Atten Percept Psychophys (2013) 75:636–643
DOI 10.3758/s13414-013-0448-7

The floor effect: Impoverished spatial memory for elevator buttons

Michael Vendetti · Alan D. Castel · Keith J. Holyoak

Published online: 20 March 2013

Abstract People typically remember objects to which they have frequently been exposed, suggesting that memory is a by-product of perception. However, prior research has shown that people have exceptionally poor memory for the features of some objects (e.g., coins) to which they have been exposed over the course of many years. Here, we examined how people remember the spatial layout of the buttons on a frequently used elevator panel, to determine whether physical interaction (rather than simple exposure) would ensure the incidental encoding of spatial information. Participants who worked in an eight-story office building displayed very poor recall for the elevator panel but above-chance performance on a recognition test. Performance was related to how often and how recently the person had used the elevator. In contrast to their poor memory for the spatial layout of the elevator buttons, most people readily recalled small distinctive graffiti on the elevator walls. In a more implicit test, the majority were able to locate their office floor and the eighth floor button when asked to point toward these buttons when in the actual elevator, with the button labels covered. However, identification was very poor for other floors (including the first floor), suggesting that even frequent interaction with information does not always lead to accurate spatial memory. These findings have implications for understanding the complex relationships among attention, expertise, and memory.

Keywords Memory · Attention · Spatial memory · Expertise

M. Vendetti (✉) · A. D. Castel (✉) · K. J. Holyoak
Department of Psychology, University of California, Los Angeles, 1285 Franz Hall, Box 951563, Los Angeles, CA 90095, USA
e-mail: michael.vendetti@ucla.edu
e-mail: castel@ucla.edu

Memory is often a product of how often one encounters, uses, and retrieves the information in question. People are remarkably good at recognizing scenes that they were shown briefly, even when the scenes are tested among hundreds of others (Nickerson, 1965). Yet, somewhat surprisingly, people have exceedingly poor memory for the details and features of common coins (e.g., Jones & Martin, 1992; Nickerson & Adams, 1979; Rubin & Kontis, 1983), objects that we see almost every day. Explicit spatial memory is rather poor for numerical keypads, such as those used on telephones and calculators (Rinck, 1999), and for the relative positions of keys on a keyboard (Logan & Crump, 2009; Liu, Crump, & Logan, 2010), despite substantial exposure. Recent research has also shown that despite years of exposure to the locations of fire extinguishers in an office setting, people have poor memory for the locations of these bright red, safety-related objects (Castel, Vendetti, & Holyoak, 2012). However, memory may be relatively poor for these objects because we rarely attend to the specific features of coins, rely on nonvisual cues to operate keyboards, and rarely (if ever) have to use fire extinguishers.

How much detail do we remember about environments in which we do attend and interact with specific details and features? People often take elevators, and they interact with elevator buttons on a daily basis. In many cases, people take the same elevator multiple times a day when working in an office setting for many years. If you take an elevator to your office, how well could you recall the relative layout of the buttons? Does years of experience influence our ability to recall such information, and can one's level of confidence be related to accuracy? These questions are critical for both applied and theoretical reasons (cf. Neisser, 1982), in order to better understand the attentional, memorial, and metacognitive processes that determine how and what we remember in real-world environments (cf. Kingstone, Smilek, Ristic, & Eastwood, 2003).

In the present study, we investigated the accuracy of people's memory for the layout of buttons in an elevator, a device

Fig. 1 Poster board apparatus used to test for implicit motor memory of elevator button locations. The actual floor labels were covered by the cardboard and all buttons were exposed, with the exception of the emergency elevator stop and emergency alarm buttons

that most of the participants used several times a day. Unlike keyboards, telephones, calculators, and keypads, people typically have to look at the elevator buttons when choosing which to press. Thus, using an elevator is an activity that is goal-directed and involves a simple, intentionally guided interaction with a button panel. Therefore, memory for the button layout in a frequently used elevator might be well encoded, so that people would show accurate spatial memory for the buttons (cf. Cañal-Bruland & van der Kamp, 2009). We were especially interested in whether a frequency effect might occur, such that buttons that are frequently pressed by a given individual (e.g., the floor button associated with one's office location or the button for the ground floor, which is likely the most commonly used button) would be recalled well, relative to other buttons.

