Understanding strategy use during cognitive task performance

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This manuscript has been uploaded to the BioRxiv preprint server. The test materials are all available in the published literature. The data will be made freely available once the construction of a dedicated data-sharing portal has been completed. In the meantime, requests for the data can be sent to e.maguire@ucl.ac.uk.

Abstract

People vary in their ability to perform cognitive tasks. One source of these individual differences is the strategy used, although this is rarely investigated despite potentially providing key insights into the underlying cognition. Here we developed a novel, comprehensive methodology for obtaining in-depth strategy use data. We then applied this technique to ten tasks, some known to be hippocampal-dependent and others not, as performed by 217 participants. We found both a consistent use and benefit of scene visual imagery strategies on hippocampal-dependent tasks, including autobiographical memory recall, future thinking and navigation. Notably, these effects were not limited to visuospatial tasks, but were also apparent for several verbal tasks such as word list learning. In contrast, tasks that are not reliant upon the hippocampus, including semantic memory, were associated with the use of verbal strategies. Overall, our strategy data suggest that scene visual imagery is prevalent across hippocampal-dependent tasks, aligning with the notion that the impairments observed in patients with hippocampal damage on these tasks may relate to their deficit in constructing visual scene imagery. We conclude that analysing strategies can illuminate our understanding of the processes underpinning widely-used cognitive tests, as well as informing individual differences and psychological theories. We advocate the interrogation of strategy use more routinely in order to increase the benefits that arise from this important dimension of cognition.

Keywords: Individual Differences; Hippocampus; Scene Construction; Autobiographical Memory; Navigation

Introduction

Healthy individuals differ widely in their ability to perform cognitive tasks. For example, some people can recollect decades-old autobiographical memories with great clarity, while others struggle to recall what they did last weekend. Similarly, spatial navigation can be undertaken with ease or involve consistently getting lost. There are numerous potential causes of individual differences including the biological (e.g. genetics, brain structure, brain connectivity) and the psychological (e.g. the strategy used, prior experience, training). However, often in psychology and cognitive science, individual differences are eschewed in favour of data that are averaged across participants. While this approach can be highly informative, it may constrain insights into features of task performance and cognitive functioning that could be helpful for refining psychological theories.

The current study focuses on one potential source of individual differences – variations in strategy use. Compared to the vast number of published studies reporting on cognitive tasks, investigations of the concomitant strategies deployed during performance are much fewer. What we do know is that strategies can vary in terms of modality, including visual imagery, verbal strategies involving sentences or stories, and more basic strategies like rote repetition (Boltwood & Blick, 1970; Dunlosky & Kane, 2007; Hertzog, McGuire, & Lineweaver, 1998; Logie, Sala, Laiacona, Chalmers, & Wynn, 1996; McDaniel & Kearney, 1984; Paivio, 1969; Roberts, 1968; Stoff & Eagle, 1971). Where strategies have been examined, they were found to affect task performance, with the use of visual imagery typically boosting performance (Paivio, 1969; 1971, see also Baddeley & Andrade, 2000; Kosslyn, 1980). Moreover, creating visual images that are bizarre and distinct or that involve interactive scenes can be particularly effective in some situations (Bower, 1970; Einstein &

McDaniel, 1987; Kroll, Schepeler, & Angin, 1986; Marschark & Hunt, 1989; McDaniel & Einstein, 1986).

Neuroimaging studies have also shown that strategy use can influence neural activity during task performance. For example, differences in the brain areas engaged during functional magnetic resonance imaging (fMRI) have been reported when participants used distinct strategies to perform the same task (Kirchhoff & Buckner, 2006; Kondo et al., 2005; Maguire, Valentine, Wilding, & Kapur, 2003; Miller, Donovan, Bennett, Aminoff, & Mayer, 2012; Speer, Jacoby, & Braver, 2003; Tsukiura, Mochizuki-Kawai, & Fujii, 2005), even when performance was equalised across strategy groups. This shows that considering only averaged brain activity across participants could blunt or even mislead interpretations about the nature of cognitive functions and the brain regions that support them.

One situation where this issue may be particularly pertinent is for understanding the role of a brain structure called the hippocampus. The human hippocampus is associated with multiple cognitive functions including the construction of scene imagery (scene construction), autobiographical memory, future thinking and spatial navigation (Addis, Wong, & Schacter, 2007; Hassabis, Kumaran, Vann, & Maguire, 2007; Maguire et al., 2000; Rosenbaum et al., 2005). Views differ on how the hippocampus helps to accomplish these feats (Ekstrom & Ranganath, 2018; Hassabis & Maguire, 2007; Maguire & Mullally, 2013; Schacter et al., 2012).

One suggestion is that these functions are linked by the use of visual imagery in the form of scenes (Maguire & Mullally, 2013; see also, Robin, 2018; Rubin & Umanath, 2015 for related theoretical viewpoints), where a scene is defined as a naturalistic three-dimensional spatially coherent representation of the world typically populated by objects and viewed from an egocentric perspective (Dalton, Zeidman, McCormick, & Maguire, 2018). An individual's ability to construct and use scene imagery to imagine or recall has been shown to predict the vividness and detail of an imagined scenario (Arnold, McDermott, & Szpunar, 2011; D'Argembeau & Van der Linden, 2004; Hebscher, Levine, & Gilboa, 2017; Robin & Moscovitch, 2014; Robin, Wynn, & Moscovitch, 2016; Sheldon & Chu, 2017; Szpunar & McDermott, 2008). Moreover, damage limited to the hippocampi is known to impede the ability to construct scene imagery (Andelman, Hoofien, Goldberg, Aizenstein, & Neufeld, 2010; Hassabis et al., 2007; Maguire & Mullally, 2013; Mullally, Intraub, & Maguire, 2012; Race, Keane, & Verfaellie, 2011; Rosenbaum, Gilboa, Levine, Winocur, & Moscovitch, 2009).

We recently conducted two studies that also speak to this issue. In the first experiment, we examined performance on tasks known to recruit the hippocampus – scene construction, autobiographical memory recall, future thinking and navigation. We found that scene construction was a key process linking performance on the four tasks (Clark et al., 2019). In a second study, we investigated the relationship between beliefs about ability, measured using standard questionnaires, and performance on the aforementioned tasks (Clark & Maguire, in press). The results showed that questionnaires involving (scene) visual imagery has the closest association with scene construction, autobiographical memory and future thinking performance (more so than autobiographical memory and future thinking questionnaires), while only navigation questionnaires were associated with navigation performance.

The studies described above implicate scene imagery in hippocampal-dependent tasks, but they do not provide direct evidence that participants actually used scene imagery as an explicit strategy during task performance. Hence, one way to address the question of the role played by the hippocampus may be to interrogate directly the strategies used to perform tasks known to depend upon the hippocampus. If participants consistently report using a strategy, for example scene visual imagery, to perform these tasks, and if this strategy confers a performance advantage, then this could offer key insights into hippocampal function.

