Drawings of real-world scenes during free recall reveal detailed object and spatial information in memory

Supplementary Information

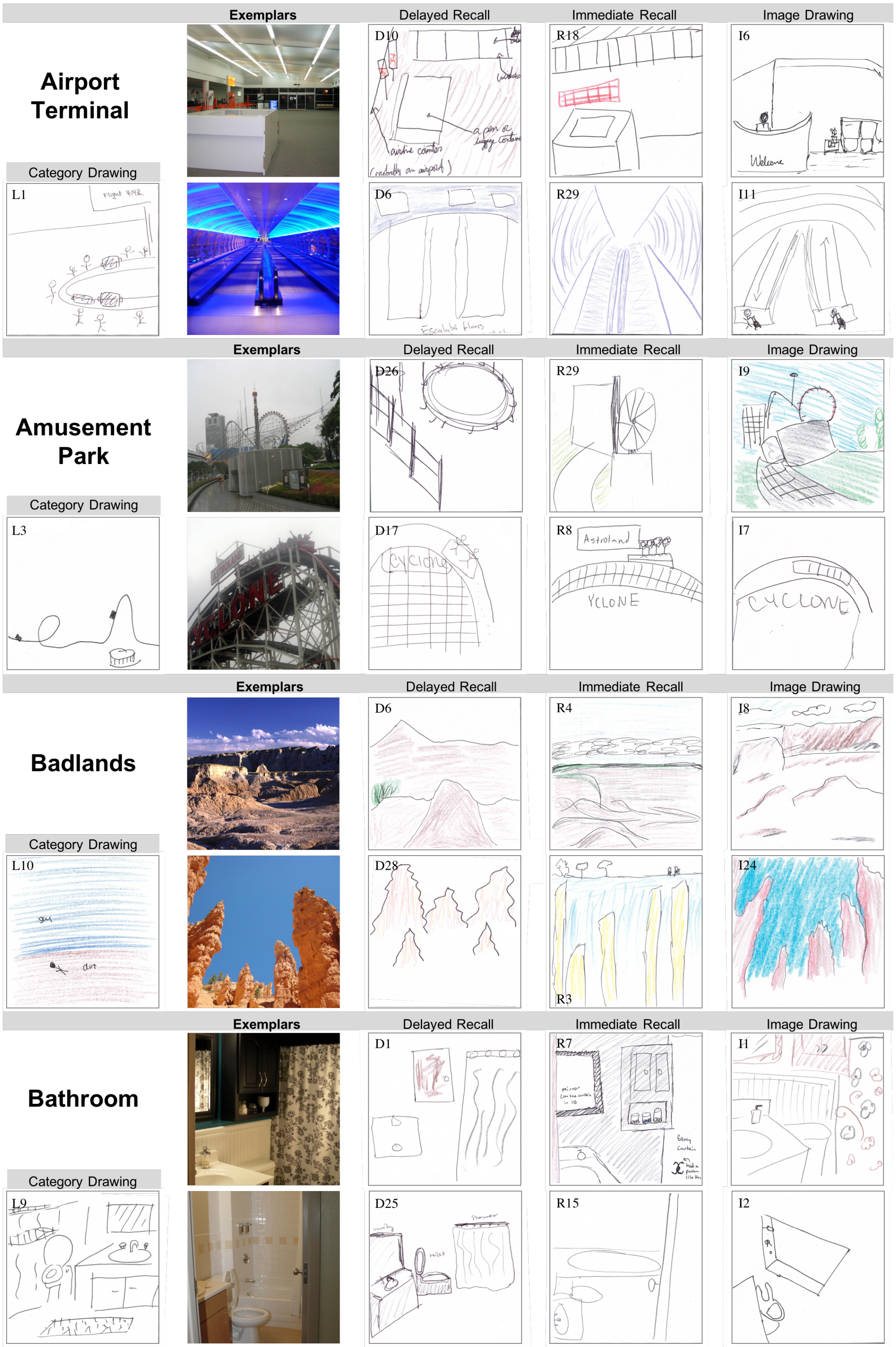
Bainbridge et al.