To test these hypotheses, we asked people who worked in an eight-story office building (plus three additional basement levels), with two identical elevators, to recall the spatial layout of the elevator button panels. We assessed memory for the location of the electronic floor indicator (something that people frequently look at when traveling in an elevator). We also conducted a follow-up session three months after the initial study, in which we tested participants' ability to locate specific buttons when actually in the elevator, in order to test implicit or procedural forms of memory for the elevator button layout in a more natural context (Johansson & Cole, 1992).

Method

Participants and locale

The participants in the initial session were 67 faculty, staff, and students in the UCLA Department of Psychology, located in Franz Hall tower. In total, 17 full-time faculty or postdoctoral fellows, 38 graduate students, and 12 staff participated in the study. The mean age of the participants was 32.3 years (range = 20–77 years of age), 57 % were female, and the mean number of years that each person had occupied their office on a given floor was 4.35 years (range = 1 week to 42 years). Thirty people (16 of whom had previously completed the earlier session) participated in a follow-up study investigating their implicit motor memory for the button locations. The mean age of the latter group was 29.2 years (range = 20–58 years of age). The participants were recruited from Floors 3–8 of the building (as Floors 1 and 2 had very few occupants who would regularly take the elevator).

Procedure and materials

People were approached while in their office or laboratory and asked if they would complete a short survey. They were then handed a blank piece of paper and asked to draw the button panel located in the elevator in Franz Hall tower. They were informed that the panel included the set of buttons in the elevator and were asked to provide as many accurate details as possible, such as the label and location of each button. The experimenter noted where they started drawing (i.e., their landmark button) and collected the drawing after the participant had finished. Participants were then asked how confident they were about the accuracy of their drawing, on a scale from 1 (*not at all*) to 10 (*extremely confident*). Following this, several other questions were asked pertaining to their memory of the elevator, including whether they knew where the floor indicator (an electronic indicator that digitally displays the floor number) was located, how they had constructed the panel from memory (e.g., whether they had used visualization or had rules for how the panel layout should be organized), and any other distinctive aspects that they remembered about the interior of the elevator. In addition, participants were asked to indicate how often they pressed each of the buttons on the panel, on a scale from 1 (*never*) to 10 (*very often*), as well as to indicate how often they took the elevator and when they had last taken it. Participants were then given a recognition test depicting four representations of button layouts, the order of which was counterbalanced across participants. Finally, the participants were asked some demographic questions, including how many years they had been in their office location, whether they had ever had offices on other floors, their employment position, and their age. They were then

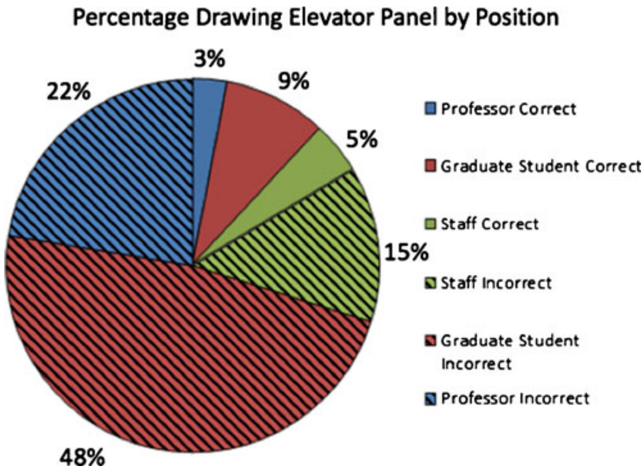

Fig. 2 Percentages of the panel drawings, broken down by professional position and accuracy. Only 16 % of the participants (two professors, six graduate students, and three staff) drew correct elevator button panels. The 84 % incorrect comprised 15 professors, 32 graduate students, and nine staff

debriefed about the study and asked whether they had any questions or comments.