The hippocampus is not only associated with naturalistic tasks such as scene construction, autobiographical memory, future thinking and navigation. Performance on a number of neuropsychological tests has also been linked to the hippocampus. If a scene imagery strategy is of particular relevance for hippocampal-dependent tasks, then the use and benefit of such a strategy for these neuropsychological tests might also be expected. We will consider in turn the neuropsychological tests of relevance for the current study.

Of particular interest are commonly-used neuropsychological tasks assessing verbal memory, as it is not clear whether visual imagery strategies have any relevance in their performance. The Rey Auditory Verbal Learning Task (RAVLT) involves learning a list of words (Strauss, Sherman, & Spreen, 2006); in the Logical Memory subtest of the Wechsler Memory Scale IV (WMS-IV) two short stories have to be memorised (Wechsler, 2009); and the Verbal Paired Associates (VPA) subtest of the WMS-IV requires the learning of word pairs (Wechsler, 2009). Performance at delayed recall on these tasks is impaired following hippocampal damage (Clark & Maguire, 2016; Graf & Schacter, 1985; Spiers, Maguire, & Burgess, 2001; Squire, 1992; Zola-Morgan, Squire, & Amaral, 1986). We have previously suggested that a scene visual imagery strategy can be used to perform these tasks and that hippocampal-damaged patients may be impaired because of their reduced ability to construct scene imagery (Clark, Kim, & Maguire, 2018; Clark & Maguire, 2016; Maguire & Mullally, 2013). However, there is currently no detailed evidence available about how participants perform these verbal memory tasks, and whether a scene visual imagery strategy is, in fact, utilised.

We recently developed the Abstract VPA task which closely mirrors the WMS VPA test but involves words with very low imageability (Clark et al., 2018). We hypothesised that this task would engage the hippocampus much less during fMRI than a VPA task comprised of highly imageable words. This is what we found – the encoding of high imagery word pairs significantly activated the hippocampus compared to the encoding of low imagery word pairs even when encoding success was controlled (Clark et al., 2018). This result suggests that strategies used to perform the Abstract VPA task should be distinct from those deployed for the other verbal memory tasks detailed above, with less reliance on, and benefit from, scene imagery.

Another widely employed neuropsychological test where delayed recall performance is impaired following hippocampal damage is the Rey-Osterrieth complex figure task (Rey, 1941; see also Spiers et al., 2001). This task assesses visuospatial processing and memory, asking participants to first copy a complicated line drawing with multiple components, and then later draw the same figure from memory. While recall would be expected to involve visual imagery, the Rey-Osterrieth complex figure offers an interesting contrast to the other visual tasks mentioned above because the stimulus is presented in a two-dimensional format. Whether or not this affects the strategy used to perform the task is currently unknown.

Along with the Abstract VPA test, the Dead or Alive task is a semantic memory task that does not seem to be hippocampal-dependent (Kapur, Young, Bateman, & Kennedy, 1989). As such, we would expect that strategy use on the Dead or Alive task to involve little, and show no benefit of, scene imagery.

It is important to emphasise that we are investigating here the strategy used to perform an individual task. This is in contrast to an individual's overall cognitive style. Strategies are employed on a task-specific basis. Often this is an intentional, or self-directed selection, but it can also be instinctive and spontaneous. A cognitive style, on the other hand, characterises an individual's general approach or tendency. For example, a person can be generally better at processing visual compared to verbal material (e.g. Kirby, Moore, & Schofield, 1988).

Indeed, "visualizers" have been found to do better on imagery tasks such as paper folding (which involves imagining the folding and unfolding of pieces of paper into different shapes) in comparison to "verbalizers" who do better on vocabulary tasks (Mayer & Massa, 2003; but see also Pashler, McDaniel, Rohrer, & Bjork, 2008). We do not deny that cognitive style can inform about individual differences. However, being a verbalizer does not mean that an individual uses only verbal strategies; for any particular task they could still employ a visual strategy. Hence, our focus here is on the strategies used to perform individual tasks.

In summary, by examining in detail the strategies used to perform a range of cognitive tasks, we may be able to expose important features of how these tasks are performed, what effect, if any, this has on performance, and potentially provide insights into functions of relevant brain regions. Here, we focus on tasks associated with the hippocampus as the exemplar of how considering strategy use can extend our understanding. However, the same principle could be applied to any cognitive domain of interest.

The current study had two main aims, first, to examine the strategies used across a variety of cognitive tasks and, second, to investigate the effects of strategy use on task performance. To address the first aim, we developed a new methodology for analysing strategy data which involved collecting detailed information in a principled and controlled manner on the strategies used to perform a task. Performance and strategy data were gathered from 217 participants on 10 different tasks. Our primary four tasks of interest assessed scene construction, autobiographical memory, future thinking and navigation, and are known to be hippocampal-dependent. The other six neuropsychological tests were included to assess this factor further using tasks that are, or are not, thought to be reliant upon the hippocampus, and also to reflect visual and verbal modalities.

We hypothesised that the use of a scene visual imagery strategy would be most apparent for tasks dependent upon the hippocampus. We further predicted that the use of a scene visual imagery strategy for hippocampal-reliant tasks would be associated with better performance.

Method

Participants

Two hundred and seventeen individuals were recruited. They were aged between 20 and 41 years, had English as their first language, and reported no psychological, psychiatric, neurological or behavioural health conditions. The age range was restricted to 20-41 to limit any possible effects of ageing. Participants reporting hobbies or vocations known to be associated with the hippocampus (e.g. licensed London taxi drivers) were excluded. The mean age of the sample was 29.0 years (95% CI; 20, 38) and included 109 females and 108 males. Participants were reimbursed £10 per hour for taking part which was paid at study completion. All participants gave written informed consent and the study was approved by the University College London Research Ethics Committee.

The sample size was determined at 216 during study design to be sufficient to answer multiple questions requiring different statistical approaches. The sample allows for adequate power to identify medium effect sizes across multiple groups using ANOVAs at alpha levels of 0.01 (Cohen, 1992). A final sample of 217 was obtained due to over recruitment.

Procedure

Participants first completed the tasks over three separate testing sessions. The order of the tasks within each visit was the same for all participants (see Clark et al., 2019). Task order was arranged so as to avoid interference, for example, not having a verbal task followed by another verbal task, and to provide sessions of approximately equal length (~3-3.5 hours, including breaks). Strategy data were collected in a separate final session, after all the tasks had been completed. All participants completed all parts of the study.

Cognitive Tasks

All tasks are published and were performed and scored as per their published use. Here, for convenience, each task is described briefly.

Tasks of primary interest. ***Scene construction task*** (Hassabis et al., 2007). This task measures a participant's ability to mentally construct a visual scene. Participants construct different scenes of commonplace settings. For each scene, a short cue is provided (e.g. imagine lying on a beach in a beautiful tropical bay), and the participant is asked to imagine the scene that is evoked and then describe it out loud in as much detail as possible. Participants are explicitly told not to describe a memory, but to create a new scene that they have never experienced before.