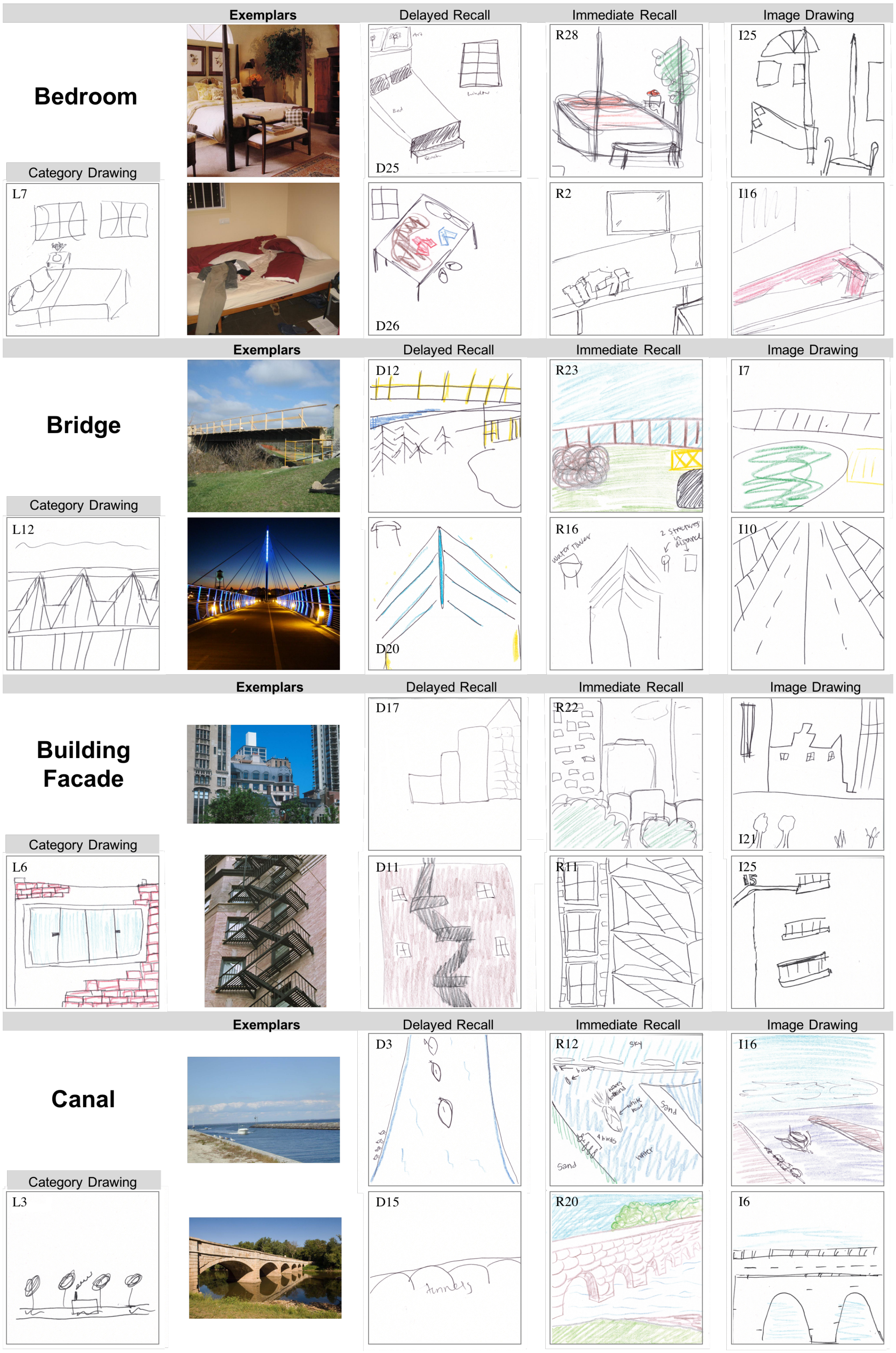
Supplementary Information

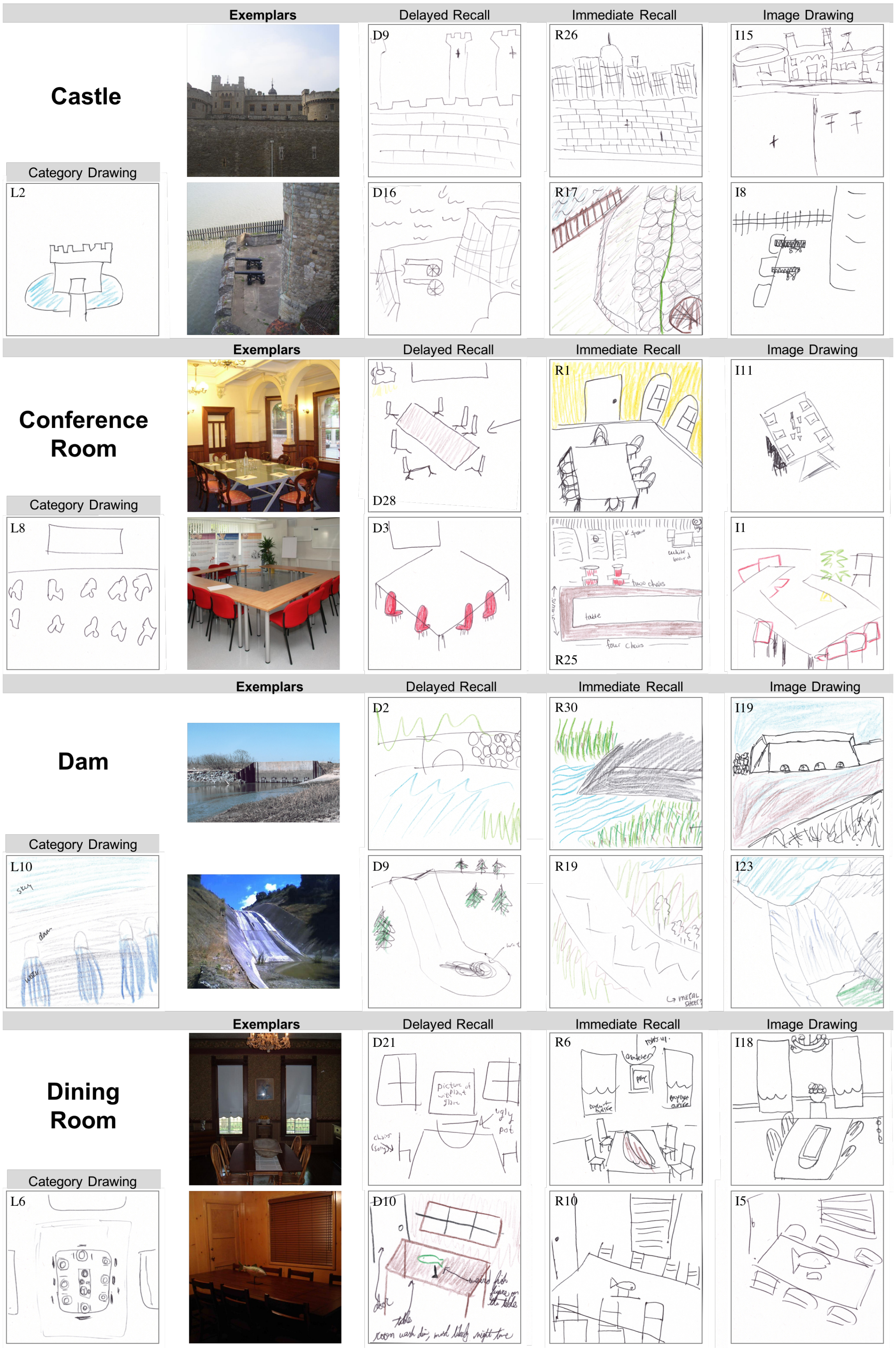
Table of Contents

Supplementary Figure 1: Example Drawings

The following pages contain example drawings for each image exemplar and for each participant in the study. The 30 scene categories are listed in alphabetical order. For each category there is an example Category Drawing (drawn from the category label), the two possible exemplar images for that category (the top one is the low memorability exemplar, while the bottom one is the high memorability exemplar), and an example Delayed Recall drawing, Immediate Recall drawing, and Image Drawing (drawn directly from the image). The examples are sampled evenly across all participants, to illustrate the range and diversity in drawing styles, drawing ability, and drawing errors. Each drawing contains the participant number for that experiment, with letter indicating the experiment (L = Category Drawing experiment, *N* = 15 participants; D = Delayed Recall experiment, *N* = 30 participants; R = Immediate Recall experiment, *N* = 30 participants; I = Image Drawing experiment, *N* = 24 participants). Elements that extended beyond the edges of the drawings were cropped for space purposes. The photographs used in the experiment and all figures are from the SUN Database [1], a publicly available image database.


Exemplars
Delayed Recall
Immediate Recall
Image Drawing
Airport Terminal
Category Drawing
L1
D10
R18
I6
D6
R29
I11
Amusement Park
Category Drawing
L3
D26
R29
I9
D17
R8
I7
Badlands
Category Drawing
L10
D6
R4
I8
D28
R3
I24
Bathroom
Category Drawing
L9
D1
R7
I1
D25
R15
I2