Three months after the initial study, we conducted another session in which we tested 30 participants on their ability to physically locate buttons in the elevator. The floor labels were covered with a cardboard overlay, to measure participants' implicit memory of the elevator button layout. We brought participants into the elevator on their office floor, covered up the indicators for the elevator buttons (see Fig. 1 for a picture of the apparatus), and had them point toward four buttons representing where they thought the buttons for the first, second, eighth, and their office floor were located. Afterward, we asked them how recently they had ridden the elevator (not counting our interview) and how often they took the elevator (several times a day, once a day, or once a week).

Results

As is shown in Fig. 2, of the 67 people tested, only 11 (16 % of the sample) could accurately draw the button layout from memory, where accurate performance required correct placement of the floor buttons ranging from A to 8 only (see Fig. 3 for the layout). We did not include the B, C, or service buttons when scoring a correct drawing, as a majority of the participants did not include these. (A, B, and C refer to the three below-ground floors, with floors B and C only being accessible to people with security-clearance swipe cards). In fact, *no* participants accurately recalled the locations of all 16 (11 floor and five service) buttons. Participants' drawings of the button panel departed greatly from the actual button layout (refer to Fig. 3 for some examples of participant drawings). However, 61 (91 %) produced a drawing that at least had the correct number of columns (two), perhaps suggesting that many participants relied upon a more general, gist-based representation (cf.

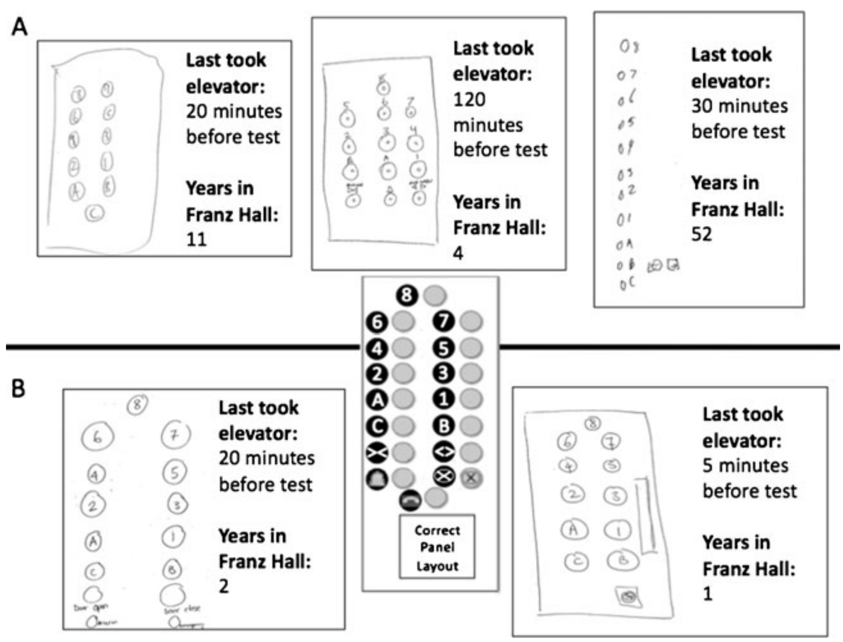

Fig. 3 Examples of panels drawn by participants. The correct button layout representation used for the recognition test is shown in the center. (**a**) Examples of incorrect drawings from participants, which varied from those that were somewhat close (i.e., had two columns and all eight floors) to those that were not closely representative of the actual elevator button panel. (**b**) Examples of correct drawings from participants. Note that participants were scored as having a correct button panel layout if they correctly drew the buttons representing Floors A–8. Thus, participants' drawings could be scored as correct even if they did not correctly depict service buttons

Intraub & Richardson, 1989; Loftus, 1992; Wolfe, 1998) of the elevator button panel when drawing from memory (although other interpretations are possible). The floor labels for the elevator buttons were actually located to the left of each button (see Fig. 3, middle panel); however, 71 % of the participants drew the button layout with the floor numbers located directly on the elevator buttons.

