, two armed robbers enter the bank and conduct the holdup. One of them tells the security ward to hand over the money and put it in a bag, while the other one keeps watch over the people in the bank. After shooting a security guard, they grab the bag of money, leave the bank, and run towards a parked car. The first 15 seconds before the robbers enter the bank and the last 15 seconds after they leave the bank were used to control for primacy and recency effects in both recall and recognition.

Two recognition tasks were designed to assess participants' memory both immediately and at 1 week. Each task included 20 sentences, 10 high-typicality actions and 10 low-typicality actions, half of them true and half false (see Appendix). The sentences followed the event in chronological order, although the same type of item was never presented more than three times in a row. Four actions were added to control for primacy and recency effects, two at the beginning and two at the end of each recognition task, one true and one false, one of high typicality and one of low typicality.

Procedure

Young and older adults were tested separately in small groups of no more than 10 participants. The video of the bank robbery was shown on a 2.5 × 2 m screen using a video projector. Immediately after watching the video, the participants were asked to rate the emotional level, the level of violence, and the impact (1 *low*–7 *high*) the event had on them. Afterwards, they were given 5 min to write down their personal details, level of education, and health-related information. Before the recall task, they had 3 minutes to complete a perceptual speed task using the test on perception of differences. For recall, the participants were given 10 minutes to write down all of the actions they remembered having seen in the event. After recall, they completed the phonemic fluency task, in which they were allowed 3 minutes to write down as many words as possible beginning with the letter p. They then performed one of the two recognition tasks. The order of the immediate and one-week recognition tasks was counterbalanced in both the young and older adults. First, the participants were told to indicate whether each of the sentences was true or false and to score their response confidence by using a scale ranging from 1 (*no certainty*) to 5 (*absolute certainty*). The participants worked at their own pace, taking between 3 and 6 minutes to respond to the 24 actions. The experimental session lasted approximately 45 minutes. The participants were called back 1 week later to continue with the experiment. First, they had 3 minutes to complete the verbal comprehension test consisting of 50 synonyms; then, they performed the second recognition task. Finally, they were debriefed and thanked for their cooperation.

RESULTS

The older adults rated (1 *low*–7 *high*) the event as more emotional (6.13 vs 5.28), Mann–Whitney $U = 639$, $p < .001$, and more violent (6.57 vs 6.14), Mann–Whitney $U = 826.50$, $p < .01$, than the younger participants, but there were no significant differences between the two groups with regard to impact level (4.42, 4.89), Mann–Whitney $U = 956.50$, $p > .05$. None of these measures was significant as a covariate in recall or recognition.

Recall

Free recall of the bank robbery, discarding the actions before the hold-up (primacy) and after the hold-up (recency), was scored by assigning one point for every recalled action, whether correct or incorrect. Table 2 displays the results.

Table 2. Mean number of correctly recalled actions and errors (*SDs* in parentheses)

	Young		Older	
Recall	High typicality	Low typicality	High typicality	Low typicality
Correct	7.56 (1.99)	6.78 (2.42)	7.50 (1.70)	4.83 (2.25)
Errors	0.26 (0.57)	0.04 (0.20)	0.26 (0.44)	0.09 (0.29)

To analyze correct recall and errors, two 2 (age group: young adults, older adults) × 2 (typicality of the actions: high, low) ANOVAs were performed, with age group as the between-participants factor and typicality as the within-participants factor. In the correct recall, the age group, F (1, 94) = 8.22, $p < .01$, $\eta^2_p = .08$, and typicality, F (1, 94) = 47.41, $p < .001$, $\eta^2_p = .34$, factors were significant. The young adults correctly recalled more actions (M = 14.34) than the older adults (M = 12.33). The participants recalled more high-typicality actions (M = 7.53) than low-typicality actions (M = 5.80). The age group × typicality interaction was also significant, F (1, 94) = 14.26, $p < .001$, $\eta^2_p = .13$ (Table 2). The young adults recalled more low-typicality actions than the older adults, $t(94) = 4.09$, $p < .001$, $d = 0.84$, but there were no differences between the two groups in the recall of high-typicality actions. The only significant factor in the errors was typicality, $F(1, 94) = 15.07$, $p < .001$, $\eta^2_p = .14$. Although the errors were few (M = 0.16), both young and older adults made more high-typicality errors (M = 0.26) (e.g., shout 'This is a stick-up!') than low-typicality errors (M = 0.06) (e.g., were ordered to shut up).

