

Attention and Incidental Memory in Everyday Settings

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Historical Context

Much of the information that we acquire from the world is done incidentally. That is, we are not actively trying to memorize certain events, faces, or objects in our environment or songs we hear. This raises an important question regarding the link between attention and memory and how this functions in real-world settings. Do we need to attend to something in order to remember it, and without consciously attending to something, will we somehow remember it? In this chapter, we explore and review how attention and memory are linked in real-world settings, and how and when incidental encoding can lead to strong memories, as well as fleeting and reconstructive representations.

Memory is often a product of attention, and of how often one encounters, uses, and retrieves the information in question. A recent study has shown the ability to preserve details of over 2,000 images, demonstrating the capacity of long-term memory to store details of objects we attend to (Brady, Konkle, Alvarez, & Oliva, 2008). People are also remarkably good at recognizing scenes they were briefly shown, even when tested among hundreds of other scenes (Nickerson, 1965), and names and faces of high school classmates from 50 years ago (Bahrick, Bahrick, & Wittlinger, 1975). However, the simple presentation (and multiple presentations) of information does not always lead to good memory (e.g., Berkerian & Baddeley, 1980). Myers (1916), in one of the first studies of what was called incidental perception, showed that people underestimated the size of a one-dollar bill but overestimated the size of a five-dollar bill although both of these tendencies appear to decrease as age and experience increases. Another classic study regarding everyday attention and memory for common objects examined people's memory for the features of common coins. Specifically, Nickerson and Adams (1979) asked participants to draw the features and layout of an American penny from memory. Although most people have seen the penny many times, participants had difficulty recalling all of the features in the correct location (see figure 20.1). While some renderings are more accurate than others, people often place features in

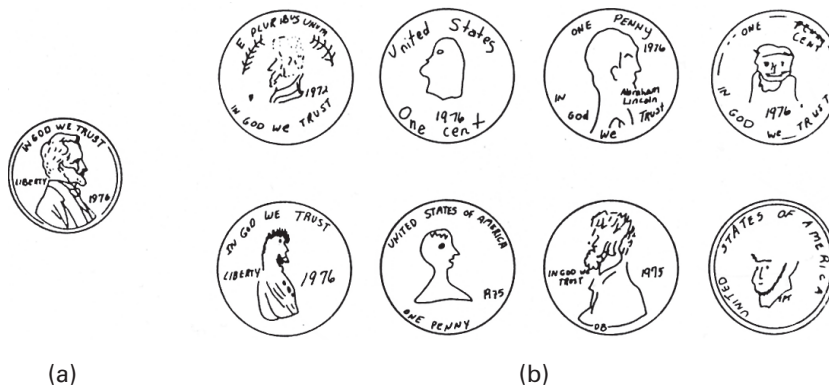


Figure 20.1

The classic “memory for a penny” study by Nickerson and Adams (1979), in which participants were asked to draw the features and layout of an American penny from memory. While most people have seen the penny many times, the recall task is an especially difficult and frustrating one. (a: left panel) The actual American penny. (b: right panel): Examples of drawings by participants who were asked to draw the penny from memory. While some renderings have certain degrees of accuracy, oftentimes people place features in incorrect locations or misremember features from the other side of the penny (e.g., “United States of America”).

incorrect locations or misremember features from the other side of the penny. More recent work has extended this notion to other more relevant objects and information, such as the keypads of calculators and telephones (Rinck, 1999), letters on keyboards (Liu, Crump, & Logan, 2010; Snyder, Ashitaka, Shimada, Ulrich, & Logan, 2014), the layout of frequently used elevator buttons (Vendetti, Castel, & Holyoak, 2013), ubiquitous and popular logos (Blake, Nazarian, & Castel, 2015), and aspects of road signs, such as the stop sign (Martin & Jones, 1998). These findings suggest that constant exposure, interaction, and use do not necessarily lead to accurate spatial recall but may allow for more general, gist-based memory (Wolfe, 1998).