Predictors of recall

In addition to coding whether or not participants provided the correct button layout, we used eight criteria to score participants' drawings, with a higher score indicating a more accurate drawing. These criteria were whether a drawing (1) had two columns, (2) had odd numbers on the right side of the panel, (3) had an asymmetrical button placed on top, (4) had higher buttons on the panel corresponding to higher floors, (5) had the "8" button alone on top, (6) included any service buttons, (7) placed the service buttons on the bottom of the panel, and (8) had the correct placing of the "door open" and "door close" buttons (as these were the mostly common drawn service buttons, included 40 % of the time). Several predictors significantly correlated with drawing score, including the time since a participant had last taken the elevator (Spearman's rho = −.28, $p < .02$) and how often overall the participant took the elevator (Spearman's rho = .28, $p < .02$). These correlations suggest that the ability to recall a spatial layout increases with frequency of interacting with it and recency of seeing it. In addition, participants' confidence in their drawings' accuracy was positively correlated with their drawing score (Spearman's rho = .36, $p < .003$), indicating that participants had some declarative and metacognitive insight into their ability to recall the button panel.

We were also interested in whether the floor on which a participant had an office had any relation to whether he or she recalled a particular aspect of the button layout. The elevator panel in Franz Hall tower has an "8" button asymmetrically placed on top. As can be seen in Fig. 4, we found that those who worked on the eighth floor were significantly better at

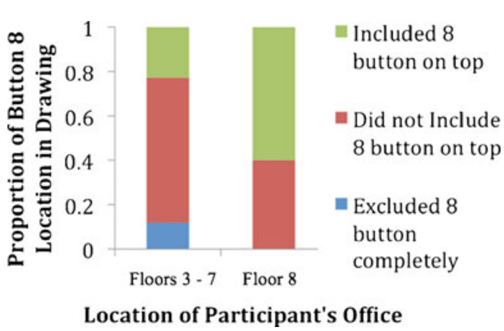

Fig. 4 Participants whose offices were located on the eighth floor were more likely to correctly locate the "8" button in their drawings

including an "8" (i.e., Score Criterion 5) in their drawings than were the occupants of the other floors combined: Fisher's exact test of independence, $\chi^2(1, N = 67) = 5.79$, $p < .025$. We found no significant effects of gender, age, years in office, or academic position on the accuracy scores (ts < 1, ps > .3).

Recognition performance

At the end of the survey, participants were given recognition memory tests for the elevator button panel as well as a standard telephone button layout (see Fig. 5 for the recognition test alternatives). When asked to pick the correct button layout from among the four alternatives, participants were significantly better than chance (25 %) at choosing both the elevator panel ($M = 55$ %, $SE = 6$ %) and telephone button ($M = 52$ %, $SE = 6$ %) layouts. A paired t test revealed that recognition performance was not significantly different for the elevator and telephone buttons, $t(66) = 0.35$, $p > .7$. As can be seen in Table 1, 15 % of all participants (i.e., ten of the 11 who were successfully able to recall the elevator button layout) were successful at both recalling and recognizing the elevator layout, whereas 10 % of all participants (i.e., seven of these same 11 people) were also able to recognize the correct telephone button layout. The participants trended toward better recognition of the elevator panel when recall had been successful, $\chi^2(1, N = 67) = 3.71$, $p = .054$; however, no such trend was apparent for recognition of the telephone layout, $\chi^2(1, N = 67) = 0.03$, $p = .88$.

Mnemonic strategies and their impact on recall

Participants may have used various strategies when recalling the panel. We examined how their recall accuracy might be related to the type of strategy used when they were asked to draw the panel from memory. When asked how they had constructed the panel from memory, participants' responses fell into two categories: visualization and schematized memory. Examples of visualization strategies included imagining that they were standing in the elevator and pressing the button for their particular floor, or visualizing the panel as well as other aspects of the elevator interior, so as to aid their recall. Responses categorized as "schematized" were more based on rules about elevators, such as knowing that the odd-numbered floors are all on the right side and that buttons representing higher floors are higher on the panel, or knowing that the "8" button was by itself at the top and that there were two buttons per row in the panel. We were interested in whether differences in drawing accuracy could be predicted from the types of strategy used for recall. We found that participants who claimed to have visualized while recalling the button layout were actually worse at recall, as indicated by a trend