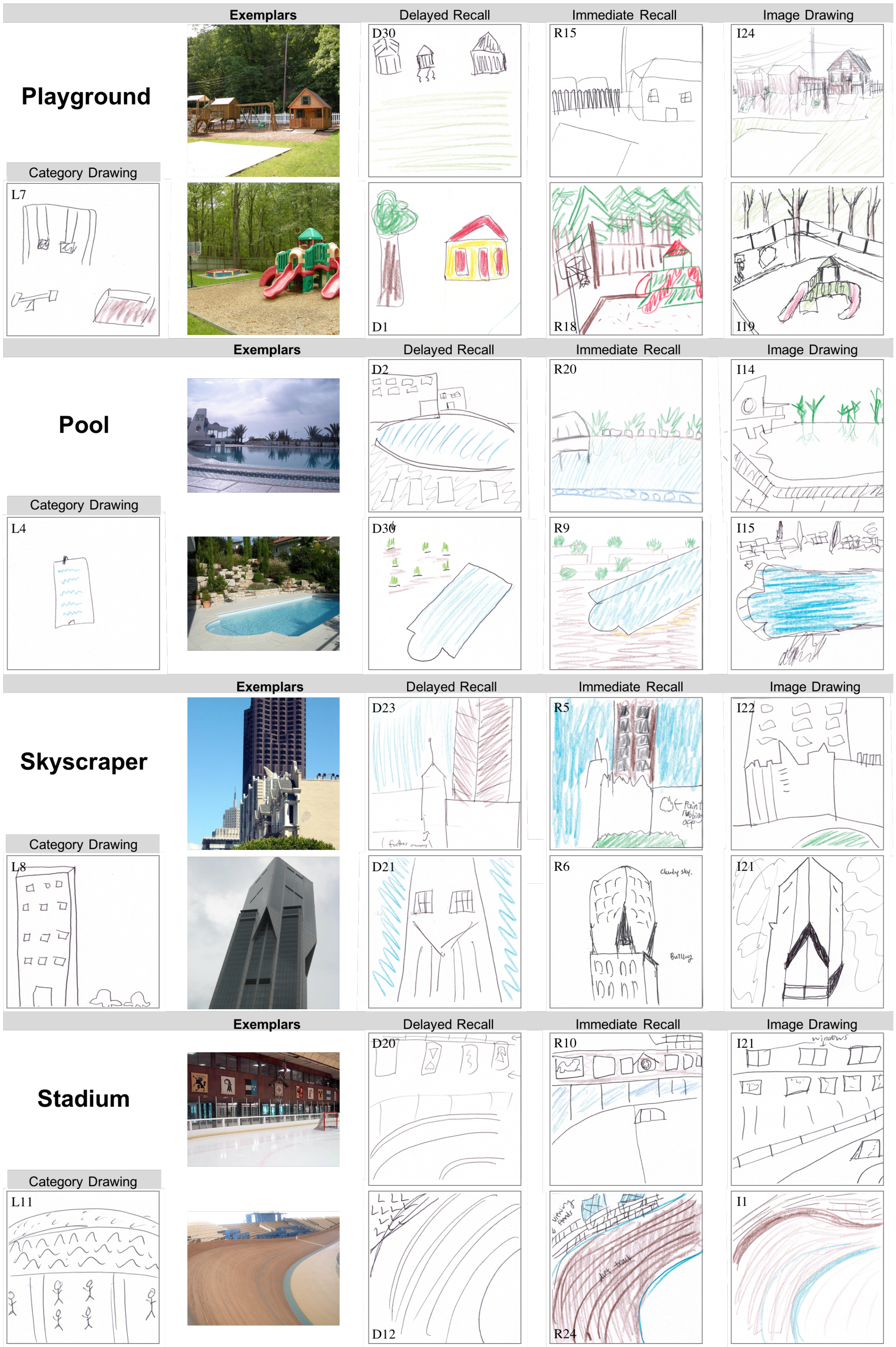

Exemplars
Delayed Recall
Immediate Recall
Image Drawing
Bedroom
Category Drawing
R28
I25
D25
L7
D26
R2
I16
Bridge
D12
R23
I7
L12
D20
R16
I10
Building Facade
D17
R22
I21
L6
D11
R11
I25
Canal
D3
R12
L3
D15
R20
I6

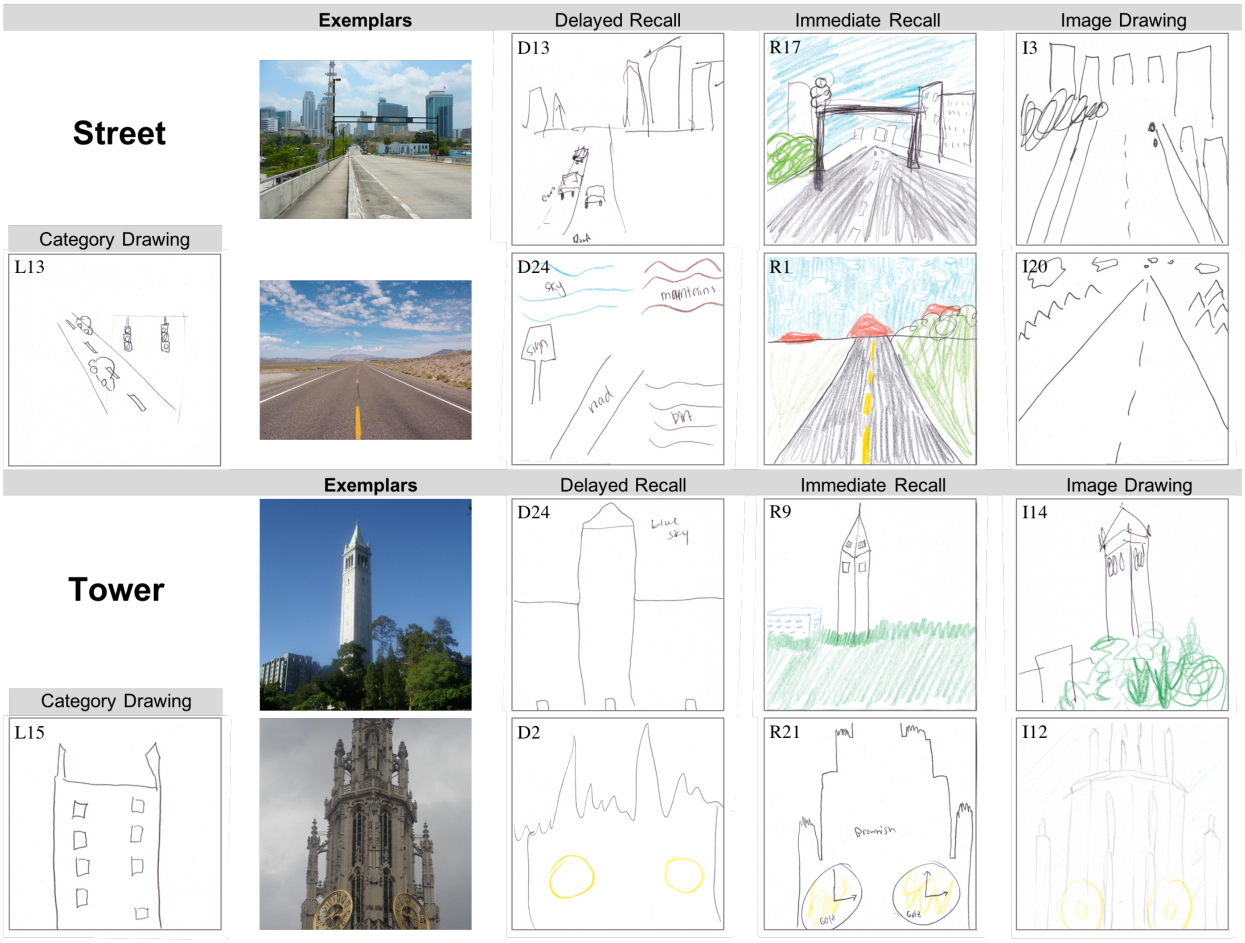

Exemplars
Delayed Recall
Immediate Recall
Image Drawing
Castle
Category Drawing
L2
D9
D16
R26
R17
I15
I8
Conference Room
L8
D28
D3
R1
R25
I11
I1
Dam
L10
D2
D9
R30
R19
I19
I23
Dining Room
L6
D21
D10
R6
R10
I18
I5


Exemplars
Delayed Recall
Immediate Recall
Image Drawing
Factory
Category Drawing
L13
D15
R8
I10
D19
R27
I17
Farm
L2
D29
R13
I13
D18
R7
I9
Fountain
L9
D19
R11
I17
D5
R28
I18
Garden
L14
D20
R27
I23
D4
R30
I13