The overall outcome measure is an "experiential index" which is calculated for each scene and then averaged. In brief, it is composed of four elements: the content, participant ratings of their sense of presence (how much they felt like they were really there) and perceived vividness, participant ratings of the spatial coherence of the scene, and an experimenter rating of the overall quality of the scene.

Double scoring was performed on 20% of the data. We took the most stringent approach to identifying across-experimenter agreement. Inter-class correlation coefficients, with a two way random effects model looking for absolute agreement indicated excellent agreement among the experimenter ratings (minimum score of 0.90; see supplementary materials Table S1). For reference, a score of 0.8 or above is considered excellent agreement beyond chance.

Autobiographical Interview (AI; Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002). In the AI, participants are asked to provide autobiographical memories from a specific time and place over four time periods – early childhood (up to age 11), teenage years (aged from 11-17), adulthood (aged from 18 to 12 months prior to the interview; two memories are requested) and the last year (a memory in the last 12 months). Recordings are transcribed for later scoring.

Memories are scored to collect "internal" details of the event; those describing the event in question (i.e. episodic details). An overall score is obtained by averaging the number of internal details provided for each autobiographical memory. Our double scoring produced excellent agreement across the experimenters (minimum score of 0.81; see supplementary materials Table S2).

We also examined participants' ratings of the vividness of their memories, given that we recently found that vividness may be a better reflection of beliefs regarding autobiographical memory recall ability, as measured by questionnaires, than the number of internal details (Clark & Maguire, in press). Vividness ratings are collected for each memory via the question "How clearly can you visualize this event?" on a 6 point scale from 1 (Vague memory, no recollection) to 6 (Extremely clear as if it's happening now). An overall vividness rating is obtained by averaging the vividness ratings provided for each autobiographical memory.

Future thinking task (Hassabis et al., 2007). This task follows the same procedure as the scene construction task, but requires participants to imagine three plausible future scenes involving themselves (an event at the weekend; next Christmas; the next time they meet a friend). Participants are explicitly told not to describe a memory, but to create a new future scene. Recordings are transcribed for later scoring. The scoring procedures are the same as for scene construction. Double scoring identified excellent agreement across the experimenters (minimum score of 0.88; see supplementary materials Table S3).

Navigation tasks (Woollett & Maguire, 2010). Navigation ability is assessed using movies of navigation through an unfamiliar town. Movie clips of two overlapping routes through this real town (Blackrock, in Dublin, Ireland) are shown to participants four times.

Five tasks are used to assess navigational ability. First, following each viewing of the route movies, participants are shown four short clips – two from the actual routes, and two distractors. Participants indicate whether they had seen each clip or not. Second, after all four route viewings are completed, recognition memory for scenes from the routes is tested. A third task involves assessing knowledge of the spatial relationships between landmarks from the routes. Fourth, route knowledge is examined by having participants place photographs from the routes in the correct order as if travelling through the town. Finally, participants draw a sketch map of the two routes including as many landmarks as they can remember. Sketch maps are scored in terms of the number of road segments, road junctions, correct landmarks, landmark positions, the orientation of the routes and an overall map quality score from the experimenters. Double scoring was performed on 20% of the sketch maps and found excellent agreement (minimum of 0.89; see supplementary materials Table S4). An overall navigation score was calculated by combining scores from all of the above tasks.

Neuropsychological tasks. ***RAVLT*** (see Strauss et al., 2006). This test assesses verbal memory using list learning. Participants hear a list of 15 words and are asked to try and remember as many as possible. The list is read out five times and memory is tested following each reading. After the five repetitions a different list of 15 words is read out, memory for which is then tested. After this "interference" trial, the participant is asked to recall as many words from the original list as possible. Delayed recall of the original list is tested 30 minutes later. Participants are not told about the delayed recall in advance. Here, as with the other recall tasks below, our performance measure was the delayed recall score, as it is most sensitive to hippocampal damage (Clark & Maguire, 2016; Squire, 1992).

Logical Memory. The Logical Memory task is taken from the WMS-IV (Wechsler, 2009) and assesses the free recall of narratives. Two short stories are read out to the participant, who is asked to retell each story immediately after hearing it. Following a 30 minute delay the participants are asked to recall each story again. Participants are not told about the delayed recall in advance. Each correct piece of information that a participant provides is awarded one point. A scaled score is calculated based on the raw score and the age of the participant. Here, our performance measure was the delayed recall scaled score.

Concrete and Abstract VPA. These tasks are based upon the WMS-IV VPA task (Wechsler, 2009). We have previously suggested that a limitation of the WMS-IV VPA task is its reliance upon concrete, imageable words (Clark et al., 2018; Clark & Maguire, 2016; Maguire & Mullally, 2013). We therefore created two additional versions of this task. In one case, only concrete, high imagery words are used, while the other comprises only abstract, very low imagery words. The words in each list are highly matched in terms of linguistic characteristics (e.g. length, phonemes and syllables) and frequency use in the English language. Otherwise, the tasks are identical to the WMS VPA. Learning takes place over four trials. In each, the same 14 word pairs (in a different order each time) are read out to the participant. Following this, the first word of each pair is given and the participant is asked for the corresponding word, with feedback (i.e., the correct answer is provided if necessary). After 30 minutes the participants are tested again in the same way but without feedback. Participants are not told about the delayed recall in advance. Here, our performance measure was the number of correct responses for each task at delayed recall.

The Rey–Osterrieth Complex Figure (Rey, 1941). This test assesses visuospatial processing and memory. Participants are first asked to copy the figure (a complicated line drawing with multiple components). Thirty minutes later, participants are asked to draw the same figure from memory. Participants are not told in advance that they will have to reproduce the figure. Scores are determined by the presence and placement of the 18 components in the figure. Here, our performance measure was the delayed recall score.

Dead or Alive task (Kapur et al., 1989). This is a test of semantic knowledge. Participants are presented with the names of 74 famous individuals and are first asked to remove any names that they do not recognise. For those that the participant knows, they are then asked to indicate whether the individual is dead or alive. The outcome of interest is the proportion of correct responses.

Tests of general cognitive ability. To test whether differences in task performance could be explained by general cognitive ability rather than strategy use, participants also completed the Test of Premorbid Functioning (TOPF; Wechsler, 2011) and the Matrix Reasoning subtest of the Wechsler Adult Intelligence Scale IV (WAIS-IV; Wechsler, 2008). The estimate of the full scale intelligence quotient (FSIQ) from the TOPF and the scaled scores from the Matrix Reasoning subtask were used to make comparisons between participant groups that used different strategies.

Strategy Use

There is currently no standard methodology for studying strategy use. We therefore designed a novel protocol for collecting and analysing detailed strategy information for each cognitive task.