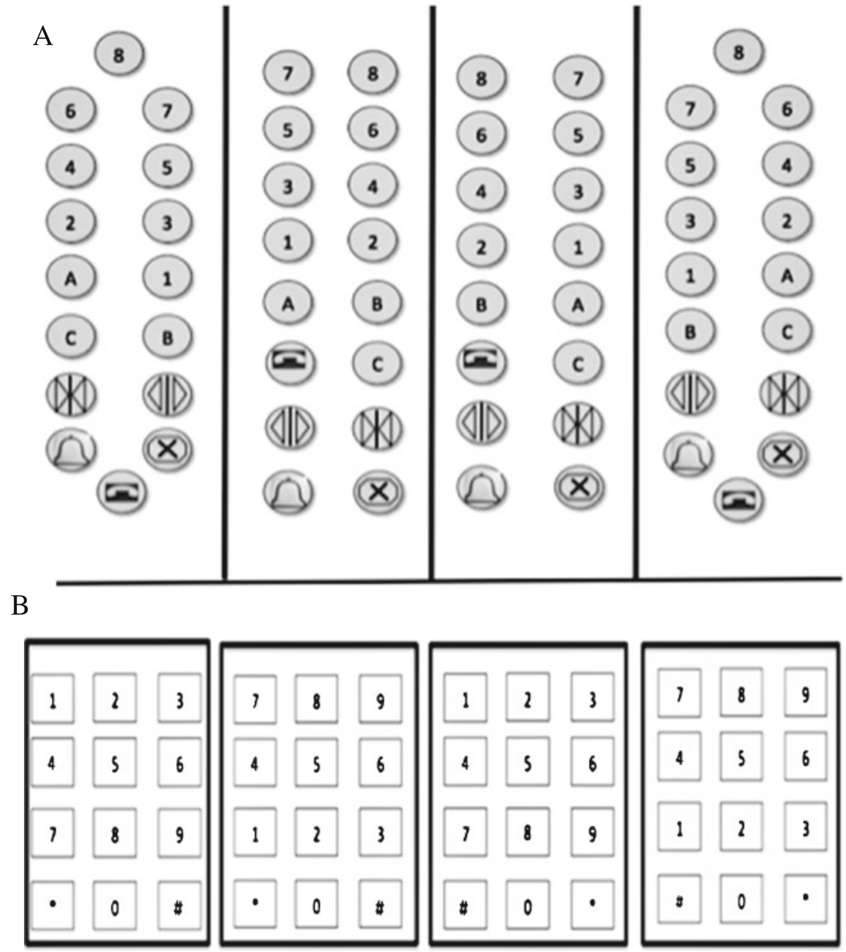

Fig. 5 Example of counterbalanced orders in the recognition test for (**a**) the elevator button panel and (**b**) the telephone keypad layout (correct answers for both examples are shown here as the first options). Participants were significantly better than chance at recognizing the correct layouts for both types (see the text)

for proportions of correct drawing, $\chi^2(1, N = 67) = 3.29$, $p < .07$, as well as for drawing accuracy scores, $F(1, 67) = 4.87$, $MSE = 2.92$, $p < .05$.

Participants were also poor (64 % incorrect) at remembering the location of the floor indicator display inside the elevator. Interestingly, of those who were incorrect at recalling the location, 55 % indicated that the floor indicator was in the middle of the door, rather than at the top right (i.e., the actual location when facing the elevator doors from the inside), perhaps suggesting some interference from a more schematized location for elevator floor indicators. Confidence scores were also significantly higher for the location of the floor indicator ($M = 5.5$, $SE = 2.6$) than for the accuracy of the elevator panel drawings ($M = 4.2$, $SE = 1.9$), $t(66) = 3.94$, $p < .001$.