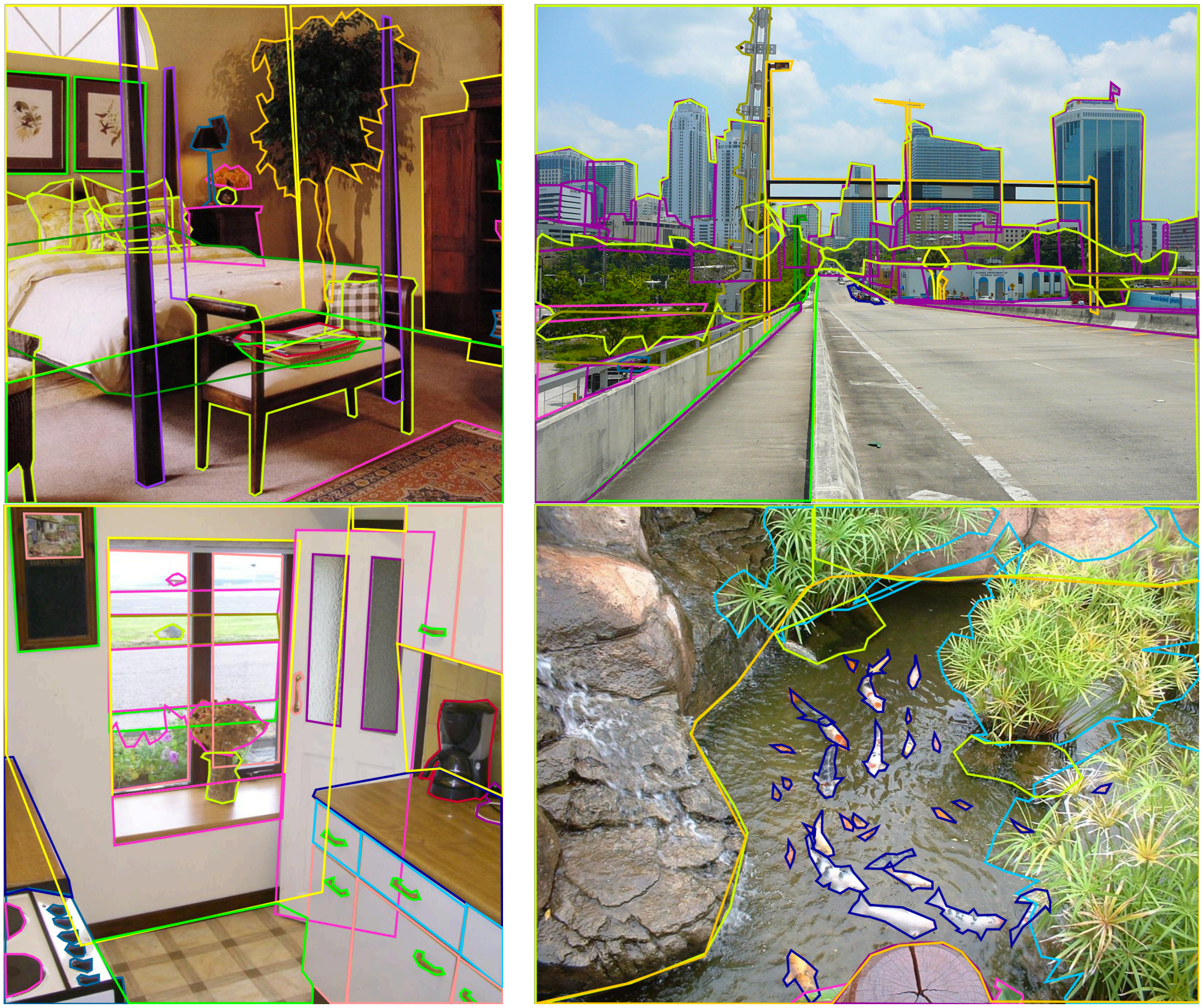

Exemplars
Delayed Recall
Immediate Recall
Image Drawing
Golf Course
Category Drawing
D27
R16
I12
L5
D22
R12
I3
House
D14
R14
I7
L15
D23
R13
I16
Iceberg
D5
R3
I8
L1
D27
R22
I7
Kitchen
D11
R24
I20
L11
D8
R23
I14


Exemplars
Delayed Recall
Immediate Recall
Image Drawing
Lake
Category Drawing
D7
R25
I4
L5
D13
R26
I6
pond
Lighthouse
D4
R2
I2
L4
D7
R5
I24
buoy in water
Living Room
D8
R19
I5
L14
D29
R4
I22
mirror
TV
Mountain
D18
R21
I2
L12
D14
R14
I4
mountain in background


Exemplars
Delayed Recall
Immediate Recall
Image Drawing
Playground
Category Drawing
L7
D30
R15
I24
D1
R18
I19
Pool
L4
D2
R20
I14
D30
R9
I15
Skyscraper
L8
D23
R5
I22
D21
R6
I21
Stadium
L11
D20
R10
I21
D12
R24
I1


Exemplars
Delayed Recall
Immediate Recall
Image Drawing
Street
Category Drawing
L13
D13
R17
I3
D24
sky
mountains
sign
road
Dirt
R1
I20
Tower
D24
blue sky
R9
I14
L15
D2
R21
Brownish
I12

Supplementary Figure 2: Example LabelMe Annotations



Supplemental Figure 2 – **Examples of LabelMe annotations.** These examples show object annotations of the experimental images using online annotation tool LabelMe [1]. These examples illustrate the level of granularity with which objects were labeled. For the bedroom image, while each pillow was labeled (as they were separable and visually distinct), each magazine at the foot of the bed was not (they were not visually distinct and their widths were too small for annotation). For the street scene, each building was labeled separately, but trees were indistinguishable and grouped together. All annotations for the images are downloadable with the experimental data.

Supplementary Note 1: Recall Performance Over Time During Test Phase

One important question is whether memory detail (object and spatial information) diminished over time during the Delayed Recall free recall test phase, either due to the amount of time needed to draw the images or fatigue. There was no significant correlation between the order an image was recalled in and how many objects it contained (Wilcoxon signed rank test versus 0: $Z = -0.07$, $p = 0.943$; Spearman rank correlation mean $\varrho = 0.007$). Participants showed no decrease in spatial accuracy for images that were recalled later, in neither the x-direction ($Z = 0.24$, $p = 0.813$, mean $\varrho = -0.01$) nor y-direction ($Z = 0.34$, $p = 0.734$, mean $\varrho = 0.02$). Similarly, object size precision did not change over the time course of the recall task; there was no correlation between image recall order and object width difference ($Z = 0.53$, $p = 0.596$, mean $\varrho = 0.04$) or height difference ($Z = 0.96$, $p = 0.339$, mean $\varrho = -0.08$). Collectively, these results suggest that fatigue or the longer delay introduced by the drawing task itself did not result in decreased detail in the drawings over time.

Supplementary Note 2: Verbal Recall Control Experiment

To compare visual recall performance with traditional measures of verbal recall, a separate group of participants completed a verbal version of the free recall experiment in which they studied the category labels (e.g., kitchen, amusement park) instead of specific images from the categories. The verbal version of the recall experiment used the same experimental timing and Digit Span Task as the main Visual Delayed Recall Experiment, and during the recall phase participants were instructed to write down as many studied words as they could remember. Participants in the verbal recall experiment recalled 16.7 category labels on average (SD = 5.7, MIN = 7, MAX = 25), higher than the number of images recalled in the Visual Delayed Recall experiment (M = 12.1, SD = 4.0, MIN = 5, MAX = 20; Wilcoxon rank sum test: $Z = 2.62$, $p = 0.009$). However, when accounting for the additional cued recall images in the Delayed Recall experiment, there is no difference in memory performance between the visual and verbal recall tasks ($Z = 0.65$, $p = 0.514$). Additional experiments will be needed in the future to precisely pinpoint the differences between using verbal and visual recall tasks to assess verbal versus visual memories.