Memory is a reconstructive process (Bartlett, 1932), and the findings from the historical and influential penny study support that this process is often at play. Specifically, the memory representations for the coins often involve blending features from other coins or from the other side of the penny (see also Rubin & Kontis, 1983; Jones & Martin, 1997). This pattern holds even with things that we think we see frequently, likely pay attention to more often, are designed for recognition and memorability, and feel we should remember better, like the Apple logo (Blake, Nazarian, & Castel, 2015). In the Apple logo study that we did in our laboratory at UCLA, we asked participants to first draw, and then later recognize the Apple logo. Participants thought they would do much better at drawing and recognizing the very frequently seen Apple, relative to

their actual performance, especially when they made their predictions before completing the memory task, offering some novel metacognitive insight regarding potential overconfidence in these types of situations. Moreover, their drawings often exhibited features present on real apples or other minimalistic or similar logos, but were not in fact part of the actual Apple logo, suggesting that their memory for the logo was a reconstruction that began with the gist, or essence, of an apple-like logo. However, with explicit practice with verbal materials and songs, memory can be exceptionally good, such as when rehearsing and recalling the Star-Spangled Banner (Rubin, 1977). In addition, even without explicit awareness, a frequently heard song can get “stuck in your head,” despite very little attention or effort used to intentionally encode the song (Hyman et al., 2013). More recent research involving memory for coins has shown that when asked to deliberately remember their features, after a brief presentation, people in fact show accurate memory (Marmie & Healy, 2004), suggesting important differences in the efficiency of incidental (or passive) versus intentional encoding of the features.

State-of-the-Art Review of Selected Area

Does frequent exposure to certain information ensure a strong memory representation, and if we pay attention to something, will we later remember it? These are common and important questions that illustrate the sometimes elusive link between attention and memory. Understanding how attention can influence memory is critical for long-term retention and learning, both in intentional and incidental learning situations. The present chapter selectively reviews how attention and memory are linked in ecologically valid contexts and real-world settings, with an emphasis on real-world tasks, materials, and goals. While there is a large literature on divided attention and explicit memory (see Craik, Govoni, Naveh-Benjamin, & Anderson, 1996), the present review focuses on the role of attention in incidental, and more everyday, settings. Understanding the manner in which attention can influence memory has implications for many different real-world problems, including classroom learning, multitasking, training, and advertising to name a few.

Researchers interested in memory and attention often study these processes in the laboratory, allowing for control over a number of important variables. However, as Neisser (1982) states, this may make us study the wrong questions in the wrong context if we want to be able to translate any of the findings in the laboratory to real-world settings (but see Banaji & Crowder, 1989). Similarly, Jenkins’s (1979) tetrahedral model of memory experiments emphasizes the sensitivity of memory (and presumably attention) to context, such that performance in a given situation is determined by interactions between four categories of variables: participant characteristics and goals, the cognitive strategy that is necessary for good performance, the nature of the to-be-remembered materials, and the manner in which one assesses performance. In the present review,

several recent studies will be outlined that capture how attention and memory interact in everyday settings, as well as implications for how to improve memory.

Inattentional Blindness and Amnesia in Everyday Settings

To better examine how attention and incidental memory encoding operate in real-world settings, several recent studies have examined how well people remember the spatial location of objects in the environment. Take, for example, the location of the nearest fire extinguisher, relative to your office, or in your home. Do you know where it is? In a workplace environment, fire extinguishers are placed in locations that make them easily accessible and in plain view, such that they can be quickly located. However, despite having viewed these bright red objects many times, people may be unaware of their precise locations or even the fact that they have seen them so often (see figure 20.2, plate 5). To examine this issue, we (Castel, Vendetti, & Holyoak, 2012) were interested in whether people could accurately remember and locate the nearest fire extinguisher in their workplace setting and, critically, whether people display impairments in being able to remember and locate these highly visible and potentially lifesaving devices. We tested the ability of occupants of an office building (in our Psychology Department at UCLA) to recall the location of the nearest fire extinguisher (there were six on each floor), as well as other objects (e.g., clock, drinking fountain). Despite years of exposure to these potentially very important objects, a majority failed to remember the location of the nearest fire extinguisher. However, they were able to locate it relatively quickly when asked to search for it, suggesting that seeing is not the same as noticing. Several people also remarked that it was probably near the elevator (even if one was much closer), suggesting that sometimes people infer the locations, have a general or “gist-based” notion, or misremember certain aspects, without relying on actual memory for a specific (nearest) location (cf. Bartlett, 1932; Intraub & Richardson, 1989; Loftus, 1992; Wolfe, 1998). The results support an important distinction between “seeing” and “noticing” objects and reveal a novel form of inattentional amnesia for salient objects (see also Vo & Wolfe, 2012; Wolfe, 1999; Wolfe, Horowitz, & Kenner, 2005; Wolfe, Alvarez, Rosenholtz, Kuzmova, & Sherman, 2011).