Table 1 Percentages of correct recognition of the elevator button panel and a phone keypad, conditional on correct versus incorrect recall of the elevator button panel

	Elevator Button Panel	Phone Keypad	*N*
P(Recognition | Recall)	91	64	11
P(Recognition | No recall)	66	63	56

The top row indicates the percentages of those participants who had correctly recalled the elevator button panel who were also successfully able to recognize the layouts of the elevator panel (left) and the phone keypad (right), among three other alternatives. The bottom row indicates the percentages of those participants who were unable to recall the elevator panel who were able to recognize the elevator and telephone button layouts.

Memory for graffiti

Through many years of continual use prior to our study, wear and tear had occurred within the elevators in Franz Hall tower. One side effect was that the wooden panels lining the insides of both elevators had small pieces broken off, just above the floor. Several years previously, an anonymous student had drawn features onto the wall behind the removed parts of the panels to emphasize their resemblance to the shape of an animal (one resembling a dog, the other a cat; see Fig. 6). This unauthorized creative effort provided us with an opportunity to determine whether participants would recall these contextually unusual items, even though they had not had any motoric interaction with these “graffiti” (certainly less interaction than with the button panel).

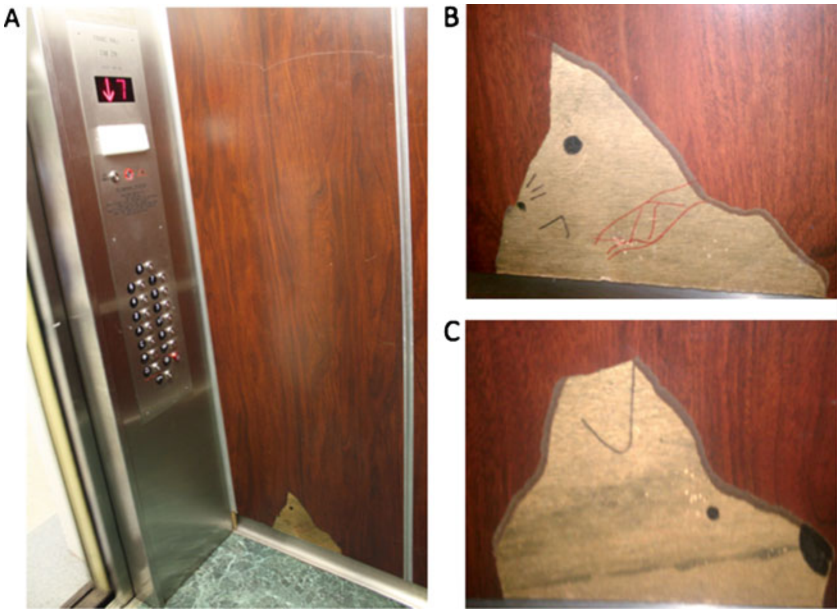

Fig. 6 (**a**) Image of the "cat" graffiti from the perspective of someone inside the elevator. (**b**) Close up of the "cat" graffiti found in the left elevator. (**c**) Close up of the "dog" graffiti found in the right elevator. (Graffiti are present in both elevators, with a "dog" in one elevator and a "cat" in the other, although he interpretations of the images as particular animals is of course subjective.) Information about the graffiti within the elevator was provided by 63 % of the participants in response to an open-ended question, suggesting that memory for unusual information can be very good, even when memory for other aspects of the same context (e.g., the button panel) is very poor

When participants were asked whether they remembered any other distinctive aspects within the interior of the elevator (without being given any more specific cues), a striking number of the participants (67 %) spontaneously recalled the presence of the animal graffiti in the elevator panels.