Supplementary Note 3: Verbal Description Control Experiment

In the main study we compared recalled memory drawings with those drawn in response to a category label cue. This comparison tests the extent to which the memory drawings reflect image content beyond an individual's canonical representation of a scene category. However, this does not rule out that image information may be stored as a verbal description and not visually.

To serve as an initial investigation into the extent to which verbal descriptions might contribute to memory drawing performance, we conducted a control experiment to investigate the information within verbal descriptions of the images used in the experiment. Specifically, how might people verbally code an image, and could this strategy be used to reconstruct the drawings we see in the current study?

Methods

Verbal Description Experiment. Participants on Amazon Mechanical Turk (AMT) viewed an image from the Delayed Recall experiment and were told to "write a one sentence description of this image that you would use to remember it." Fifteen participants per image (to match the number of participants who saw each image in the Delayed Recall Experiment) were recruited for each of the 60 images from the experiment. Participants could write descriptions for as many images as they desired; 175 participants total were recruited for the experiment, and on average participants wrote descriptions for 5.9 images each.

Description Matching Experiment. To test the *diagnosticity* within each description, separate AMT workers were asked to match each sentence to one of three photographs presented in random order: the low memorable, medium memorable (foil), or high memorable image from the same scene category as the sentence. Methods were comparable to the Drawing Matching Experiment. 364 workers in total participated in this experiment, with 24 workers judging each sentence. Each worker could complete as many trials as they desired, completing on average 59 trials each.

Word Labeling. To test the *detail* within each description, the Stanford Log-linear Part-Of-Speech Tagger [2] was used to automatically label the part of speech of each word in the verbal descriptions. Words labeled as nouns were automatically scored for concreteness on a scale of 1 to 5 using Brysbaert et al.'s concreteness ratings dataset [3], and words with a concreteness of at least 4 were labeled as objects. Example words with a concreteness of higher than 4 include *mountain* (4.96) or *machine* (4.25), while example words below 4 include *footsteps* (3.96) or *vacation* (3.14). These nouns with a concreteness of at least 4 were used to approximate the object detail within the verbal descriptions. Spatial information was measured with a count of all spatial signal words (e.g., *between*, *under*, *around*, *adjacent* [4]) across the verbal descriptions. Finally, subjective detail was measured as automatically tagged adjectives (e.g., *beautiful*) and adverbs (e.g., *messily*).

Results

Example descriptions are presented in Supplementary Figure 3, while performance on the Description Matching Experiment are shown in Supplementary Figure 4. Verbal descriptions were diagnostic of their original image, matched correctly on 86.0% of trials (SD = 8.7). While verbal descriptions made from the image were significantly less diagnostic than drawings made from the image (Wilcoxon rank sum test: $Z = 4.05$, $p = 5.13 \times 10^{-5}$), they were matched significantly better than drawings made from the category label ($Z = 9.40$, $p = 5.30 \times 10^{-21}$). They showed no difference in matching from drawings made from memory after a delay ($Z = 0.60$, $p = 0.550$), although this comparison should be taken with a grain of salt, as the verbal descriptions were not made from memory. Thus, short verbal descriptions can be diagnostic of a scene category exemplar.

While the verbal descriptions were diagnostic of their original image, they contained little concrete detail about objects or spatial information. On average, a description of a given image contained 2.8 concrete nouns (SD = 0.6), or 3.8 nouns overall (SD = 0.7). In contrast, drawings from the image contained much higher levels of object detail ($Z = 9.23$, $p = 2.76 \times 10^{-20}$), with 9.4 objects per image (SD = 4.0). The verbal descriptions also contained low levels of spatial information in contrast to the drawings, with 1.1 spatial words per sentence on average (SD = 0.4). Finally, the verbal descriptions also contained 1.7 subjective details on average (SD = 0.4), indicating that such verbal descriptions may be personalized and viewer-specific (e.g., "My dream vacation pool.” and “Factories polluting the air.” - Supplementary Figure 3), rather than an objective verbal description that could be used to faithfully reconstruct the original image.

These results indicate that verbal descriptions of an image are diagnostic, but less diagnostic than drawings made of an image. That being said, the matching performance for these descriptions was akin to that for the drawings made from memory. The ability to match a drawing or verbal description to its original image thus may only depend on a few important items rather than large amounts of detail. However, while these verbal descriptions are diagnostic of their image, they contain only a few specific, salient object and spatial details combined with personally meaningful subjective information. In contrast, the memory drawings contain many more objects, and importantly, they are located in precise spatial locations and at precise sizes, information rarely included in the descriptions. These verbal descriptions were also made during perception, and thus may not accurately represent the amount of verbal detail that can be maintained and recalled from memory. Future work will be necessary to compare the resolution of verbal to visual memory and see the degree to which verbal strategies contribute to visual recall detail and vice versa.

Supplementary Figure 3: Example Verbal Descriptions

Blue = concrete noun   Red = spatial signal

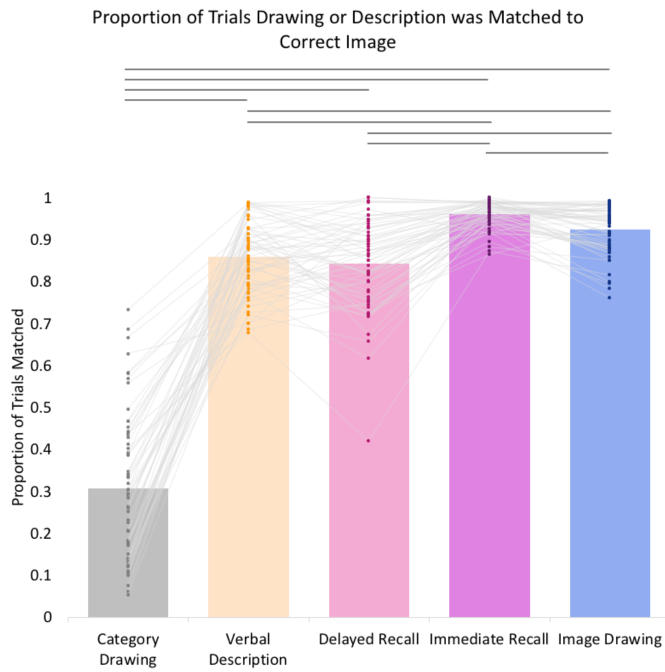
1. A beach resort pool with tile and palm trees.
2. We see a pool, perhaps at a hotel, with palm trees behind.
3. The pool was amazing and surrounded by palm trees.
4. Tropical paradise is right here!
5. When peace and quite meet the sky, you will find me here.
6. My dream vacation pool.
7. There is a large pool surrounded by middle eastern tiling with palm trees in the background of a very sunny day.
8. Reflective pool in a tropical location.
9. Vacations would be so relaxing in this pool with gorgeous blue skies all around.
10. The pool, the tropical trees and the white building remind me of a time in Abu Dhabi.
11. Large swimming pool, attached to the house via the deck, surrounded by palm trees.
12. Picture of a pool with trees in the background during a cloudy day.
13. Still pool surrounded by white ground and building as a storm is rolling in.
14. This is a blue pool with a weird looking house and trees behind it that's situated under a very cloudy sky.
15. This is a picture of a pool with lots of Caribbean trees in front of it.