Identification of strategies. To identify possible strategies used to perform the tasks, 30 participants were recruited who did not take part in the main study (15 female; average age 27.07 years, 95% CI: 24.34, 29.80). Participant recruitment was based on an individual's general use of visual imagery. The use of imagery is a well-known strategy (Andrews-Hanna, Saxe, & Yarkoni, 2014; Greenberg & Knowlton, 2014; Paivio, 1969) and we wanted to represent all types of strategies, not just those that are imagery based. General imagery use was determined via the Spontaneous Use of Imagery Questionnaire (SUIS; Reisberg, Pearson, & Kosslyn, 2003), where scores can range from 12 (very low/no spontaneous use of imagery) to 60 (high spontaneous use of imagery). The average score of the participants in this identification of strategies study was 40.03 (95% CI: 36.31, 43.76) with a range from 24 to 57.

To collect information on individual task strategies, participants first performed the cognitive tasks, after which they were asked open-ended questions about the strategies they employed for each task. Participants were encouraged to report all strategies that they used for a task and in as much detail as possible, regardless of how much or little they used them. Strategy responses from the participants were then combined with any additional strategies identified from the extant literature. This provided a large pool of potential strategies, ranging from 12 to 24 strategies for each task. The strategies identified for each task are provided in the supplementary materials (Strategies for each task).

We next sought to classify the strategies into categories across the tasks. Three main strategy categories were observed: Scene Visual Imagery strategies, Other Visual Imagery strategies and Verbal strategies. A Scene Visual Imagery strategy is one which evoked a visual image of a scene, i.e. the visual imagery had a sense of depth and background. The Other Visual Imagery strategy is one which evoked visual imagery, but this could not be defined as a scene. There was no sense of depth or background, a typical example being an image of a single object. A Verbal strategy is one which evoked no visual imagery at all, with reliance instead upon words and phrases.

Within the three main categories, strategy sub-categories were also apparent. Tables 1-3 show the strategy sub-categories that were identified across the tasks, with a brief explanation of each, and generalised, composite examples that reflect participants' descriptions. The strategy sub-category to which each individual strategy was allocated is shown in the supplementary materials (Strategies for each task). Within the strategy sub-categories, two additional points should be noted. First, on some tasks, multiple strategies were provided that belonged to the same sub-category. For example, for autobiographical memory recall two Simple Verbal sub-category strategies were identified: "*I verbally listed, using words or sentences alone, single facts about the memory, although not in a coherent or chronological order*" and *"I thought of the word for a single element, fact or detail in particular that stood out*". Second, unlike the main categories, not all sub-categories were reported for each task. For example, no Visualising Words strategies were observed for navigation.

We acknowledge that the strategy classification system reflects the research questions of the current study, namely, investigating the relevance and possible influence of visual scene imagery for hippocampal-dependent tasks (Barry, Barnes, Clark, & Maguire, 2018; Clark et al., 2019; Clark et al., 2018; Dalton et al., 2018; McCormick, Rosenthal, Miller, & Maguire, 2018). There may be other ways to classify the strategies that assess different aspects of these data that are not under consideration here.

Overall, from our open-ended questions study and the literature search, we were able to create a list of 12 to 24 potential strategies for each task. Importantly, while each strategy list was specific to a task in question, they all contained the same three main strategy categories and, where possible, strategy sub-categories. This allowed for the collection of highly detailed strategy data that was comparable across multiple tasks.

Table 1. Scene Visual Imagery strategy sub-categories.

Strategy sub-categories	**Explanation and Example**
Immediate Scene Construction	This strategy describes the instantaneous construction of a visual scene that creates a complete, fully-formed visual representation. *I had an immediate visual mental image of a scene with all elements appearing together all at once as a fully-formed scene that you could easily step into.*
Gradual Scene Construction	This strategy involved a more gradual constructive process, progressively building up a scene in a series of steps. *I used visual mental imagery that combined multiple elements to build up a scene, with a definite background or backdrop [e.g. I imagined the scene gradually, adding or changing elements].*
Screen Scenes	Here a participant visualised something (e.g. words) in their mind as though it was written on a piece of paper or a computer screen. As such, there was a definite background element to the image created. *I had a visual mental image of the task as it appeared on the computer screen – so I visualised the screen with the stimulus on it, as though I was re-experiencing parts of the task again.*
Aural leading to Scene Visual Imagery	Here the participant used an auditory strategy which then led to the use of visual imagery in the form of a scene. *I heard the information in my mind as though someone was speaking it to me. This then caused me to experience related visual imagery. The visual imagery that was evoked could be described as something scene-like.*
Vague Visual Scene-Like	This strategy described the use of vague and dim visual imagery. This was included to ensure that participants felt able to indicate the use of visual imagery even if it was not particularly clear or detailed. For this strategy type, the visual image was identifiably scene-like. *I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy. My very vague impression is that the image was scene-like.*

Table 2. Other Visual Imagery strategy sub-categories.

Strategy sub-categories	Explanation and Example
Complex Non-Scene Visual Imagery	This strategy involved a complex visual image (e.g. multiple objects), but without any form of background or depth to the image. In other words, it was not a scene. *I used visual mental imagery that combined multiple different elements to create a cohesive image in my mind. These elements were not combined to form a scene; there was no background to the image.*
Simple Visual Imagery	This strategy concerned very basic and simple visual imagery, typically of single objects on their own with no background imagery. *I visually imagined a single object in isolation with no background or context.*
Visualising Words	This strategy described the visualisation of words on their own (i.e. they were not imagined on a piece of paper or computer screen); there was no background to the image. *I visualised words in my mind as though they were written in the air – floating with no background or backdrop, and with no other associated visual imagery.*
Aural leading to Non-Scene Visual Imagery	Here the participant used an auditory strategy, which then led to the use of visual imagery that was not in the form of a scene *I heard the information in my mind as though someone was speaking it to me. This then caused me to experience related visual imagery. The visual imagery that was evoked could be described as something comprising single objects (not a scene).*
Vague Visual Complex Non-Scene Visual Imagery	This strategy described the use of vague and dim visual imagery. This was included to ensure that participants felt able to indicate the use of visual imagery even if it was not particularly clear or detailed. For this strategy type, the image had multiple elements, but no sense of a background or scene. *I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy. My very vague impression is that the image had multiple elements but was not a scene.*
Vague Visual Simple Visual Imagery	This strategy described the use of vague and dim visual imagery. This was included to ensure that participants felt able to indicate the use of visual imagery even if it was not particularly clear or detailed. For this strategy type, the image consisted of only individual items. *I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy. My very vague impression is that the image involved a single isolated object (not a scene).*
Vague Visual No Description	This strategy described the use of vague and dim visual imagery. This was included to ensure that participants felt able to indicate the use of visual imagery even if it was not particularly clear or detailed. For this strategy type, the participant was unable to describe the visual imagery at all. *I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy. I cannot describe the image.*