The ability to locate the fire extinguisher might reflect mechanisms of attentional priority and goal-directed attention (e.g., Anderson, Laurent, & Yantis, 2011; Castel, McGillivray, & Friedman, 2012; Yantis & Johnson, 1990). Although people may not remember the location of the nearest fire extinguisher, which could be considered beneficial since unnecessary information would not be retained in memory, they can, however, locate a bright red object when this becomes goal relevant (hopefully, in the case of a real fire). It may be that when goals become activated, people can execute action-specific programs (e.g., Cañal-Bruland & van der Kamp, 2009) that enable them to locate a previously unnoticed fire extinguisher. The fire extinguisher study



Figure 20.2 (plate 5)

The location of a fire extinguisher relative to an office door (from Castel, Vendetti, & Holyoak, 2012). The study was partially inspired by the observation, recently illustrated by one of the authors of the article (depicted above), that we are remarkably good at ignoring highly visible objects, and remarkably bad at remembering their location. While taking a building safety training class, the fire safety instructor asked people to note the location of the nearest fire extinguisher, relative to their office. In the safety training class, several people admitted they did not know the location or guessed at the location, and people were told they should learn the location of the nearest fire extinguisher. Upon returning to his office, one of the authors of the eventual field research article (K. H., of Castel, Vendetti, & Holyoak, 2012) made a conscious effort to look for the nearest fire extinguisher and made a startling discovery: The conspicuously placed bright red object in question was right next to his office door, in plain view and literally inches from the doorknob that he had turned for the past 25 years!

also created an important learning event via the initial failed retrieval, as participants were asked to locate the nearest fire extinguisher after they indicated verbally that they did not know the location. People typically found the fire extinguisher in less than 5 seconds, although sometimes they overlooked the closest option. In a follow-up study, conducted with the same participants after a 2-month “retention interval,” all of the earlier tested participants remembered the location of the nearest fire extinguisher, suggesting that the earlier failed retrieval (and/or self-revelation that they did or did not know the location of the nearest fire extinguisher) served as an effective intervention that enhanced later memory for these lifesaving devices. This follow-up study also offers important insight on the ability to recall information that is considered salient and necessary; when participants were initially asked for the location of these devices, the location became a salient issue, further explaining why the follow-up study showed improved results. Perhaps even being required to *use* a fire extinguisher would also lead to improved recall of its spatial location.

Although people had poor memory for the location of fire extinguishers, one reason may be that they rarely had to interact with these objects, and as mentioned, people may be wasting cognitive resources to retain unnecessary information. Much like coins, people likely become habituated, and attention is not actively directed toward the objects in question. In another related study, we (Vendetti, Castel, & Holyoak, 2013) examined how people remember the spatial layout of the buttons on a frequently used elevator panel to determine if physical interaction (rather than simple exposure) would ensure effective incidental encoding of spatial information. Participants who worked in an eight-story office building (again, our convenient real-world setting, the UCLA Psychology Department) displayed very poor recall for the elevator panel (see examples of drawings in figure 20.3) but above-chance performance when asked to recognize the panel among several options. Interestingly, 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 wall. In a more implicit test, in which participants entered the elevator but the labels on the buttons were covered, the majority of participants were able to locate their office floor and eighth floor buttons when asked to point toward these buttons when in the actual elevator. 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.