Recognition

The recognition results are shown in Table 3. To analyze the proportion of hits, false alarms, A' accuracy scores, and B''_D bias scores, four 2 (age group) × 2 (typicality) × 2 (interval) ANOVAs were performed, with age group as the between-participants factor and typicality and interval as the within-participants factors. The A' scores were used as estimates of sensitivity (Snodgrass & Corwin, 1988). The values range from 0 to 1. A score of 0.5 indicates chance performance, and higher scores reflect higher sensitivity and accuracy. The B''_D scores (Donaldson, 1992) indicate the response criterion adopted by the participants. The values range from −1 to +1. A 0 score indicates a neutral response criterion, positive values a stricter or more conservative response criterion, and negative values a more lenient or liberal response criterion.

Hits

The typicality factor was significant, $F(1, 94) = 200.71$, $p < .001$, $\eta^2_p = .68$, as was the typicality × interval interaction, $F(1, 94) = 4.23$, $p < .05$, $\eta^2_p = .04$. The proportion of hits was greater for high-typicality actions (M = 0.86) than for low-typicality actions (M = 0.67). There were no differences in the proportion of hits for high-typicality actions immediately (M = 0.86) or at one week (M = 0.86), but for the low-typicality actions, the proportion of hits was lower at 1 week (M = 0.64) than immediately (M = 0.69), $t(95) = 2.02$, $p < .05$, $d = 0.28$, showing that only the most representative facts of an event are well retained in the long term.

False alarms

The age group, $F(1, 94) = 38.08$, $p < .001$, $\eta^2_p = .28$, typicality, $F(1, 94) = 263.74$, $p < .001$, $\eta^2_p = .74$, and interval, $F(1, 94) = 8.37$, $p < .01$, $\eta^2_p = .08$, factors were significant. The older adults had a higher proportion of false alarms (M = 0.44) than the younger adults (M = 0.32), and more false alarms were elicited with high-typicality actions (M = 0.50) than with low-typicality actions (M = 0.27). The incidence of false alarms was greater at 1 week (M = 0.41) than immediately (M = 0.36). Also significant were the interactions age group × typicality, $F(1, 94) = 11.22$, $p < .01$, $\eta^2_p = .11$, and typicality × interval, $F(1, 94) = 6.55$, $p < .05$, $\eta^2_p = .07$. The older adults had a higher proportion of false alarms than the younger adults in high-typicality actions (0.59 vs 0.42), $t(94) = 6.54$,

Table 3. Mean proportions of hit and false alarm, and A' accuracy and B''_D bias scores for high-typicality and low-typicality actions (*SDs* in parentheses)

	Young		Older	
Recognition	High typicality	Low typicality	High typicality	Low typicality
Immediate				
Hits	0.84 (0.11)	0.68 (0.18)	0.88 (0.08)	0.71 (0.17)
False alarms	0.40 (0.17)	0.17 (0.11)	0.59 (0.18)	0.28 (0.17)
A'	0.81 (0.08)	0.83 (0.12)	0.76 (0.12)	0.79 (0.12)
B''_D	−0.50 (0.42)	0.35 (0.44)	−0.80 (0.20)	0.02 (0.58)
Week				
Hits	0.86 (0.10)	0.63 (0.20)	0.86 (0.10)	0.66 (0.16)
False alarms	0.43 (0.15)	0.29 (0.18)	0.59 (0.16)	0.33 (0.18)
A'	0.82 (0.09)	0.77 (0.13)	0.75 (0.11)	0.75 (0.12)
B''_D	−0.62 (0.31)	0.16 (0.52)	−0.75 (0.31)	0.02 (0.55)