Table 3. Verbal strategy sub-categories

Strategy sub-categories	Explanation and Example
Verbal Cohesion	This strategy involved verbal techniques to describe the stimulus as a cohesive whole using words or sentences alone and without the use of visual imagery. *I verbally repeated to myself, using words or sentences alone, statements in a coherent order to keep all the facts linked together. This did not involve visual imagery.*
Verbal Subgroups	This strategy involved verbal techniques but for smaller elements or subgroups of elements using words or sentences alone and without the use of visual imagery. *I verbally grouped together and repeated to myself different pieces of information using words or sentences alone and not involving visual imagery as I did this.*
Simple Verbal	This strategy involved verbal techniques for listing single items/parts of a stimulus. The stimuli were not linked together and no visual imagery was used. *I repeated to myself key pieces of information.*
Aural No Visual Imagery	This strategy involved aural techniques, with no visual imagery being elicited. *I heard the information in my mind as though someone was speaking it to me. I recalled sound snippets or sections of audio. This did not elicit any visual imagery.*

Strategy data collection. Following the identification of possible strategies for each task, we devised a standardised methodology to collect strategy data from the large group of participants in the main experiment. This procedure is participant-paced and -led, but with the involvement of the experimenter where required. Three steps are involved. First, a brief reminder of the task is presented. Second, participants select the strategies they used for that task from a list of the possible strategies. Third, participants rank their selected strategies in relation to their degree of use.

Task reminder. The task reminder varies according to the task. For some tasks, a picture of the task is presented, while for others the tasks are verbally described. The experimenter then ensures that the participant fully remembers the task (providing additional information if required) before the participant moves on to the strategy selection.

Strategy selection. Following the reminder, the possible strategies for the task are presented as a list on a computer screen. For each strategy, participants are requested to respond either “Yes” (that they used the strategy) or “No” (that they did not use the strategy). A response is required for every strategy to ensure that none are accidently overlooked. It is made clear that selecting one strategy does not preclude the selection of any of the others, as more than one strategy can be deployed during a task.

The presented strategies are tailored to the task in question, but always belong to one of the sub-categories detailed in Tables 1-3. The strategies shown to the participants for each task, along with their strategy sub-category, are provided in the supplementary materials (Strategies for each task). Note that participants are not aware of the strategy category distinctions.

For all tasks, the option “Other” with space to describe a new strategy, not represented on the list, is also available.

Strategy ranking. A list of the strategies that a participant indicated using for the task is then presented to them. They are asked to rank each of the strategies according to how much of the time they used them. Outside of these instructions they are free to indicate any form of ranking. Thus, if they felt they used multiple strategies equally this can be indicated. For example, if three strategies were chosen they could be ranked:

- 1, 2, 3 – where the strategy ranked 1 was used most of the time, followed by the strategy ranked 2, and then the strategy ranked 3.
- 1, 1, 1 – where all strategies were used equally.
- 1, 2, 2 – where one strategy was used the most, and the other two less frequently, but the secondary strategies were used equally.

Question order. The task reminders and strategy selection were presented in two orders (with half the participants doing each order) to reduce the possibility of order effects. For order 1 the task order was: Logical Memory, Rey Figure, Concrete VPA, AI, Abstract VPA, Navigation, RAVLT, Dead or Alive, Scene Construction, Future Thinking. The strategies were listed with the visual imagery strategies first, followed by the verbal strategies. For order 2, the task order was the reverse of order 1, and the strategies were listed starting with the verbal strategies first followed by the visual imagery strategies.

Data Analysis

While a broad range of strategies was provided for each task in order to maximise the opportunity to capture how participants performed (Tables 1-3, supplementary materials, Strategies for each task), it was not practical to analyse all aspects of these data. We therefore applied the following filters to the data from each task:

For the AI, strategies were collected separately for each time period and then combined. For navigation, strategies were collected for each of the individual tasks, and then combined. For the neuropsychological tasks with multiple phases (RAVLT, Logical Memory, Concrete VPA and Abstract VPA) we focused on the strategies used during the delayed recall phase as this matched the delayed recall task performance data to which they were related.

All “Other” responses were examined. If the description closely resembled a strategy that was already listed, this was re-allocated from Other to that strategy. There was no situation where the Other description referred to a new strategy that was not already represented on the list.

For all tasks, we focused specifically on Rank 1 strategies, i.e. the strategy or strategies that the participant used most often and deemed the most important for that task.

Strategy frequency. It was not appropriate to statistically compare the frequency use of all 16 possible strategy sub-categories (Tables 1-3) for each task. Statistical analysis (Chi Square tests thresholded at $p < 0.05$) was therefore performed at the level of the three main strategy categories, namely, Scene Visual Imagery, Other Visual Imagery or Verbal. However, the data relating to all relevant sub-categories is shown in the figures. Note that for this frequency measure, all of the Rank 1 choices of all the participants are reflected in the analyses and figures.

Association of strategies with cognitive task performance. We next investigated whether the use of different strategies influenced performance on the cognitive tasks. As with the strategy frequency analyses, it was not appropriate to statically compare performance across all 16 possible strategy sub-categories for each task, and so we condensed the strategy options for analysis purposes as detailed below.

Strategy group allocation: tasks of primary interest. To investigate the influence of strategy use on performance for the tasks of primary interest, participants were allocated to one of three strategy groups, separately for each task. Given the strategy use distribution identified for these tasks in the strategy frequency analysis (see Results), these were: Immediate Scene Construction, Gradual Scene Construction, and Other (any strategy that was not Immediate or Gradual Scene Construction). The strategy allocation method was guided by numerous previous reports of the benefits of visual imagery on task performance (e.g. Paivio, 1969; 1971, see also Baddeley & Andrade, 2000; Kosslyn, 1980), and our hypothesis relating to the value of scene imagery. Therefore, whenever a participant included Immediate Scene Construction as a Rank 1 strategy, they were allocated to this strategy group, even if they had other Rank 1 strategies. They were allocated to the Gradual Scene Construction strategy group if they indicated this as a Rank 1 strategy without selecting the Immediate Scene Construction strategy among their Rank 1's. Where a participant did not include either an Immediate Scene Construction or a Gradual Scene Construction strategy among their Rank 1's, they were allocated to the Other strategy group.

Strategy group allocation: neuropsychological tasks. As with the tasks of primary interest, participants were allocated to one of three strategy groups, separately for each task. Given the more equal distribution across the main strategy categories identified by the strategy frequency analysis (see Results), these were: Scene Visual Imagery strategy (any participant who indicated using any scene strategy among their Rank 1's); Other Visual Imagery strategy (a participant who selected an Other Visual Imagery strategy and where a Scene Visual Imagery strategy was not included among their Rank 1's); Verbal strategy (a participant who selected a Verbal strategy and where a Scene Visual Imagery strategy or an Other Visual Imagery strategy were not included among their Rank 1's).