Similar findings exist in other domains, in that people have relatively poor recall for frequently encountered information, including stop signs (Martin & Jones, 1998), and even frequently encountered logos (e.g., Apple, Google) that are thought and designed to be highly memorable (see Blake, Nazarian, & Castel, 2015). However, in advertising, when certain information is more central to the focus of attention, or used when communicating, this information may be well encoded and retained (see chapter 25 in the

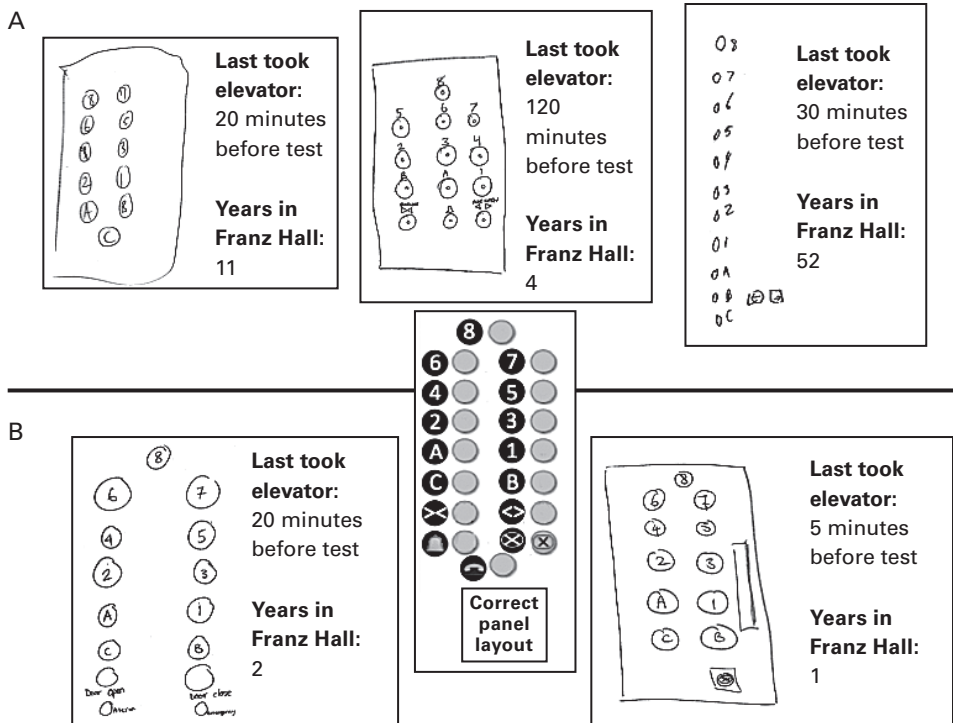


Figure 20.3

Examples of elevator panels drawn by participants, from Vendetti, Castel, and Holyoak (2013). The correct button layout representation is shown in the center. (A: top panel) Examples of incorrect drawings from participants, which varied from those that were somewhat close (i.e., had 2 columns and all 8 floors) to those whose drawing was not closely representative of the actual elevator button panel. (B: bottom panel) Examples of correct drawings from participants. Note: Participants were scored as having a correct button panel layout if they correctly drew the buttons representing the A-8 floors. Thus, participants' drawings could be scored as correct even if they did not correctly depict service buttons.

current volume). For example, professional soccer teams' sponsors advertising directly on the jerseys of the players, or the embedding of a company name in a team name (e.g., New York Red Bulls and Bayer 04 Leverkusen), can enhance memory because of attentional focus as well as repeated retrieval and use of the information during conversation. In addition, background music has been shown to influence consumer choices, such that people who were exposed to either French or German music were more likely to buy French or German wine at a supermarket (North, Hargreaves, & McKendrick, 1999). Taken together, these findings are broadly consistent with other work indicating

that passively seeing or hearing information repeatedly can influence behavior but does not necessarily facilitate memory for it (e.g., Berkerian & Baddeley, 1980; Nickerson & Adams, 1979; Rubin & Kontis, 1983). That is, remembering information requires more detailed semantic, analytical, and/or deeper levels of processing (e.g., Craik & Lockhart, 1972; Craik & Tulving, 1975) than can be gained by a brief glance.