1. We see red chairs around a square of narrow tables in a meeting room.
2. A meeting room with red chairs that has tables set up in a large square so participants can work in a group.
3. A stylish table for discussion in a board room.
4. There is a group of four wooden tables surrounded by red chairs.
5. There is a wooden sectional table in the shape of a square with a small opening and several red chairs around it with posters in the background.
6. Red chaired conference room.
7. A meeting room with the tables arranged in a square and red chairs.
8. This looks like an office gathering environment.
9. This is a conference room with a square wood top table with open center and is surrounded by red chairs with black legs.
10. Red chairs around a square table know all the marketing secrets just shared.
11. A conference room with a square wood table and red chairs.
12. This is a light brown wooden table surrounded by red chairs in front of a window that also has some banners and a tree there.
13. A room with 10-12 red chairs setup around a circular face front meeting style desk.
14. Meeting hall.
15. A round table has been prepared for today's meeting with the agenda found printed on the table.

1. The picture is of two smoke stacks, with white smoke, in front of mountains.
2. The two big items were blowing so much smoke!
3. Smokey power plant stacks.
4. There are two nuclear towers with smoke coming from the top.
5. Factories polluting the air.
6. Two stacks for a nuclear power plant behind power lines and surrounded by trees.
7. Active nuclear power plant located in a mountainous region.
8. Two nuclear power plant stacks, both emitting steam.
9. Two industrial silo's with billowing smoke.
10. The smoke is clean.
11. Two wide smokestacks expelling white smoke into the air, with green mountains behind them and electrical wires in front of them.
12. There are two smoke stack blowing white puffs of smoke in a rural area.
13. I see two large smoke stack plants with smoke coming out of both of them.
14. Smoke pours out of the towers, disappearing into the sky.
15. This is a smoking factory in the middle of a countryside.

Supplementary Figure 3 – Example verbal descriptions. Verbal descriptions for three example images from the Verbal Description Experiment, in which online participants wrote a one-sentence description of the image that would help them remember the image. Sentences are colored blue for automatically labeled concrete nouns (an approximation of object detail) and spatial signal words (an approximation of spatial detail). The descriptions contained fewer objects and much fewer spatial details than drawings of the images. Descriptions also often included subjective, idiosyncratic details, e.g., “My dream vacation pool”, or abstract descriptions, e.g., “Factories polluting the air.”

Supplementary Figure 4: Description Matching Performance



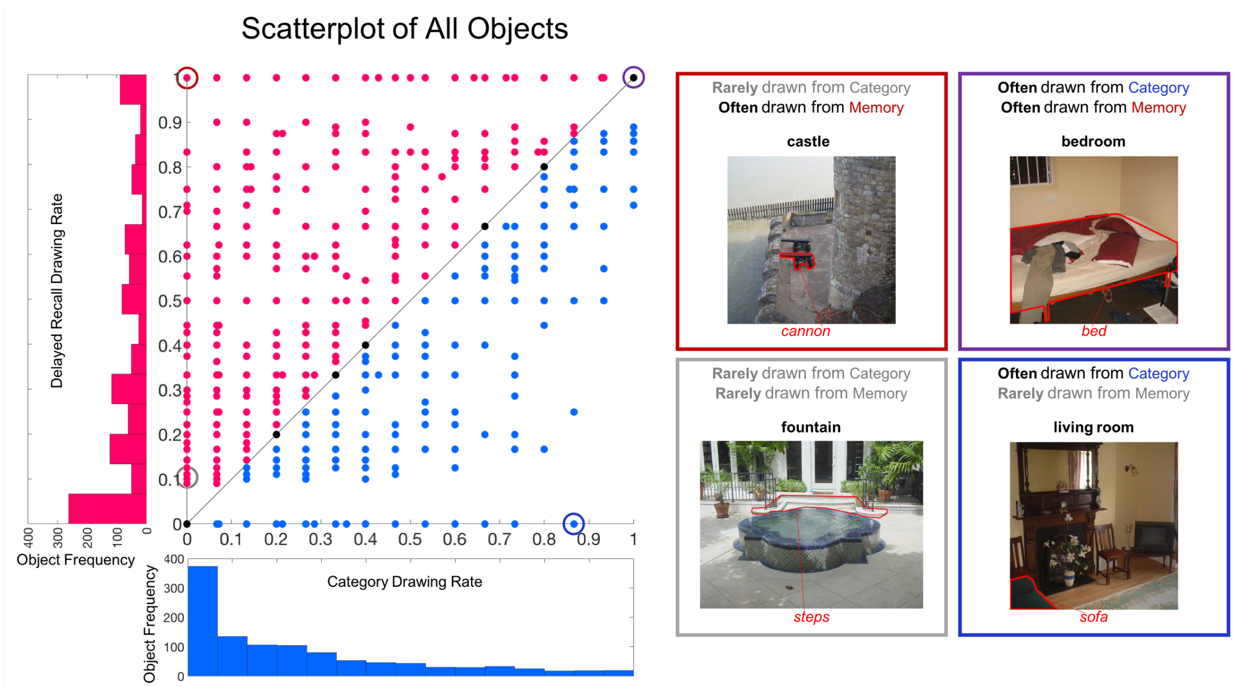
Supplementary Figure 4 – Description matching performance. The average proportion of correct AMT worker matches of each drawing type (Category Drawing, Delayed Recall, Immediate Recall, Image Drawing) as well as verbal descriptions of an image, with the original image. Each dot indicates each of the 60 images used in the experiment, and lines connect the same image across the different drawing and description conditions. Horizontal lines above the graph show all significant pairwise comparisons using a Wilcoxon rank sum test ($p < 0.05$).

Supplementary Note 4: Relative Frequency of Object Drawing

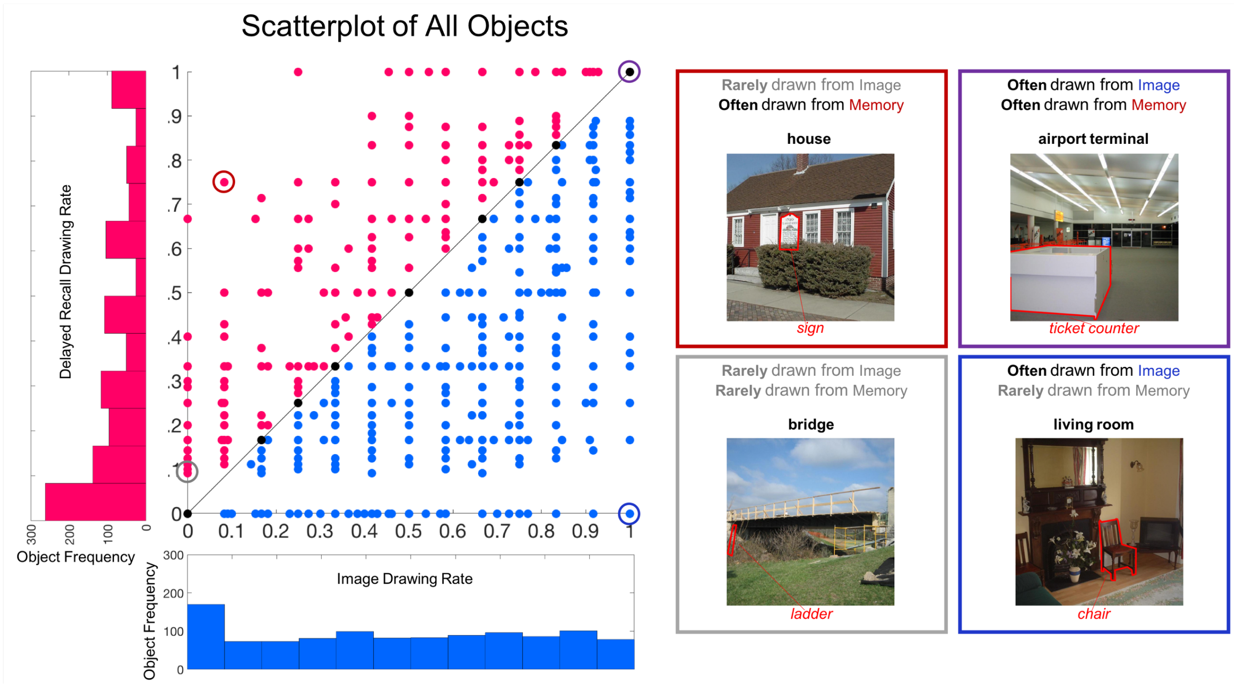
In order to compare how frequently objects contained in the scene images were drawn in the different experimental conditions, we plotted the relative frequency of object drawing for Delayed Recall versus Category Drawing (Supplementary Figure 5) and Delayed Recall versus Image Drawing (Supplementary Figure 6).