$p < .001$, $d = 1.34$, and low-typicality actions (0.30 vs 0.23), $t(94) = 3.10$, $p < .01$, $d = 0.63$, but the difference between young and older adults was greater in the high-typicality actions (0.17) than in the low-typicality actions (0.07), $t(95) = 15.31$, $p < .001$, $d = 1.56$. The proportion of false alarms remained unchanged from immediate ($M = 0.49$) to 1-week recall ($M = 0.51$) for the high-typicality actions, whereas for the low-typicality actions, there were more false alarms at 1 week ($M = .31$) than immediately ($M = 0.22$), $t(95) = 3.77$, $p < .001$, $d = 0.52$.

Accuracy A' scores

The interval factor, $F(1, 94) = 6.25$, $p = .01$, $\eta^2_p = .06$, and the typicality × interval interaction, $F(1, 94) = 4.76$, $p = .03$, $\eta^2_p = .05$, were significant. Accuracy was better immediately ($M = 0.80$) than at 1 week ($M = 0.77$). For high-typicality actions, there were no differences in accuracy between the immediate ($M = 0.78$) and 1-week ($M = 0.78$) recognition task, but accuracy for low-typicality actions was poorer at 1 week ($M = 0.76$) than immediately ($M = 0.81$), $t(95) = 3.12$, $p < .01$, $d = 0.44$.

Response bias B''_D scores

The age group, $F(1, 94) = 18.74$, $p < .001$, $\eta^2_p = .17$, and typicality, $F(1, 94) = 452.64$, $p < .001$, $\eta^2_p = .83$, factors were significant. The older adults adopted a more lenient response criterion ($M = -0.38$) than the younger adults ($M = -0.15$). The participants showed a high response bias for high-typicality actions ($M = -0.67$), while showing a conservative response criterion ($M = 0.14$) for low-typicality actions.

Confidence

Confidence was rated on a scale of 1 (*no certainty*) to 5 (*absolute certainty*). Average confidence scores are shown in Table 4. To analyze confidence, a 2 (hits, false alarms) × 2 (age group) × 2 (typicality) × 2 (interval) ANOVA was performed. The participants exhibited greater confidence for hits ($M = 4.39$) than for false alarms ($M = 3.86$), $F(1, 95) = 43.54$, $p < .001$, $\eta^2_p = .31$. The age group, $F(1, 94) = 5.64$, $p < .05$, $\eta^2_p = .06$, typicality, $F(1, 95) = 96.82$, $p < .001$, $\eta^2_p = .51$, and interval, $F(1, 95) = 6.95$, $p < .01$, $\eta^2_p = .07$, factors were also significant. The older adults rated their responses with higher confidence ($M = 4.30$) than the younger participants ($M = 3.96$).

Confidence was greater for high-typicality actions ($M = 4.43$) than for low-typicality actions ($M = 3.83$) and was higher immediately ($M = 4.19$) than at 1 week ($M = 4.06$). The hits/false alarms × typicality interaction, $F(1, 76) = 17.81$, $p < .001$, $\eta^2_p = .19$, was significant because the difference in confidence between hits and false alarms was significantly less in high-typicality actions ($4.59 - 4.27 = 0.32$) than in low-typicality actions ($4.20 - 3.46 = 0.74$), $t(77) = 3.78$, $p < .001$, $d = 0.56$. With confidence across the interval factor (immediate, 1 week) collapsed, the hits/false alarms × age group × typicality interaction was significant, $F(1, 76) = 6.70$, $p = .012$, $\eta^2_p = .08$. The difference in confidence between hits and false alarms for high-typicality actions was equivalent in young ($4.49 - 4.17 = 0.32$) and older adults ($4.67 - 4.36 = 0.31$), whereas for low-typicality actions, the difference in confidence between hits and false alarms was higher in young adults ($4.08 - 3.07 = 1.01$) than in older adults ($4.31 - 3.84 = 0.47$), $t(76) = 2.69$, $p < .01$, $d = 0.59$. This means that for low-typicality actions, younger adults discriminated hits from false alarms better than older adults.