Integration with Laboratory-Based Studies and Theory: The Relationship between Incidental Memory, Inattentive Blindness, and Inattentive Amnesia

In the domain of visual attention and memory, there have been several powerful demonstrations of “inattentive blindness,” in which people do not see objects when they are directing attention to other locations (Mack & Rock, 1998; see also chapter 9 in the current volume). Strikingly, Simons and Chabris (1999) have shown that people will often fail to notice a gorilla walk through a scene if they are busy attending to other aspects of the scene. Similarly, Simons and Rensink (2005) have shown demonstrations of change blindness, where people often do not notice a change in a scene, even when this change occurs with previously studied objects that are in the focus of attention. Despite having good relational memory for natural scenes (e.g., Hollingworth, Williams, & Henderson, 2001), people often have poor memory for specific objects in question. Wolfe (1999) has suggested that inattentive amnesia occurs when people have previously seen the objects in question but do not have a specific memory for having seen these objects, possibly because of a failure of attentional control and interruption in encoding the objects in memory. This has been shown in real-world settings, in which people will show inattentive blindness and amnesia for very prominent and important buildings (e.g., the library on a university campus; see figure 20.4, from Rosielle & Scaggs, 2008). The result of not noticing large-scale changes to highly familiar environments (such as the library not present in a familiar picture of campus) suggests that visual long-term memory for familiar scenes lacks the precision to be able to effectively identify even large-scale changes. In addition, other participants were asked to estimate the difficulty of change detection for another individual who would be asked to perform the same task. Those individuals felt that others should easily be able to notice such a large change, suggesting a metacognitive illusion regarding the ability to detect these changes (see also Levin, 2002). It is likely that the fire extinguisher falls prey to inattentive blindness and subsequent object-based amnesia and could also be subject to habituation effects, leading to poorer memory for it. As shown in other laboratory-based visual search tasks, inattentive amnesia and inefficiencies in visual search can influence how we locate and remember objects in real-world settings (e.g., Kingstone et al., 2003; Vo & Wolfe, 2012; Wolfe, Horowitz, & Kenner, 2005; Wolfe, Alvarez, Rosenholtz, Kuzmova, & Sherman, 2011) although we might not always be aware of the effect of inattentive blindness (Levin, 2002).



Figure 20.4

Stimuli from the change detection study entitled “What if they knocked down the library and nobody noticed? The failure to detect large changes to familiar scenes” by Rosielle and Scaggs (2008). College students were asked to identify what (if anything) was wrong with the pictures of a highly familiar scene from their college campus and were surprisingly poor at identifying the seemingly large change to the familiar environment (i.e., the missing library building in the altered scene). In addition, other participants were asked to estimate the difficulty of change detection for *another* individual who would be asked to perform the same task, and these participants felt that these other participants *should* be able to detect this seemingly large change, suggesting a metacognitive illusion regarding the ability to detect these changes.

Another mechanism at play when recalling frequently encountered information is a visualization strategy, and subsequent reconstruction of this visual image during retrieval. This reconstruction can lead to predictable and theoretically informative memory errors. For example, attempting to visualize the spatial layout of the elevator panel may trigger more erroneous generic information that can interfere with the actual memory for the correct layout, possibly due to schema-based intrusions (see also Rubin & Kontis, 1983) and the reliance on a sometimes accurate gist-based approach (Wolfe, 1998). Reliance on reconstructive visualization can also lead to vivid and convincing false memories. People will sometimes falsely remember objects that were not actually presented in a scene if their schema for that type of scene dictates that certain objects should indeed be present. For example, people will falsely remember that a graduate student’s office had books on the bookshelf, even if no books were actually present (Brewer & Treyens, 1981). In addition, Roediger and McDermott (1995) showed that people would falsely recall words that were not presented in lists. In this study, participants were asked to study a list of words (awake, dream, blanket, etc.), and when tested for recall, they would frequently falsely recall the critical lure, or the word “sleep.” A similar mechanism may be the culprit when people have vivid, but not

always accurate, “flashbulb” memories of events that are actually more reconstructive in nature (see Schmolck, Buffalo, & Squire, 2000).