Strategy group allocation: alternative methodology. It could be argued that our method of strategy allocation was biased towards the Visual Scene Imagery strategies. To address this issue, we conducted a set of parallel analyses where non-imagery Rank 1 strategies took precedence.

For the tasks of primary interest, a participant was allocated to the Other strategy group if they indicated the use of any strategy that was not Immediate Scene Construction or Gradual Scene Construction among their Rank 1's, even if they also indicated an Immediate Scene Construction or a Gradual Scene Construction strategy as Rank 1's. Allocation to the Immediate Scene Construction strategy group was made in the absence of an Other strategy among the Rank 1's, and to Gradual Scene Construction if they selected this strategy without the selection of either an Other strategy or an Immediate Scene Construction strategy among their Rank 1's.

For the neuropsychological tasks, participants were allocated to the Verbal strategy group if the participant indicated the use of a Verbal strategy among their Rank 1's even if they also indicated the use of a visual imagery strategy as a Rank 1. Allocation to Scene Visual Imagery strategy group was made in the absence of an a Verbal strategy being identified as a Rank 1, and to Other Visual Imagery if they selected this strategy as a Rank 1 in the absence of either a Verbal strategy or a Scene Visual Imagery strategy among their Rank 1's.

Overall, we found that the influence of strategy use on performance was consistent regardless of how participants were allocated to a strategy group. Consequently, in the main text, we report the results where participants were allocated to a visual imagery group whenever such imagery was identified as Rank 1, and we provide a summary of the results using the alternative method of strategy allocation. Full details of the results where the alternative method of strategy allocation was used are provided in the supplementary materials.

Statistical analyses. For each task, following the allocation of participants to a particular strategy category, the strategy groups were first examined for any differences in age, gender proportion, FSIQ and Matrix Reasoning scores using univariate ANOVAs, and Chi Square tests for gender. Where a difference was identified on a measure (at $p < 0.05$), it was then included as a covariate in the main performance analysis.

Task performance across the strategy groups was compared using univariate ANOVAs (or ANCOVA where appropriate), with follow-up Bonferroni corrected t-tests. Where data were not normally distributed (RAVLT, Concrete VPA), the equivalent non-parametric tests were used. There were no missing data, and no data needed to be removed from any analysis.

Results

The performance data from the cognitive tasks have been presented in previous papers that addressed completely different research questions to those under consideration here (Clark et al., 2019; Clark & Maguire, in press). The previous research questions assessed the relationships between scene construction, future thinking, autobiographical memory and navigation in terms of task performance (Clark et al., 2019), and how questionnaire data were related to task performance on each of the aforementioned tasks (Clark & Maguire, in press). By contrast, here, we examined the strategies individuals used to perform the tasks and the effects of strategy use on task performance. The strategy data have not been included in any previous paper.

Cognitive Tasks

A summary of the performance on the cognitive tasks is presented in Table 4. For all tasks (with the exception of Concrete VPA, where performance was close to ceiling) there was a wide range of scores, suggesting substantial variation between the participants. We next asked whether differences in strategy use were related to task performance.

Table 4. Mean scores, with 95% confidence intervals (CI), for performance on the cognitive tasks.

Task	**Mean**	**Lower CI**	**Upper CI**
Scene Construction Experiential Index (/60)	40.50	29.50	50.13
Autobiographical Memory Internal Details (total number)	23.95	13.80	37.42
Autobiographical Memory Vividness (/6)	4.62	3.38	5.80
Future Thinking Experiential Index (/60)	39.12	25.00	49.99
Navigation (/250)	143.46	88.90	201.50
Rey Auditory Verbal Learning Task delayed recall (/15)	12.92	8.90	15.00
Logical Memory delayed recall scaled score (/19)	12.58	8.00	17.00
Concrete Verbal Paired Associates delayed recall (/14)	12.94	8.00	14.00
Abstract Verbal Paired Associates delayed recall (/14)	7.03	1.00	13.10
Rey-Osterrieth Complex Figure delayed recall (/36)	22.28	12.45	31.00
Dead or Alive proportion correct (%)	81.32	66.12	94.52
Full Scale Intelligence Quotient*	102.75	92.04	114.35
Matrix Reasoning scaled score (/19)	12.53	8.00	17.00

Note. Task order is for display purposes only. *The Full Scale Intelligence Quotient is estimated from the Test of Premorbid Functioning.

Strategy Frequency

Tasks of primary interest. We first examined strategy use across each of the tasks of primary interest (scene construction, autobiographical memory, future thinking and navigation). As shown in Figure 1, for all of these tasks there was a preference for Scene Visual Imagery strategies, shown in green [Scene construction: *Scene Visual Imagery strategies* = 82.15%; *Other Visual Imagery strategies* = 8.61%; *Verbal strategies* = 9.27%; χ^2 (2) = 323.47, p < 0.001; Autobiographical memory: *Scene Visual Imagery strategies* = 66.20%; *Other Visual Imagery strategies* = 20.12%; *Verbal strategies* = 13.68%; χ^2 (2) = 244.64, p < 0.001; Future thinking: *Scene Visual Imagery strategies* = 81.48%; *Other Visual Imagery strategies* = 9.09%; *Verbal strategies* = 9.43%; χ^2 (2) = 309.84, p < 0.001; Navigation: *Scene Visual Imagery strategies* = 49.12%; *Other Visual Imagery strategies* = 28.24%; *Verbal strategies* = 22.64%; χ^2 (2) = 100.2, p < 0.001]. In particular, the Immediate

Scene Construction and Gradual Scene Construction strategies were prominent. This provides the first detailed evidence that individuals use scene imagery strategies in all of these tasks.

