TASK IRRELEVANT SCENE PERCEPTION AND MEMORY DURING HUMAN BIPEDAL NAVIGATION IN A GENUINE ENVIRONMENT

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ABSTRACT

Navigation by humans to and from a point of origin while walking is a little understood ability. A portable eye tracker was used to investigate navigation while walking as well as to investigate incidental visual memory for the navigational scenes. Twelve males with a mean age of 19.08 years (*R* = 18 - 24) were assigned a task that required walking in a novel environment and returning to a point of origin. Participants appeared to accomplish navigation by using multiple methods and strategies. Incidental visual memory was found to be 58.82%.

1. INTRODUCTION

The relationship between scene perception and the task irrelevant memory for a scene has implications for the Army's tactical vision of the Objective Force *seeing first.* The expedient nature with which the infantry accomplishes such tasks as clearing buildings, performing maintenance, and planning tasks may diminish the ability to identify secondary points of interest in an environment. For example, when clearing buildings, the focus is on navigating the environment, identifying targets, and survival. However, there may be items such as documents, maps, or unknown technological devices with potential uses beyond the soldier's current scope of operations and these items may have wide reaching implications for the bigger picture of winning the war. While the soldier is narrowly focused on the current task and may not actively search for or identify such items, the soldier may incidentally view items and be able to recall such items at a later time. The current research suggests people have a limited ability to recall incidentally learned task irrelevant visual information.

1.1 Navigation

Walking from one place to another seems a simple endeavor, but the mechanisms used by humans to accomplish navigation have been debated. Some researchers do not distinguish the cognitive elements of navigation from the physical motor elements (e.g., Conroy, 2001), while others have speculated two components of navigation, wayfinding and motion. Wayfinding has been defined as the cognitive aspects of navigation that do not involve motor actions (Darken & Sibert 1996; Sadeghiam, Kantardzic, Lozitskiy, & Sheta, 2006). Sadeghiam, et al. proposed several cognitive elements of wayfinding that parallel the psychological notion of spatial knowledge (Thorndyke & Hayes-Roth, 1982; Thorndyke & Stasz, 1980).

In order to navigate, one must have some knowledge of one's juxtaposition in relationship to the objects in the environment and this knowledge has to be updated when moving through the environment (Turano, Lei Hao, & Hicks, 2005). Gibson (1950, 1979) proposed two visual mechanisms that allow sighted people to navigate: the focus of expansion and optic, or retinal, flow. (See Warren, 1998 for a review). Focus of expansion refers to the region in the visual field at which an object appears to increase in size as one moves toward it because as one gets closer, the object covers more of the visual field. For example, if an observer stares at the center of a book (the point of expansion) located on a shelf across the room and walks toward it, the book appears to get larger, because as the observer nears the book, the image of the book covers an increasingly larger area on the retina. Using the focus of expansion to navigate can be accomplished by overlapping the focus of expansion on a desired goal and walking toward it (Gibson, 1950, 1979; Turano, et al., 2005; Warren, 1998; Warren, Kaye, Zosh, Duchon, & Sahuc, 2001).

Optic flow refers to the dynamic juxtaposition of the environment on the retina as a person moves within an environment. Returning to the book example, if the observer passed a lamp while approaching the book, the image of the lamp fell on different regions of the retina as the observer moved, until the observer passed a point where the lamp was no longer in the observer's visual field. Navigation can also be accomplished with optic flow by using a flow-equalization strategy in which the radial displacement of images on the retina is consistently maintained at proportional rates in relation to the visual field (Duchon & Warren, 2002; Turano et al. 2005). In other words, a proximal distance from an object can be maintained by keeping the image so that it falls onto the periphery of the retina with consistent movement. An example is walking parallel to a fence without looking directly at the fence.

Empirical research has demonstrated that optic flow can be used for navigation during walking (Harris & Carre, 2001; Turano, et al., 2005). Computer simulations also indicate that optic flow is capable of providing the impetus for navigation (e.g., Kim & Turvey, 1999; Wilkie & Wann, 2002, 2003). Kim and Turvey (1999) proposed the *"units" of an optic array are projections of facets, faces, and surfaces of the environmental layout to the point of observation.* Optic flow is simply the relative velocity of points across the visual field as a person moves in the environment. Presumably, optic flow should operate regardless of whether one looks in the direction one is moving, or not, because optic flow depends on external environmental cues that change depending on the direction of movement. Using oscillating dots presented in linear and rotating fashions, Regan and Beverley (1985) experimentally demonstrated differences between processing linear and rotating stimuli, which suggested unique processing mechanisms may exist that are sensitive to the curl of velocity (i.e., vorticity) and the divergence of velocity (i.e., dilation), which in turn implies special processing mechanisms may exist for optic flow. Regan and Beverley further speculated the mechanism for processing optic flow may include an ability outside one's awareness that parallels vector calculus to determine and track the extent of optic flow changes when moving.