Object or item distinctiveness can also play an important role in how well we remember the presence or absence of certain objects in the real world, in terms of capturing attention and leading to good memory for the object information in question. In the elevator study, a particularly striking finding was that a remarkable number of participants incorrectly recalled the location of the floor indicator (the illuminating and dynamic sign that indicates what floor the elevator is at), something that people will often attend to when traveling in an elevator, sometimes to avoid making eye contact with others in the elevator. In striking contrast, participants’ recall was remarkably good for the unusual animal-like graffiti (shaped like either a dog or a cat, depending on the elevator) that was present in both elevators. This disparity in recall may be related to the degree of match each object had in terms of the relation to an elevator schema. The actual position of the elevator floor indicator (top right, above the button panel) may have conflicted with a prior elevator layout schema (indicator in top middle, centered above the doors), creating interference, whereas the peculiar graffiti presumably did not match an elevator schema at all, therefore triggering allocation of attention, noticeable distinctiveness, and hence better encoding into memory (Hunt & McDaniel, 1993; Parker, Wilding, & Akerman, 1998; von Restorff, 1933). It may be that the human memory and attention systems may become tuned to ignore information that is constantly present, as there is no functional reason one needs to encode the precise details of the Apple logo, except perhaps to detect or spot counterfeit logos (which may be more prevalent in the growing market of pseudo-Apple products), or the location of the fire extinguisher unless there is an actual fire. We may rely on an archival system of information such that only necessary information is stored and highly active in memory while less relevant details are not accessible (Nickerson, 1980). In addition, memory for specific episodes may become more semantic in nature, such that we have a more generic memory for certain events, as well as a more personal memory for other events. Roediger and Crowder (1976) showed that people will tend to remember the first few presidents, as well as the most recent presidents, suggesting that primacy and recency effects can occur for semantic memory. This is likely due to recency and frequency of use when recalling information that is essentially encoded incidentally, and these factors could also influence how people recall historic events.

Ways to Enhance Memory and Intentional Learning

One way to enhance memory is through some form of effortful and semantic processing of information, and often this will provide the necessary first step of capturing attention. In real-world settings, this can have important implications for learning in classrooms, as well as marketing. Many people, including students of all ages, have

the intuition that items that are easier to process are then easier to remember, even when this is not true (Koriat, 2008). Interestingly, for those who view intelligence as a changeable construct, creating challenges or difficulties in education and during study are viewed as more engaging and helpful. The people who tend to fall prey to the idea that easy learning means easy remembering tend to also have the notion that intelligence is a fixed trait (Miele, Finn, & Molden, 2011). In addition, Werth and Strack (2003) showed that questions and answers that were easy to read, as opposed to difficult, produced higher ratings of judgment that the participant would answer the question correctly. Additionally, another study showed that the fluency of encoding is associated with predictions of improved recall (Hertzog, Dunlosky, Robinson, & Kidder, 2003). However, research has shown that if the to-be-learned material is processed in a way that challenges the learner to a certain degree, learning is enhanced for this material, a concept known as “desirable difficulties” (Bjork, 1994; McDaniel & Butler, 2010). Desirable difficulties have been shown to enhance learning in classroom settings. For example, Diemand-Yauman et al. (2011) demonstrated that text in a disfluent typeface (e.g., Monotype Corsiva) was remembered better than text in a clear typeface (e.g., Arial). Similarly, Sungkhasettee, Friedman, and Castel (2011) found that people recalled inverted words better than upright words, even though people’s predictions regarding memorability did not differentiate between the upright and inverted words. In a real-world setting, this desirable difficulty can be exploited by marketing and advertising, by making certain information more distinctive, as well as more difficult to process (see figure 20.5). Accordingly, this could have the (perhaps intentional) effect of leading to attentional capture of this information, as well as better memory for the inverted and somewhat otherwise-bland/not memorable name of the “The Standard” hotel.