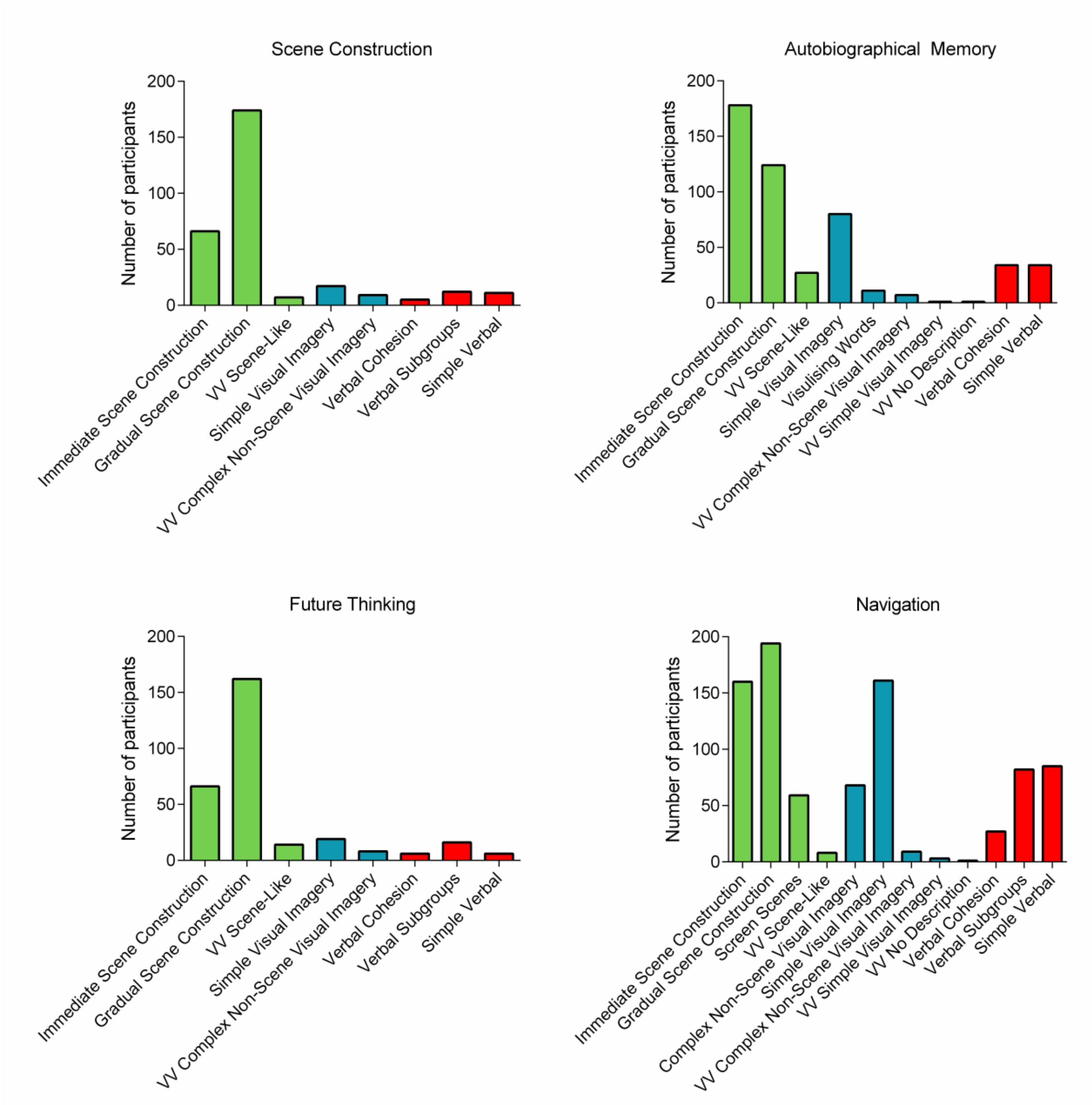

Figure 1. Rank 1 strategy choices for scene construction, autobiographical memory, future thinking and navigation. Green bars represent Scene Visual Imagery strategies, blue bars Other Visual Imagery strategies and red bars Verbal strategies. Note that participants could choose and rank as many strategies as they wished for each task. VV = Vague Visual.

Neuropsychological tasks. As shown in Figure 2, there was a wider variety of strategy use for the neuropsychological tasks compared to the tasks of primary interest described above. For the RAVLT, there was an approximately equal spread of strategy use across Scene Visual Imagery, Other Visual Imagery and Verbal strategies [*Scene Visual Imagery strategies* = 36.41%; *Other Visual Imagery strategies* = 31.65%; *Verbal strategies* = 31.93%; χ^2 (2) = 1.53, p =0.47]. This is particularly noteworthy as the RAVLT is typically thought of as a verbal memory task.

For the Logical Memory task, there was a greater use of Verbal over Scene Visual Imagery and Other Visual Imagery strategies, although the extent of Scene Visual Imagery use is again notable given the verbal nature of the tasks [*Scene Visual Imagery strategies* = 37.89%; *Other Visual Imagery strategies* = 11.08%; *Verbal strategies* = 51.03%; χ^2 (2) = 96.5, $p < 0.001$].

In contrast, for the Concrete VPA, there was a considerable preference for the imagery based strategies, in particular Scene Visual Imagery [*Scene Visual Imagery strategies* = 44.82%; *Other Visual Imagery strategies* = 29.97%; *Verbal strategies* = 25.21%; χ^2 (2) = 22.40, $p < 0.001$]. On the other hand, and in line with our expectations, the Abstract VPA showed a greater representation of Verbal strategies [*Scene Visual Imagery strategies* = 21.73%; *Other Visual Imagery strategies* = 20.06%; *Verbal strategies* = 58.22%; χ^2 (2) = 100.18, $p < 0.001$].

The Rey Figure showed a different strategy profile to the other neuropsychological tasks. Here, the Other Visual Imagery strategies were used the most [*Scene Visual Imagery strategies* = 25.28%; *Other Visual Imagery strategies* = 65.45%; *Verbal strategies* = 9.27%; χ^2 (2) = 178.93, $p < 0.001$], and in particular, the Complex Non-Scene Visual Imagery strategy. Scene Visual Imagery strategies on the other hand were deployed less often. Unsurprisingly, given the nature of the task, Verbal strategies were rarely used.