Implicit memory follow-up

As is shown in Fig. 7, although participants were very poor at explicitly recalling the elevator button layouts when drawing them from memory, when tested using a more implicit form of memory, a majority of the participants were able to correctly point to the elevator buttons corresponding to their office floor and the eighth floor (67 % and 93 %, respectively).[1] However, participants were much worse at identifying the buttons for Floors 1 and 2 (see Fig. 7). When asked, most participants indicated that they had forgotten about the A, B, C, and service buttons, a memory error that led to displacement of the buttons for Floors 1 and 2. Unlike in the case of participants' performance in the explicit memory test, how often one took the elevator and the time since last taking it were not significantly related to accuracy on the more implicit memory test (Spearman's rhos = .08 and –.03, respectively, $ps > .65$). Participants' explicit memory for the floors tested in the implicit task indicated that memory was better for the first and office floor button locations than for the second and eighth buttons, $F(3, 61) = 3.10$, $MSE = .18$, $p < .036$.

General discussion

In the present study, we demonstrated that people are extremely poor at recalling the elevator button layout from their workplace. Unlike memory for other common objects, such as coins (Nickerson & Adams, 1979) or keypads (Rinck, 1999), the elevator is something that requires specific visual and motoric interactions with certain buttons and is typically used several times a day. Perhaps it advantageous *not* to memorize the layout of any particular elevator button panel, due to possible interference with other elevators, given the ease with which one can make button selections inside an elevator, where other spatial cues are present. Nonetheless, several factors were related to more accurate memory for features of the button panel, including recency and amount of elevator use. These findings (combined with the fact that participants' confidence ratings predicted accuracy) argue against a purely procedural-based memory of

[1] Since we found no difference in overall accuracy between the 16 participants who had previously been tested on their elevator memory and the 14 who had not, $t(28) = 0.83$, $p = .41$, all of the reported analyses were collapsed across these subgroups.

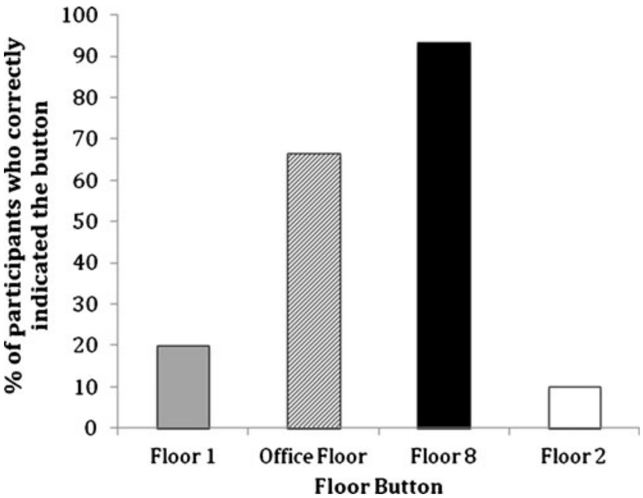

Fig. 7 Percentages of participants who were able to correctly identify floor locations. A majority of participants were able to identify their office floor and the eighth floor buttons (67 % and 93 %, respectively). Participants were much worse at identifying the buttons for Floors 1 and 2. When asked afterward, most participants said that they had forgotten about the **A**, **B**, and **C** floors, along with the service buttons at the bottom of the button layout

the spatial layout, suggesting that at least some aspect of the memory is declarative.[2]

The fact that attempting to visualize the layout led to lower recall scores than did a more schematic approach raises several possibilities. Attempting to visualize the layout may have triggered more erroneous information that interfered with memory for the correct layout, possibly due to schema-based intrusions (see also Rubin & Kontis, 1983). Another possibility is that spatial memory for the elevator panel was sometimes reconstructed through a more schematic, or gist-based, approach (Wolfe, 1998). Perhaps having an accurate schema for the general spatial layout of the elevator panel provided scaffolding upon which retrieving the specific information could then be based, thus making recall attempts more accurate. Future research could test this hypothesis by assigning a particular strategy to participants while they engaged in a recall attempt for spatial layouts, and testing whether visualization interferes with recall, schematization improves it, or both.