Retrieval practice can enhance attention and memory for information that may be the subject of inattention blindness. The “field study” setting offers a relatively simple but powerful form of intervention training that may enhance memory for the nearest fire extinguisher through subsequent retrieval practice. For example, in the fire extinguisher study, participants in the initial session engaged in a form of errorful learning (a desirable difficulty), often failing to know the location of the nearest fire extinguisher, but then finding it, which likely enhanced memory when tested in the 2-month follow-up. This form of initial failed retrieval and retrieval practice (e.g., Bjork, 1994; Karpicke & Roediger, 2008; Kornell, Hays, & Bjork, 2009; McGillivray & Castel, 2010) could allow for the potent formation of an episodic memory (cf. Tulving, 1983) for the location of the fire extinguisher, thus acquiring information that could potentially prove to be lifesaving in the event of a fire. Recent work suggests that survival processing can enhance memory (e.g., Nairne & Pandeirada, 2010), and that memory can and should be tuned to adaptive survival mechanisms, such as remembering the location of a lifesaving object. Asking people to search for a survival-relevant object during training may enhance the likelihood of finding this object



Figure 20.5

This iconic yet simplistic Hollywood hotel sign can capture attention due to the distinctive inverted word, even when the word itself not very unique (or standard). The processing of inverted words can also confer memory benefits (e.g., Sungkhasettee et al., 2011), as people engage in an additional effortful process for these words, resulting in what may be a desirable difficulty (Bjork, 1994) in terms of how this additional processing can lead to greater retrieval strength at a later time.

during an actual fire, or when searching visual displays for dangerous and rare items, and when training people to use surveillance systems (Fleck & Mitroff, 2007; Gelernter, 2013; Wolfe, Horowitz, & Kenner, 2005).

In terms of training and transfer, it would be informative to know if the awareness of the location of the fire extinguisher in one context (e.g., at one's office) may enhance attention and memory for fire extinguishers in other settings, possibly as a result of failing to initially find it in the first context. Anecdotally, the authors and many participants in the fire extinguisher study later noted that fire extinguishers in other settings and locations now appear to “pop out” at them, suggesting that retrieval failure can lead to enhanced noticing. This may also be related to the observation, for example, that when people buy a new car, they then begin to notice the prevalence of that same

car that they did not notice before, perhaps as a result of attentional focus and personal relevance of the objects in question.

While the current chapter focused on incidental memory as a by-product of attention, there is a large literature on how attention (or lack of attention) impacts intentional learning. In terms of episodic memory and attention, there are a number of studies demonstrating that impairments in attention lead to poorer memory, especially in terms of remembering associations (Naveh-Benjamin, 2000; Castel & Craik, 2003). Divided attention also leads to what is known as the cocktail party effect, in which hearing one's name in a seemingly unattended channel captures attention even when people were not attempting to monitor this source of input (Moray, 1959), although this effect may depend on working memory capacity (Conway, Cowan, & Bunting, 2001). Distraction can lead to significant brain-related activity that impairs learning (Foerde, Knowlton, & Poldrack, 2006). Distraction, and divided attention, also plays an important role in real-world settings when trying to remember names and faces, as well as in how talking on a cell phone can lead to poor memory and inattentive blindness (Hyman et al., 2010; Strayer, Drews, & Johnston, 2003), and when the mind wanders while reading (see chapter 10 in the current volume).

Summary and Future Directions

In summary, the present review highlights how attention and memory are linked in real-world settings, and how and when incidental encoding can lead to strong memories, as well as fleeting and reconstructive representations. Several mechanisms are involved when incidental memory is compromised, including habituation, inattentive blindness and amnesia, as well as lack of semantic processing. Methods to improve the products of incidental memory include retrieval practice, goal-based attention, distinctness, and the use of desirable difficulties that result in enhanced processing.

It is critical that future studies build off of the important insight gathered from laboratory-based attention and memory studies. The use of more ecologically relevant materials, in combination with more real-world settings and in vivo field studies, can provide a complementary theoretical approach for studying cognition and have more translational impact (e.g., Dodd et al., 2012; Kingstone et al., 2003; Kingstone, Smilek, Birmingham, Cameron, & Bischof, 2005; Smilek et al., 2007). This translational approach emphasizes the observation and description of human behavior, as well as the personal and subjective reports that often accompany people's behavior (including their successes and failures), as people engage in tasks in real-world situations.