For Delayed Recall versus Category Drawing, it is clear there is no simple relationship for relative object frequency. While some objects are frequently drawn in both cases, (e.g., a bed in a bedroom) and some are frequently not drawn in both cases (e.g., steps in a fountain scene), some objects are more likely to be drawn in one condition than the other. For example, while a cannon is frequently drawn during Delayed Recall for a castle scene, it is not common in the Category Drawings. At the same time, there were some objects more frequently drawn during Category Drawing than Delayed Recall (e.g., a sofa in a living room). Across the 60 experimental images, on average 10.3 objects per image were drawn more frequently during Delayed Recall than Category Drawing (SD = 5.4). In contrast, 6.5 objects per image (SD = 5.0) were more frequently drawn from the category name than from delayed recall. These results show that recall performance cannot be predicted merely by how typical that object is within a scene category, and further investigation will be required to understand why some canonical objects are forgotten or what makes some non-canonical objects particularly memorable.

For Delayed Recall versus Image Drawing, there is a similar spread of data-points. Some objects were frequently drawn in both conditions (e.g., the salient ticket counter in an airport terminal scene) or not drawn in either (e.g., the obscured ladder in a bridge scene). However, some were more likely to be drawn from the image than recalled (e.g., the chair in a living room), while others were more likely to be recalled than drawn from the image (e.g., the sign on a house). Across the 60 experimental images, on average 4.9 objects per image were drawn more frequently from Delayed Recall than from the image (SD = 4.6), while 11.4 objects per image (SD = 5.7) were drawn more frequently from the image than from Delayed Recall. These results indicate that different objects may be particularly salient during perception versus memory, and further exploration will need to examine what makes an object easily recalled even when less salient during perception.



Supplementary Figure 5 – Comparison of objects between Category Drawings and Delayed Recall Drawings. (Left) Scatterplot of all objects in the experimental images, showing the rate at which they are drawn in Category Drawings versus Delayed Recall Drawings. Red dots indicate objects that were drawn more often from Delayed Recall than in Category Drawings, while blue dots indicate objects more often drawn in Category Drawings. Black dots indicate objects drawn with equal frequency. The histograms indicate the number of objects with a given drawing rate, by condition. Highlighted points indicate example objects (Right), bordered with the same corresponding color, to show example objects at the extreme ends of both axes.



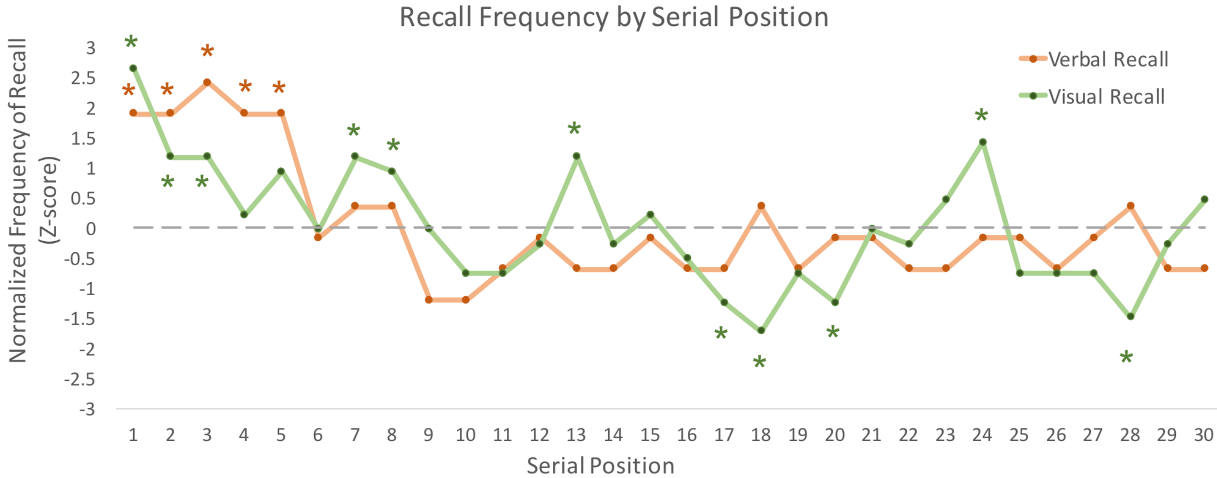
Supplementary Figure 6 – Comparison of objects between Image Drawings and Delayed Recall Drawings. (Left) Scatterplot of all objects in the experimental images, showing the rate at which they are drawn in Image Drawings versus Delayed Recall Drawings. Red dots indicate objects that were drawn more often from Delayed Recall than in Image Drawings, while blue dots indicate objects more often drawn in Image Drawings. Black dots indicate objects drawn with equal frequency. The histograms indicate the number of objects with a given drawing rate, by condition. Highlighted points indicate example objects (at the right), bordered with the same corresponding color, to show example objects at the extreme ends of both axes.

Supplementary Note 5: Digit Span Task

The Digit Span Task was primarily used to create a temporal gap between the study and test phases of images or words, however performance here is also a useful metric of working memory. On average, participants performed at 58.17% (SD = 12.6%) on the Digit Span Task during the Delayed Recall experiment, in turn remembering 96.1% of 3-digit sequences (SD = 8.4%), 95.0% of 4-digit sequences (SD = 8.9%), 82.2% of 5-digit sequences (SD = 19.5%), 66.1% of 6-digit sequences (SD = 23.4%), 43.3% of 7-digit sequences (SD = 29.9%), 17.2% of 8-digit sequences (SD = 24.6%), and 7.2% of 9-digit sequences (SD = 12.9%). There was no significant correlation between performance on the Digit Span Task and number of images recalled (Spearman's rank $\varrho = 0.23$, $p = 0.225$), nor number of items recognized ($\varrho = 0.04$, $p = 0.834$).