One possibility is that, like typing, pressing certain buttons in an elevator (especially for people who frequently use the elevator) becomes a highly proceduralized process. The finding that a majority of the participants were able to correctly indicate their office floor button supports the notion that one could rely on procedural memory to identify button locations. It should be noted, however, that our test for implicit memory of the button layout was not purely implicit. Because the layout of the buttons was displayed, participants could make a judgment based on their explicit memory of button panel layouts, in order to decide where the eighth floor button would or should be (i.e., at the top; over 90 % successfully located this button, possibly because they inferred that it should be at the top of the panel, resulting in a type of "ceiling" effect). In addition, providing participants with the layout structure also led them astray when attempting to locate the first and second floor buttons, which many people indicated as being closer to the bottom of the panel than they actually were (most often due to failing to consider the A, B, and C floor buttons and the service buttons on the bottom of the layout).

Participants showed above-chance recognition performance for both the elevator panel and the telephone panel. This finding was not attributable to all participants narrowing their choices down to two of the most similar layouts (i.e., the asymmetrical elevator button layouts or the telephone layout with 1, 2, and 3 on top). For example, even for participants who chose one of the two asymmetrical layouts, roughly 30 % still provided an incorrect response. Participants may have had difficulty remembering the precise spatial locations when asked to recall from memory, but they could efficiently (and perhaps implicitly) reach for some correct buttons when actually in the elevator environment. Participants may have had good memory for their own floor because this information is important to remember and people frequently push this button (Castel, 2008), whereas the Floor 1 button often may have already been pushed by other passengers. Also, frequent use of the buttons may lead to habits and skills that are not recalled well through explicit memory strategies. Nonetheless, the participants' confidence about their drawings' accuracy was positively correlated with their drawing scores, suggesting that participants had some declarative and metacognitive insight into their ability to recall the button panel.

The present findings are broadly consistent with other work indicating that simply seeing or hearing information repeatedly does not necessarily enhance memory for it (e.g., Berkerian & Baddeley, 1980; Castel et al., 2012; Nickerson & Adams, 1979; Rubin & Kontis, 1983) and that remembering information requires more detailed semantic, analytical, and/or deeper levels of processing (e.g., Craik & Lockhart, 1972; Craik & Tulving, 1975). A particularly striking finding from the present study was that a remarkable number of participants incorrectly recalled the location of the floor indicator display, something that people attend to when traveling in an elevator. In striking contrast, participants' recall was remarkably good for the animal graffiti present in both elevators. This disparity in recall may be related to the degree of match that each object registered to an elevator schema. The actual position of the

[2] Further support comes from a classroom pilot study testing explicit memory for the button panel with undergraduate students who had a class in Franz Hall and interacted with the elevator there much less often than did the participants in our main study. Only 5 % (2/44) of the undergraduate students were correctly able to recall the button layout. Their accuracy level tended to be lower than that for our sample who did regularly interact with the elevator, $\chi^2(1) = 3.62$, $p < .06$.

elevator floor indicator (top right, above the button panel) may have conflicted with a prior elevator layout schema (indicator in top middle, centered above doors), creating interference, whereas the peculiar graffiti presumably did not match an elevator schema at all, therefore triggering both allocation of attention and noticeable distinctiveness—hence, better encoding into memory (Hunt & McDaniel, 1993; Parker, Wilding, Akerman, 1998; von Restorff, 1933). In addition, recall of the floor indicator may have suffered during the retrieval attempt—relative to the graffiti—due to the high amount of interference from floor indicators in other elevators that participants had used.

Overall, people displayed relatively poor spatial memory for the features of the elevator button panel and the location of the floor indicator in the present study. Their poor performance could be attributed to lack of intentional learning for this information. Prior work with coins has shown that when asked to deliberately remember the features of coins, after brief presentation people in fact show accurate memory (Marmie & Healy, 2004), suggesting important differences in the efficiency of incidental versus intentional encoding of the features. The present study suggests that frequent, deliberate interaction with information does not necessarily lead to accurate spatial memory, an observation that could have important implications for models of memory, attention, and expertise, as well as for the development of training programs.

Author Note This study was supported by ONR Grant No. N000140810186. We thank Robert Bjork, Barbara Knowlton, Michael Dodd, Jesse Rissman, and Martin Monti for helpful advice at various points during this research. We also thank Stephanie Sabatine for her help in running the follow-up implicit-memory task in the elevators.

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