The use of new technology plays a major role in how we modify attention and what we attempt to remember. For example, we now heavily rely on Google or Wikipedia as a source of knowledge, which can lead to good incidental memory for where to find information (the virtual location, Web site, or electronic file folder on our computer),

even when we are unable to recall the actual information in question (Sparrow, Liu, & Wegner, 2011). There may be good reasons not to burden one's memory for certain information, as long as it can be made accessible when needed. For example, one may not require a precise representation of the location of a fire extinguisher because one understands that fire extinguishers are placed in a systematic manner, and *should* be relatively easy to find when needed. To reduce information "overload," relying on one's external access to information may in fact be advantageous.

In terms of student learning in classroom settings, as students often use laptops to take notes during lectures, this practice of typing (rather than writing or scribbling) can also lead to people's "transcribing lectures" in a verbatim manner rather than focusing on important conceptual information (e.g., Bui, Myerson, & Hale, 2013; Mueller & Oppenheimer, 2014). Other important directions for future study include how attention and memory are modified during new learning practices and in stressful settings. For example, the role of attention during intentional learning has important implications when learning takes place in potentially distracting or stressful settings (e.g., military training), and in eyewitness memory situations that involve stress (e.g., Morgan, Hazlett, Baranoski, Doran, Southwick, & Loftus, 2007), as well as when learning is self-guided or involves dynamic learning environments (e.g., in large virtual classrooms; see Farley, Risko, & Kingstone, 2013; Risko et al., 2012; Szpunar, Moulton, & Schacter, 2013). The role of attention during incidental and intentional learning, and the associated subjective confidence, has direct implications for eyewitness testimony (see also chapter 21 in the current volume), as well as for how the face of an older criminal can disappear when situated in a tourist and retirement friendly beach city (as was the case with Whitey Bulger, the notorious Boston mobster who went unnoticed in Santa Monica, California, for over a decade). Furthermore, future studies should investigate the effect expertise has on incidental memory. Participants showed poor spatial recall for the locations of fire extinguishers but performed better when asked again during a 2-month follow-up study. It may be that object relevance plays a key role, and that perhaps volunteer firefighters will demonstrate better recall (and motivated memory) as it is part of their training to locate and use fire extinguishers or other fire-relevant equipment, often in stressful situations.

Most of the studies described in the present review test college undergraduates as the sample. It is important to know how these findings generalize to people of varying ages, backgrounds, and levels of motivation. Thus, a fruitful avenue for further study is understanding how cognitive aging can lead to important changes in how one allocates attention, and also what one tries to remember. For instance, some research in this area suggests that aging can lead to changes in goal-based attention and not simply declines in global attention resources (see Castel, McGillivray, & Friedman, 2012; Castel, 2008). In addition, the potential inability to control attention (or greater distraction) in older adults may lead to the surprising by-product of incidental memory for

potential information that can be used for creative problem solving (e.g., Kim, Hasher, & Zacks, 2007). Finally, a parallel future direction is investigating the degree to which people are aware of how attention can modify incidental learning, and whether metacognitive awareness of attention and memory shortcomings (e.g., Levin, 2002) can improve performance, such as when people become aware that they have been mind wandering, or, contrary to their own intuitions, are not aware of the location of the nearby fire extinguisher, despite having seen it every day.

Box 20.1

Key Points

- Seeing or hearing something many times does not mean it will be well remembered. Many studies have shown that simple repetition and passive encoding do not lead to effective learning and memory, and this may be counter to what many learners might think.
- Inattentive blindness and inattentive amnesia can result for frequently encountered objects and information, such that people may stop noticing (and/or not be able to recall) the location of the nearest fire extinguisher or the button panels on an elevator.
- Retrieval failure, and awareness of inattentive amnesia, can result in a potent learning event, if people seek to test, and restudy, the information in question, and this mechanism has important theoretical and practical value.

Box 20.2

Outstanding Issues

- New technology allows us to be able to off-load information, as opposed to using our own attention and memory, but can also lead to distraction, and future research will assess how this distraction can impair learning and memory in the (virtual) classroom.
- Metacognitive awareness of attention and memory illusions can be informative, and future research will be needed to better understand why we do/do not appreciate the principles of attention and memory in everyday settings, and how this can inform training and education.

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