The greater tendency among the older adults to respond *true* (more lenient criterion) might result in more correct guesses, reducing the size of the age difference in hits and explaining the lack of a difference for high-typicality events. An analysis of responses with high confidence (values of 4 and 5 in the 1 to 5 scale) for hits and false alarms might show the magnitude of this bias for both young and older participants. To this end, a 2 (hits, false alarms) × 2 (age group) ANOVA was performed. The proportion of high-confidence responses was greater for hits ($M = 0.86$) than for false alarms ($M = 0.39$), $F(1, 94) = 689.62$, $p < .001$, $\eta^2_p = .88$, and for older ($M = 0.69$) than for younger adults ($M = 0.55$), $F(1, 94) = 36.04$, $p < .001$, $\eta^2_p = .28$. The hits/false alarms × age group interaction was significant, $F(1, 94) = 15.38$, $p < .001$, $\eta^2_p = .14$. The proportion of high-confidence responses was greater for older than for younger adults both in the hits (0.88 vs 0.80), $F(1, 94) = 7.32$, $p < .01$, $\eta^2_p = .07$, and in the false alarms (0.50 vs 0.29), $F(1, 94) = 46.44$, $p < .001$, $\eta^2_p = .33$. Although response bias may still mask the age effect in true recognition for hits, the size of this effect was prominent for the false alarms but small for the hits.

DISCUSSION

We conducted this study to examine the effects of script-driven processing on eyewitness memory in young and older adults. Because of the lack of reference data from older adults on previous knowledge about crimes, we first

Table 4. Recognition confidence (1 to 5) for high-typicality and low-typicality actions (*SDs* in parentheses)

	Young		Older	
Confidence	High typicality	Low typicality	High typicality	Low typicality
Immediate				
Hits	4.64 (0.34)	4.22 (0.67)	4.75 (0.35)	4.35 (0.56)
False alarms	4.25 (0.92)	3.20 (1.10)	4.42 (0.58)	3.71 (0.87)
Week				
Hits	4.35 (0.59)	3.95 (0.81)	4.60 (0.59)	4.27 (0.73)
False alarms	4.09 (0.85)	2.95 (1.13)	4.31 (0.78)	3.97 (0.98)

collected normative data to determine the typicality of the actions for a bank robbery. Our results confirm that young and older adults generally agreed on what constituted the script of a bank robbery in terms of type of actions listed, number of actions recalled, and production frequency. Similarly, Light and Anderson (1983) found no differences between young and older adults in generic knowledge for routine daily activities such as grocery shopping. Our results would support the hypothesis that there are no substantial differences between young and older adults in how script information for eyewitness events is represented in semantic memory. Our data are also consistent with preserved or even facilitated semantic functioning among older adults (e.g., Park et al., 2002).

In the recall task, participants focused their accounts primarily on typical actions that are what best represent an event (García-Bajos & Migueles, 2003). Although participants made few errors and it is known that free-recall tasks provide accurate testimonies (Loftus, 1979; Migueles & García-Bajos, 1999), the young and older adults had more schema-consistent (i.e., high-typicality) than low-typicality errors. As a whole, correct recall and errors indicate that the young and older adults used the bank robbery script in a similar fashion. There were no differences between the two groups in the recall of schema-based materials. The only difference between the young and older adults was in the correct recall of low-typicality actions, which had little representation in the script and require cognitive resources to be maintained in memory. In other words, as in processing-intensive tasks (Hedden et al., 2005; Park et al., 2002), older people have difficulty remembering specific information that requires attention or cognitive resources. Consistently, in this study, older participants showed poorer performance in perceptual speed and in phonemic fluency than younger adults.