While some research supports the notion of optic flow facilitating navigation, other research has brought its importance into question. Cutting, Reading, and Wang (2002) examined whether people motivated in the direction they looked and Cutting et al. found that people veered in the direction looked. Cutting et al. had participants walk straight while looking to the side in an illuminated condition and in a darkened condition. Cutting et al.'s results appear to contradict optic flow theory. Because the participants never had the opportunity to look at a destination goal, an argument could be made that the veering behavior resulted from participants using an egocentric-direction strategy for navigation (Harris & Bonas, 2002; Rushton, Harris, Lloyd & Wann, 1998; Turano et al., 2005; Warren et al., 2001). During egocentric-direction strategies, a person is believed to visually mark, or tag, a goal and walk toward it. Cutting et al. found no difference between the extent of veering and the lighting conditions. If visual based navigation depended on optic flow, one would have anticipated differences because almost no visual input was available in the darkness condition. Conversely, if navigation depended on checking headings against a focus of expansion, one would have expected the veering behavior to be the same.

However, the ability to navigate in dimly lighted environments and environments with few external cues has been demonstrated in research (Hollands, Patala & Vickers, 2002; Land & Tatler, 2001; Rushton et al., 1998) and sighted individuals may rely on more than vision to navigate. Participants in Cutting et al.'s (2002) research may have used navigation strategies that depended very little, or not at all, on vision. Humans are equipped with other systems that can be used to aid navigation. Proprioception is the sum of the kinesthetic system and the vestibular system. Kinesthesis refers to the knowledge one has about ones body in regard to the relationships between body parts due to sensations from muscles, tendons, and joints. The vestibular system relies on organs in the inner ear and provides feedback about one's orientation and movement. Proprioception gives one the internal sensations of directional movement.

In order to navigate from one point to another and back to the initial point (point of origin) one must have some strategy or internal representation of the point of origin. Some researchers have speculated about the existence of internal maps (e.g., Hirtle & Jonides, 1985; Huttenlocher, Hedges & Duncan, 1991; McNamara, 1986; Stevens & Coupe, 1978; Rosenbaum, Ziegler, Winocur, Grady, and Moscovitch, 2004; Taylor & Tversky, 1992). Wang and Brockmole (2003) suggested the processes that guide navigation in complex representational systems are poorly understood. Their postulate may also apply to less complex environments.

While it is possible people may rely on internal representations for navigation in less complex environments, it is also possible to rely on other internal cues as well as external cues for navigation. For example, internal vestibular cues could be used to navigate and return to roughly the same point of origin by walking 100 paces, executing a 90° left pivot step, walking another 100 paces followed by another 90° left pivot step, followed by another 100 paces and another 90° left pivot step, followed by another 100 paces. Alternatively, external cues could be used for navigating by following a sidewalk around the block to arrive at the original point of origin, or a shopper may exit a store and depend on cues, such as a sign indicating a specific parking row, to locate his or her car. However, rather than intentionally learning the landmark to be later recalled (e.g., the sign for the parking row), the shopper could wander about until his or her car is found, or his or her car could be located by remembering a particular landmark, such as a streetlight with a bent pole, that he or she did not intentionally remember or put much thought into when entering the store. The latter is an example of incidental memory.

1.2 Incidental Memory

Incidental visual memory refers to memories for visual information that are not actively learned. Castelhano and Henderson (2005) investigated whether the intention to remember visual details from scenes impacted visual memory. They had participants view scenes in a memorization condition (intentional learning) and in a visual search condition (incidental learning). Regardless of how the scenes were viewed initially, participants were able to remember the details of the scenes. They found that memory for objects depended on whether the object was looked at, how often it was looked at, and the length of time it was viewed, not what instructions were given to the participant.