Participants performed similarly on the Digit Span Task during the Verbal Free Recall experiment, remembering on average 50.54% (SD = 11.83%) of sequences. Again, there was no significant correlation between digit span performance and number of category labels recalled ($\varrho = 0.34$, $p = 0.217$). There was also no significant difference in performance on the Digit Span Task in the Delayed Recall experiment and the Verbal Free Recall experiment (Wilcoxon rank sum test: $Z = 1.78$, $p = 0.074$). In sum, these results suggest no relationship between working memory ability and longer-term recall or recognition performance in either the visual or verbal domains.

Supplementary Note 6: Primacy and Recency Effects



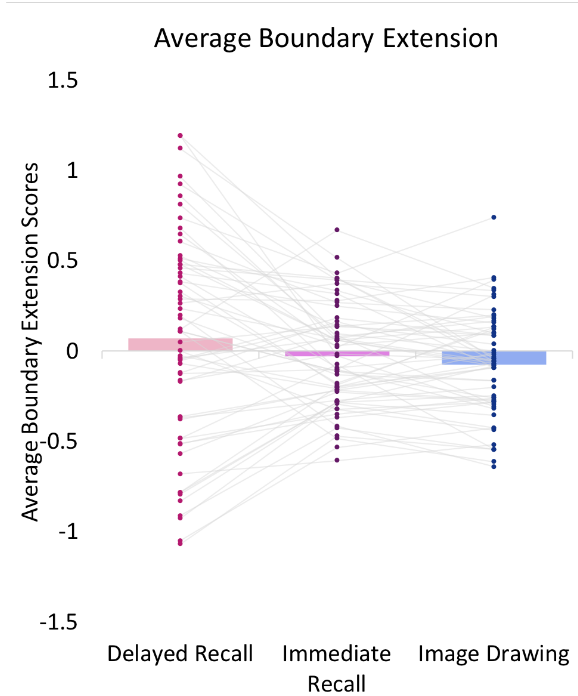
Supplementary Figure 7 – **Recall frequency by serial position.** Normalized frequency of image recall, ordered by item serial position (e.g., the first data point indicates participants who remembered the 1st image they saw, etc). The normalized frequencies for the Verbal Free Recall experiment are in orange, and the normalized frequencies for the Delayed Recall experiment are in green. Frequencies are normalized by the mean and standard deviation of frequency of recall across all serial positions within experimental type. Asterisks indicate significance from chance level in a permutation test over 1,000 iterations ($p < 0.05$). While both trends show a primacy effect, there is no strong evidence for a recency effect in either condition.

For both the Delayed Recall experiment and the Verbal Free Recall experiment, participants tended to show a primacy effect, generally recalling items presented at the beginning of the study phase (Supplementary Figure 7). This was confirmed with a permutation test, where the item order of remembered items was shuffled within each participant (preserving the number of items remembered) and then summed for each item position, over 1000 iterations to approximate the null distribution. For the Delayed Recall experiment, participants significantly remembered items presented in the first position ($p < 0.001$), second ($p = 0.022$), third ($p = 0.016$), seventh ($p = 0.016$), eighth ($p = 0.043$), thirteenth ($p = 0.022$), and 24th ($p = 0.005$) better than chance. They also remembered items in the seventeenth ($p = 0.034$), eighteenth ($p = 0.003$), and twentieth ($p = 0.043$) positions worse than chance. These results seem to indicate a primacy effect for the first three items, however, there is generally noise across serial positions, with peaks and troughs at seemingly arbitrary item positions (7, 8, 13, 17, 18, 20, 24), and there is no clear evidence for a recency effect. The Verbal Free Recall experiment shows a clear primacy effect, with participants significantly remembering only the first three items better than chance (first: $p = 0.011$, second: $p = 0.007$, third: $p < 0.001$). There is no evidence for a verbal recall recency effect.

While this primacy effect replicates the common effect in verbal free recall work [5], this effect has not been reported in visual free recall, with several previous works finding no primacy effect when visual recall was assessed with verbal descriptions [6,7]. It is not surprising that we find no recency effect, as there was an 11-minute delay between the study and free recall phase for both experiments. There is also a significant correlation in item order frequency between the Delayed Recall experiment and the Verbal Free Recall experiment (Spearman's rank correlation: $\varrho = 0.38$, $p = 0.038$), indicating that primacy and recency effects are likely the same regardless of stimulus modality.

Supplementary Note 7: Boundary Extension

Participants showed more boundary extension [8,9] for drawings made from Delayed Recall (M = 0.07, SD = 0.58) compared with Image Drawings (M = -0.08, SD = 0.29, rank sum test: $Z = 1.96$, $p = 0.050$), although this comparison fails Bonferonni correction for multiple comparisons (threshold $p = 0.017$). There was no significant difference in boundary extension between Delayed and Immediate Recall ($Z = 1.44$, $p = 0.150$) and Immediate Recall and Image Drawing ($Z = 0.66$, $p = 0.512$). Refer to Supplementary Figure 8 for the comparison of conditions. This indicates that when participants were recalling these scene images after a delay, they generally extended the boundaries around the scene and drew the images as further away. There is also a significant correlation between boundary extension scores for Delayed Recall drawings and Image Drawings (Spearman's rank correlation: $\varrho = 0.64$, $p = 3.81 \times 10^{-8}$), indicating that if there is a tendency towards boundary extension for when drawing from an image, then boundary extension is likely to occur when drawing from memory. These results replicate previous findings of boundary extension [10,30]. There is no significant correlation in the boundary extension scores for Delayed Recall drawings between the low memorable image and the high memorable image of the same category (Spearman's rank correlation: $\varrho = 0.16$, $p = 0.41$), so note that these data cannot be used to make conclusions about differential boundary extension effects by scene category.



Supplementary Figure 8 – **Boundary extension by condition.** The average boundary extension score for each image category by experimental condition (Delayed Recall, Immediate Recall, and Image Drawing). Boundary extension scores range from -2 for the drawing being much closer than the photograph (boundary contraction) up to 2 for the drawing being much farther than the photograph (boundary extension). A score of 0 indicates drawings are at the same distance as the original image. Delayed Recall drawings show a tendency to have more boundary extension than Image Drawings (p = 0.05).

Supplementary References

1. Isola, P., Xiao, J., Torralba, A., & Oliva, A. What makes an image memorable? *IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit.*, 145-152 (2011).
2. Toutanova, K., Klein, D., Manning, C., & Singer, Y. Feature-Rich Part-of-Speech Tagging with a Cyclic Dependency Network. *Proceedings of HLT-NAACL 2003*, 252-259 (2003).
3. Brysbaert, M., Warriner, A. B., & Kuperman, V. Concreteness ratings for 40 thousand generally known English word lemmas. *Behav. Res. Methods* **46**, 904-911 (2014).
4. Fry, E. B., Kress, J. E., & Fountoukidis, D. L. The reader's book of lists, 3rd edition. *Englewood Cliffs, NJ : Prentice Hall*, 185-187 (1993).
5. Murdock, B. B. The serial position effect of free recall. *J. Exp. Psychol.* **5**, 482-488 (1962).
6. Shiffrin, R. M. 1973. Visual free recall. *Science* **180**, 980-982 (1973).
7. Tabachnick, B., & Brotsky, S. J. Free recall and complexity of pictorial stimuli. *Mem. Cognit.* **4**, 466-470 (1976).
8. Intraub, H., & Richardson, M. Wide-angle memories of close-up scenes. *J. Exp. Psychol. Learn. Mem. Cogn.*, 179-187 (1989).
9. Agrell, B., & Dehlin, O. The clock-drawing test. *Age Ageing* **27**, 399-403 (1998).