Recognition tasks generate more errors than recall tasks (Loftus, 1979; Migueles & García-Bajos, 1999); however, in legal contexts, eyewitnesses must often answer true/false questions to determine the veracity of the events or to differentiate between correct and incorrect information. There were no differences between young and older adults with regard to true recognition (i.e., hits) of the actions of the event or accuracy. However, bias of script-driven processing was more pronounced in the older adults than in the younger adults. Older adults accepted more false information, primarily in high-typicality actions, but also in low-typicality actions less representative of the script, possibly because, independent of their typicality, all the actions were coherent and consistent with the event. Response bias can offer us an additional index to understand participants' decisions. Although both groups adopted a more liberal criterion for the typical and more accessible items than for the low-typicality and more specific actions, older adults showed more lenient response bias (i.e., tendency to answer *true* in the recognition task) for all contents. In other words, the greater willingness to respond might result not only in more false alarms but also in more hits or correct guesses on the part of the older adults, therefore reducing the size of age-related difference in the recognition task. This tendency to accept information, true or false, is consistent with a bias for responding in studies that have examined recognition memory of witnessed events in young and older adults (Aizpurua et al., 2009; Pansky, Goldsmith, Koriat, & Pearlman-Avnion, 2009).

With regard to retention interval, witnesses are evaluated repeatedly in real-life eyewitness situations. In our study, repeated evaluation consolidated the memory in the long term, but only for the most representative contents of the script. The current findings suggest a specific mechanism by which eyewitness memory may become more script consistent, more gist dependent, and more schematic over time: the least typical actions were the contents most vulnerable to the passage of time because remembering the low-typicality actions of an event requires attentional resources and controlled processing. The loss of verbatim detail over time and greater reliance on gist is consistent with the fuzzy-trace theory (e.g., Brainerd & Reyna, 1990). Moreover, although scripts help retain memory of high-typicality actions, the passing of time produced more false alarms and greater confidence, which strengthens false memories (e.g., García-Bajos & Migueles, 2003; Tuckey & Brewer, 2003b). Therefore, with long retention intervals, it might become harder to distinguish between the actions of an event and contents of the script.

Bias of script-driven processing was higher in the older age group, suggesting a greater use of previous knowledge with age. Similar to studies using word lists (Jacoby et al., 2005; Norman & Schacter, 1997; Schacter et al., 1997) or misleading postevent information (Dodson & Krueger, 2006; Dodson et al., 2007), older adults accepted more false information and with higher confidence than younger adults, that is, they believed in their false memories. With the use of vividness ratings, a study by Karpel, Hoyer and Toglia (2001) even found that old people added perceptual attributes (e.g., color, location) to the suggested and falsely recognized items. Older adults' tendency to accept false contents may be explained by their greater dependency on gist than young adults (Brainerd & Reyna, 1990; Koutstaal et al., 2003), leading them to base their recognition decisions on previous knowledge (Mather et al., 1999) and on information plausibility (Aizpurua et al., 2009; Reder et al., 1986) to a greater degree than younger adults. This idea is supported by the lenient response criterion and high confidence adopted by the older adults in this study. Mechanisms proposed to underlie increased false recognition in older adults also include aging-related 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 et al., 1997). These explanations might be related to each other, in the extent that older adults show an over-reliance on semantic gist to compensate for age-related decline in verbatim information availability about the event. Therefore, we consider that older adults' greater difficulty in discriminating between perceived memories and memories from other sources in eyewitness situations is most likely due to both source memory deficits (Aizpurua, García-Bajos, & Migueles, 2011; Johnson, Hashtroudi, & Lindsay, 1993) and the incremented bias of script-driven processing with age. Future research is needed to better understand the interactions between different levels of cognitive deficits in aging and schema-based processing in the generation of false memories in the real world.

Finally, the present study can contribute to establish tight relationships between memory accuracy and metacognitive experience. Bias of script-driven processing—based on false alarms, response bias, and confidence—was outstanding in older adults. More importantly, bias in older people depends basically on the typicality of the contents assessed and, although to a lesser degree, extends to other low-typicality actions congruent with the event. Even so, the difference in confidence between hits and false alarms was similar in young and older adults for high-typicality actions, showing that in terms of metacognitive experience young and older participants were equally misled by typical script contents. However, for low-typicality actions, the younger participants were better, in consonance with better recall performance, than the older adults at calibrating confidence ratings to discriminate hits from false alarms.