Rather than asking participants to memorize scenes Williams, Henderson, and Zacks (2005) used a conjunction visual search task to investigate incidental visual memory. They had participants count the number of target objects (e.g., green drills) in a display of real-world distractor objects (e.g., red drills, green watering cans and yellow axes). Williams et al.'s search arrays were constructed so that distractor objects were related to the target object by category (type), by color, or they were not related to the target object. Category distractors were objects from the same category as the target, but they were different in color. Color distractors were objects from a different category than the target, but they were the same in color. Unrelated distractors were neither the same color nor from the same category as the targets. Williams et al. found that target objects were generally viewed more often and remembered better than distractor objects. Target memory rate was 85% while distractors related to the target were remembered at approximately 60% and unrelated distractor memory was slightly above chance. They also replicated Castelhano and Henderson's (2005) finding of a relationship between visual memory and viewing behavior for distractor objects. However, both the Williams et al. and Castelhano and Henderson search tasks required participants to remain stationary and look at stimuli presented on computer monitors with the goal of searching a confined space that instructed the participants to look at the search stimuli that were tested in the memory tests.

1.3 Hypotheses

The navigation task in the current research manipulated participants into searching the environment by directing them to find a soft drink vending machine and incidental memory was anticipated for the scenes. Since participants were required to navigate in a novel environment and return to a point of origin, they were expected to locate at least one landmark to serve as a reference point for recognizing the point of origin. Additionally, participants were expected to choose multiple focuses of expansion to serve as heading reference points while navigating.

2. METHOD

2.1 Participants

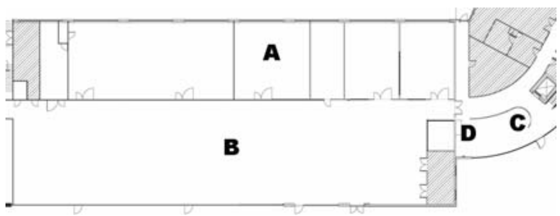
The participants were 12 males with a mean age of 19.08 years (R = 18 - 24) who received monetary compensation for their participation. All participants were in self-reported "average" or better health status. No participants reported a history of head or brain anomalies (traumatic injuries or illnesses). A standard *Snellen* eye chart was used to screen visual acuity. Two participants demonstrated below average visual acuity (20/40). One individual was not wearing his prescribed corrective lenses and the other was unaware of possible visual abnormalities. The latter was referred to a physician for a vision examination. Both men were allowed to participate and their data was retained for analysis. All other participants demonstrated normal, or corrected-to-normal, visual acuity. All participants also demonstrated normal color vision on an *Ishihara's Tests for Colour Deficiency* (2006). Immediately prior to their participation in the current experiment, the participants took part in a motion capture study that required wearing a portable motion capture suit and the eye tracker.

2.2 Materials and Design

The navigation task included three rooms: the lab, a workshop, and a break area. See *Figure I* for an illustration of the layout. The lab served as the starting and ending point of the navigation task. The workshop floor dimensions were 230 feet × 49.5 feet with a ceiling height of 35 feet in one area and a dropped ceiling with a height of 9.5 feet in an area 7.5 feet from the wall with lab entry door spanning the entire length of the workshop. A 30 feet section spanning the breadth of the workshop at the area farthest from the lab also had the dropped ceiling. The break area consisted of an open floor plan with a glass block curved wall.

The stimuli for the memory test were photographs of the workshop area taken with a digital camera. The photographs were composed by taking advantage of natural occlusions in the workshop when they occurred. The photographs were constructed so that none of the manipulated objects overlapped in the photographs. When possible, the photographs were taken from 3 different angles of incidence (left, right, and head-on). The images were reduced and cropped to 300 x 300 pixels. Three versions were photographed of each viewing angle when possible: (a) the original, unchanged scene (see *Figure 2*), (b) an object was added to the scene (see *Figure 3*), (c) and an object was removed from the scene (see *Figure 4*). A fourth version of each scene was created by manipulating a duplicate of the original scene photograph with Adobe Photoshop CS by changing the color of an object(s) in the scene (see the note on *Figure 2*).

Figure 1. Floor layout.



Note: *A. Human factors and Ergonomics Lab*
B. Workshop
C. Curved glass wall
D. Soft drink vending machine

Thus, each scene had as many as 3 views and each view had as many as 3 foils which is a possible 9 foils for each scene. However, in order to prevent overlap of the manipulated scene regions and due to naturally occurring obstructions, composing 3 views of each scene was not always feasible, nor was adding or removing objects always feasible.

Figure 2. Original and Color Changed Scene

Note: All test images were presented in color. The circled objects were changed from blue to maroon to create the color change foil.

Figure 3. Object Added Foil.

Note: The circled object was added to the scene.

Figure 4. Object Removed Foil.

Note: The object was removed from the area circled.

2.3 Apparatus

Right eye position was recorded during the experiment with an Applied Science Laboratories Mobile-Eye tetherless infrared-video-based eye tracker. The eye tracker uses sub threshold infrared illumination to track the cornea and pupil reflection at a 60 Hz sampling rate and a Sony Handycam for video capture at 29.97 frames per second. Therefore, the actual sampling rate is approximately 30 Hz. *E-Prime* software (Schneider, Eschman, & Zuccolotto, 2002) was used to control stimuli presentation for the visual memory tests. Memory test stimuli were displayed at a resolution of 800 × 600 pixels × 24 bit color on a flat screen computer monitor viewed at approximately 75 cm (35.43° × 26.57° of visual angle). Test scenes were 300 × 300 pixels and subtended approximately 8.89° × 8.89° of visual angle at 75 cm viewing distance.

2.4 Procedure

Upon arrival at the receptionist desk, participants were escorted to the lab without passing through the portion of the workshop they would later be asked to navigate. Once in the lab, participants were given an informed consent and asked to read it. Participants were also prompted for questions. After any questions were answered and consent was ascertained, demographic and anthropometric data along with a brief medical history was collected. Visual acuity and color vision was tested. Participants were then fitted with a portable motion capture suit and the eye tracker.

The navigation and memory tasks reported in the current research were part of a larger motion capture study of other natural tasks that did not involve memory testing. Prior to the navigation task, interactions with the participants took approximately 1 hour. Participants wore the eye tracker for the other tasks as well as the navigation task. Although the motion capture limited some motions (e.g., placing arms above the head), it was not removed prior to the navigation task because it did not interfere with walking. It was assumed participants would view the environment differently if they were aware navigation or scene memory was being studied. Therefore, participants were not told about the memory test prior to testing and they were not told we were investigating navigation until debriefing. Participants were told a human-machine interaction task was being modeled. We gave each participant change to buy a soft drink from a vending machine and told the participant to buy a drink of his choice. We pointed to the left and instructed the participant to, *"Just go that way until you find the drink machine."* If participants sought clarification, the researcher repeated the hand gesture and verbal instructions. No other clarification was offered.

Navigation consisted of walking out of the lab through a door and turning left, then walking 110 feet through a closed pair of double doors. There were six other rooms with doors between the lab and the double doors leading to the break area. Four had glass windows and the room interiors could be seen well enough by walking to the doors and looking through the windows that no participants were anticipated to mistake the rooms for having a vending machine. Additionally, each room was labeled as to what it was (e.g., machine shop, materials lab, etc.,). Although the break area was not visible through the doors, it was visible through a small opening in the wall immediately after exiting the workshop via the double doors. A barricade was placed to prevent participants from using the immediate path. Thus, participants had to walk an additional 30 feet around the curving glass wall, turn 90° and walk another 25 feet to reach the vending machine. After interacting with the vending machine, participants had to return around the glass block wall, pass through the double doors, walk partially through the workshop, and pass through the lab door.

Immediately following the navigation-machine interaction portion of the experiment, participants were given an unannounced two-alternative forced-choice recognition test. Participants were tested on 18 scenes from the workshop. Test objects were presented to the right and left of a fixation point. The foil item was the same scene with either an item added to the scene, removed from the scene, or with a color replaced for an object in the scene. For example, one presented scene had various automobile and machinery parts, including a blue fender and air dam on a shelf (see *Figures 2, 3, & 4*). The foil scene was the same scene with a bucket added to the shelf, or the air dam removed from the shelf and replaced with an exhaust system to prevent the shelf from being empty, or the color of the fender and air dam was changed from blue to maroon. No scenes were tested more than once for any participant. Participants input their responses using a standard button box. Participants were instructed on the initial screen to identify the scene they observed during the navigation task and to respond by pressing the left button if the left picture was of the scene they observed and the right button if the right picture was of the scene they observed. The participants were instructed to guess if they were uncertain. No feedback was given.