In conclusion, older adults are likely to economize cognitive resources, making a more liberal use of script-driven processing than younger people. Research suggests that the degree of aging is relevant (e.g., Luo & Craik, 2009; Pansky et al., 2009; Wright & Holliday, 2007); therefore, it is important to point out that our study applies to the younger end of the elderly adult spectrum. Although with the decreased availability of cognitive resources for processing specific information typical in healthy aging, our participants were mentally high-functioning older adults. It is reasonable to think that this cognitive decline and knowledge dependence would be more prominent in older elderly adults. Many of the biases from the activation of prior knowledge may seem unimportant. For example, being certain there was a beach ball at a beach scene when there was not (Miller & Gazzaniga, 1998) or remembering a non-existent word in a list of associated words (e.g., Jacoby et al., 2005). However, in the case of eyewitnesses, remembering or erroneously accepting typical actions, such as threatening someone with a weapon, can have serious consequences in legal contexts. In fact, testimonies containing typical contents seem more credible, render more guilty verdicts (Smith, 1991, 1993), and could give rise to serious errors in the court room. How to discern whether a memory comes from automatic, rapid, fluid activation of prior knowledge or from a vivid recollection of an episodic experience is a challenge for eyewitness memory research in general and for cognitive aging in particular.

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APPENDIX

Actions of the bank robbery used in the two recognition tasks and percentage of participants mentioning each action in the normative study

Recognition actions, version A	Young	Older	Recognition actions, version B	Young	Older
High-typicality, true	*37.71*	36.61	*High-typicality, true*	*39.71*	*38.77*
Shout: 'Don't anyone move! Hands up!'	35.71	27.69	Enter with the face covered	30.00	36.92
People are frightened	32.85	35.38	Threaten and point weapons at people	60.00	64.61
Threaten to open the till	25.71	30.76	People stand still, frozen	25.71	26.15
Force the security guard to put the money in a bag	31.42	26.15	Be nervous and rush people	35.71	27.69
Take the bag and leave with the money	62.85	63.08	Keep watch and control people	47.14	38.46
High-typicality, false	*33.42*	*33.84*	*High-typicality, false*	*35.46*	*35.38*
Put on the balaclava upon entering	27.71	30.76	Shout: This is a stick-up!	25.71	26.15
Try to sound the alarm	31.42	32.30	Shout: Everyone on the floor!	27.14	26.15
People become nervous	35.71	41.53	The people drop to the floor	38.57	27.69
Threaten customers at gun point	48.57	38.46	Ask for the money	55.71	67.69
People scream	25.71	26.15	Hand the bag of money over to the robber	30.00	29.23
Low-typicality, true	*2.56*	*2.45*	*Low-typicality, true*	*2.28*	*2.45*
Order the guard to toss his gun on the ground	4.28	3.07	Force employees to leave the counter	2.85	3.07
Threaten to shoot and kill him	1.42	3.07	The people keep quiet	2.85	3.07
The people stand there with their hands up	4.28	1.53	Put the gun at guard's neck	1.42	3.07
Say to his partner: 'Let's go!'	1.42	1.53	Another guard appears	2.85	1.53
The video cameras recorded the event	1.42	3.07	Try to put out his gun	1.42	1.53
Low-typicality, false	*2.56*	*2.15*	*Low-typicality, false*	*2.85*	*2.76*
A customer tries to hide his money	1.42	1.53	Threaten to kill a customer	2.85	3.07
Some customers try to get out	4.28	1.53	Try to calm down the robber	4.28	3.07
Push a customer	2.85	4.62	Take the keys to the till	2.85	3.07
Tell people not to look at him	1.42	1.53	Set off the alarm	1.42	3.07
When they leave, one of the guards shoots at them	2.85	1.53	Assist the injured person	2.85	1.53