3. RESULTS

3.1 Analyses

All videos were independently coded by a senior undergraduate student and the primary author of the current paper. From a possible 31,944 coded frames, 26,325 were agreed upon. Disagreements were resolved by conference. Although approximately 2% of disagreements were counting errors, most were subjective and centered around whether participants were looking at windows or through windows, whether an area was being used as a focus of expansion, and whether participants were looking at a particular sub-scene or looking through that scene at another scene. (Although the memory test images were taken so the scenes did not overlap, the workshop afforded scene overlap). All statistical analyses were calculated using *SPSS 13.0*.

3.2 Viewing Behavior

The reported eye movement and viewing behavior results are for 9 participants only. While transferring the video from the capture device to the analysis computer, one video was inadvertently corrupted and unusable. The other two excluded videos had frame drop rates ≥ 90%. In one case, the dropped frames appear to have been due to the participant keeping his head pointed in the direction of travel while looking to the side at angles beyond the capability of the camera. The other participant scratched his forehead and bumped the eye tracker which jarred the infrared collector out of adjustment. Percentages of the lengths of time spent looking at a focus of expansion were calculated by adding all the instances of looking at what appeared to be a focus of expansion for the entire navigation sequence minus the time spent interacting with the vending machine.

Due to participants exploring the environment with their eyes, scene viewing behavior was erratic, so much so that calculating fixations for the scenes was not prudent. Participants often appeared to make ballistic saccades from one object to another within a scene. If this was the case, apparent fixations consisted of a single frame, but without at least 2 frames, an apparent fixation may have been a sample taken in mid-saccade. All calculations are based on a minimum of 2 consecutive frames and are believed to underestimate actual viewing behavior. Of the 9 videos retained for analyses, the average rate of frame drop was 22.17% and, other than eye blinks, it appears most of those were due to participants looking beyond the angle capabilities of the camera. Despite the possible frame rate concerns, some objects were viewed as many as 53 frames (nearly 2 *s*) and the eye tracking data afforded some analyses.

3.3 Navigation Behavior

The average total time spent navigating (total time from start to finish excluding the machine interaction time) was 118.4 seconds (R = 86.2 - 182.7 *s*). The 182.7 *s* time is inflated because the gentleman walked past the break area. Although, 2 participants did not view any of the same scenes during the return trip through the workshop, an average of 2.55 objects (4.7%) viewed during the initial trip through the workshop were viewed again during the return trip through the workshop. Six participants viewed an initial object immediately outside the lab, but only 2 viewed the object again when returning to the lab.

Vertical architectural elements were viewed more often than any other aspect in the environment with 11.24% of the total navigation time spent viewing walls, columns, and other vertical spatial boundaries. Participants appear to have defined an average of 6 areas of reference that may have been focuses of expansion. Including the initial reference gaze, participants averaged 21.1 looks at the prospective focuses of expansion for an average of 9.9% of the time spent while walking. In some instances the possible focuses of expansion included walls and these instances were counted as both possible focuses of expansion and vertical spatial boundary looks. The subjective ranges of times per looks at a possible focus of expansion varied from a short 0.07 *s* glance to a long 5.2 *s* stare. The average reference look at a possible focus of expansion was 0.52 *s*.

3.4 Incidental Visual Memory

The average time spent navigating through the environment that was tested for memory was 60.5 *s*. (R = 44.47 - 78.88 *s*). The average time spent viewing the tested scenes was 6.9% (calculated by using a minimum of 2 consecutive frames). Results for the two-alternative forced-choice memory test indicated the incidental memory for the scenes was 58.82% [$t(11) = 2.39$, $p = .036$, SE = .037] with a standard deviation of 12.79%. Performance for 2 participants was more than 2 standard deviations from the mean which suggests they may have been outliers. One participant appears to have been confused as to which buttons to press during the memory test (35.29% performance). The other participant did the navigation task prior to the motion capture tasks for the other experiment (88.24% performance). Both were included in the reported memory results. Performance excluding the two possible outliers ranged from 47.06% to 64.71%.

4. DISCUSSION

4.1 Navigation

Although we anticipated participants would locate a landmark to serve as a reference point for locating the lab, the use of possible landmarks is rather speculative. Interestingly, while six (66%) participants in the current research appeared to visually tag an object immediately after leaving the lab, only one participant appeared to have used the object as a landmark to reference the location of the lab door (egocentric-direction strategy), because he looked at the object immediately after leaving the lab and after viewing the object on the return trip to the lab, he immediately looked at the lab door and continued looking at it until he gasped the door handle. The other gentleman, who looked at a prospective landmark during the return trip, initially viewed the room number placard with the lab name on it for 2 views for a total of 31 frames (1.03 s) after leaving the lab, but he failed to respond to the view during the return to lab and walked past the lab door, which suggests he failed to remember the landmark. However, this was also the same participant who missed the break area on the first pass which caused him to spend approximately 1 minute longer between the initial viewing and the second viewing than the other participant.

Similarly, determining if the other objects viewed during the trips through the workshop (m = 2.55) were used for navigational landmarks requires knowing intent. It is not known whether the participants remembered them from their first trip through the workshop and referenced them as landmarks, whether the participants remembered them from their first trip through the workshop and found them interesting enough to give them a second look, or if participants did not remember them during their second trip through the workshop and some salient characteristic of the objects captured the participants' attention during both trips through the workshop.

The use of the focuses of expansion for navigation is also speculative because determination, likewise, requires knowing the participant's intent. The examples that appear to have been demonstrated by the participants in the current research can be divided into the categories of heading-navigation and approach-navigation. A few examples of locating a point and motivating toward it appear to have been purely for maintaining a heading. For example, when returning around the curved wall from the vending machine, two participants fixated on a single 4 inch × 4 inch wall tile located opposite the curved wall for several steps, until they reached the hallway to turn 90°, without ever looking at the apex of the wall they were walking past. However, with the exception of wall opposite the glass wall, all the looks at a prospective focus of expansion greater than 20 consecutive frames (0.61 *s*) appear to be approach related behaviors, which also have a navigational component, and all were related to doors. Specifically, once participants got within a few steps of a door they intended to walk through, participants fixated on doors and then the door handles, or the door handles directly without fixating on the doors, prior to grasping them.

There is an old axiom that says, *"Even a blind squirrel finds an acorn every now and then."* Similar to a blind squirrel wandering about looking for an acorn, all the participants in the current research, save one, appears to have relied solely on external cues to find the point of origin. They walked from the break area to the lab and peered into the windows of each room they passed and once they observed the interior of the lab, they approached the door. Thus, their internal representations regarding a point of origin appear to have been a combination of knowing the direction needed to travel and the memory for the objects inside the lab. Although the video captures did not appear to indicate the participants in the current research compiled an internal map they referenced when returning to the point of origin, it is possible they compiled a map and only looked through the windows and doors to verify their internalization. It is also possible the participants counted the doors and knew which door to return to and they too looked through the windows and doors for verification purposes. Lastly, the participants may have employed a step counting strategy and used vision for verification purposes as well.

There also remains a question about the uses of a focus of expansion and the confining architectural elements of the building for navigational purposes. The floor of the workshop has a diagonally striped line 7.5 feet from the wall and running parallel with the wall that serves to designate the area between the line and the wall as a path of sorts. No participants veered outside this path, yet the only thing preventing them from doing so was a 2 inch wide piece of tape on the floor. There were two doors on the other side of the tape-line that could have been prospective break rooms that no participants investigated. It is unclear if the participants were following the instructions they received to *"just go that way"* or if they were observing the path on their own accord. Although the participants clearly looked at the constraining architectural elements, it does not necessarily indicate they constructed a mental map of the area. Conversely, while all the participants looked at the doors at the end of the path and may have referenced them for heading information by using them as a focus of expansion during the initial trip through the workshop by overlapping the focus of expansion on the goal and walking toward it, during the return through the workshop only one participant appears to have designated a focus of expansion at the opposite end of the path, which was a 230 feet long straight away, and used it for referencing while walking. Participants appeared to reference the wall by looking directly at it during the return trip to maintain their distance from it and they may have also relied on peripheral vision and optic flow (flow-equalization strategy).

4.2 Incidental Visual Memory

The key finding of the current research is finding incidental memory for the scenes viewed during the navigation task. Previous research investigating incidental visual memory has used scenes or object arrays presented on computer monitors. The current research found incidental memory in a genuine environment. Although memory was approximately 59%, there is a difference between walking through a workshop and navigating an environment while clearing a building. When clearing a building with possible aggressors, a soldier's focus may be narrower than the sample used in the current research, if for no other reason than *fight-flight syndrome* may be in effect. However, even the soldier who is narrowly focused may be able to recall incidental information because he or she is interacting with the environment.

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