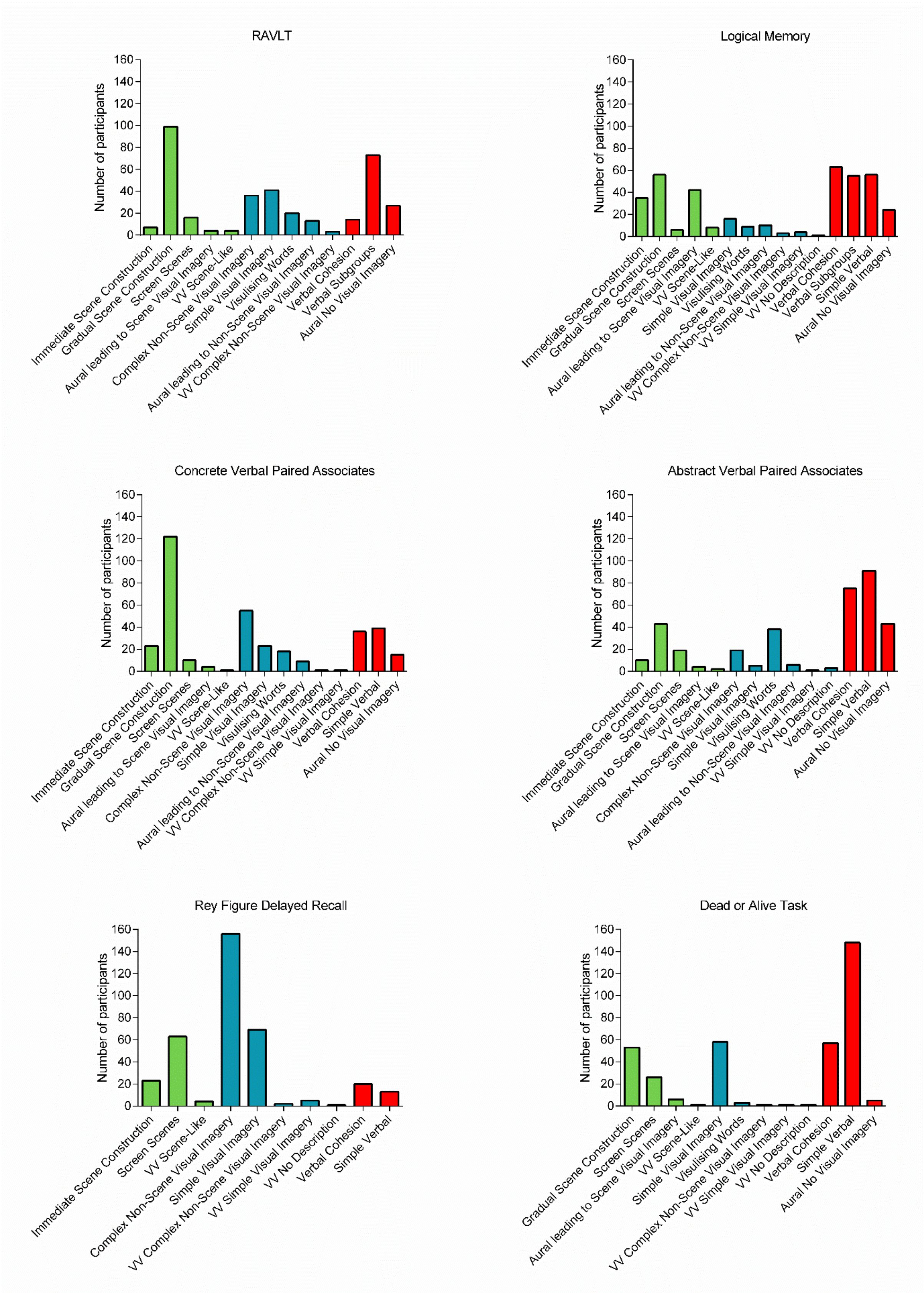

Figure 2. Rank 1 strategy choices for the neuropsychological tasks. Green bars represent Scene Visual Imagery strategies, blue bars Other Visual Imagery strategies and red bars Verbal strategies. Note that participants could choose and rank as many strategies as they wished for each task. VV = Vague Visual.

Finally, for the Dead or Alive task, Verbal strategies were most common [*Scene Visual Imagery strategies* = 23.89%; *Other Visual Imagery strategies* = 17.78%; *Verbal strategies* = 58.33%; χ^2 (2) = 103.27, p < 0.001]. However, visual imagery strategies were still evident to some degree, with both Scene Visual Imagery and Other Visual Imagery strategies reported.

In summary, for the neuropsychological tasks, we observed different patterns of strategy use for the different tasks. For the RAVLT, no strategy category was used more than the others, for the Logical Memory task, Verbal strategies were used the most, for the Concrete VPA the preference was for Scene Visual Imagery strategies, and for the Abstract VPA it was for Verbal strategies. The overarching belief that all of these tasks measure verbal memory performance seems, therefore, to be overly-simplistic. On the other hand, the Rey Figure and Dead or Alive tasks showed the expected patterns of strategy frequency. For the Rey Figure, Other Visual Imagery strategies were used the most, while for the Dead or Alive task it was Verbal strategies.

Association of strategies with cognitive task performance

Tasks of primary interest. As described in the method section, to look at the effects of strategy use on performance, participants were allocated to one of three strategy groups, separately for each task. Given the strategy use distribution described above (see Figure 1) these were: Immediate Scene Construction, Gradual Scene Construction or Other.

Scene construction. For the scene construction task, 66 participants were allocated to the Immediate Scene Construction strategy group, 139 to the Gradual Scene Construction strategy group and 12 to the Other strategy group. Before examining performance of the strategy groups, we compared them for age, gender, FSIQ and Matrix Reasoning scores. No differences on any of these measures were identified (see supplementary materials Table S5).

We assessed performance on the scene construction task using a univariate ANOVA finding a significant effect of strategy group [Figure 3; *Strategy group*: $F(2,214) = 18.91$, $p < 0.001$, $\eta^2 = 0.15$]. Bonferroni corrected follow-up t-tests identified significant differences between all the strategy groups [*Immediate Scene Construction vs. Gradual Scene Construction*: mean difference = 2.48, 95% CI (0.45, 4.51), p = 0.011, d = 0.44; *Immediate Scene Construction vs. Other*: mean difference = 10.71, 95% CI (6.45, 14.98), p < 0.001, d = 1.97; *Gradual Scene Construction vs. Other*: mean difference = 8.23, 95% CI (4.14, 12.32), p < 0.001, d = 1.52].

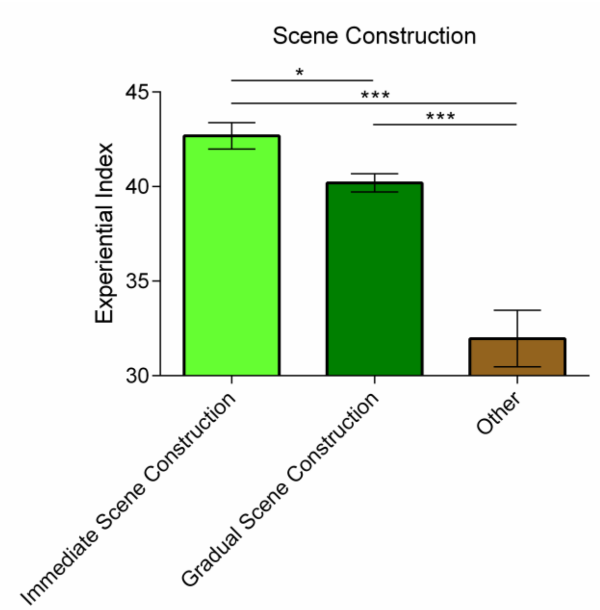

Figure 3. Mean scene construction scores for the three strategy groups. $^{***}p < 0.001$, $^{*}p < 0.05$, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Allocation to a strategy group by the alternative method revealed the same pattern of performance, where those in the Immediate Scene Construction strategy group scored significantly better than both the Gradual Scene Construction and Other strategy groups (see supplementary materials, Table S6 and Figure S1 for details). However, while performance was higher in the Gradual Scene Construction group than the Other strategy group, this difference was not significant.

In summary, regardless of how participants were allocated to a strategy group, individuals using an Immediate Scene Construction strategy performed best on the scene construction task. In addition, when using the main strategy allocation method, individuals who used a Gradual Scene Construction strategy also performed better than those who did not use a scene strategy.

Autobiographical memory. For the AI, 178 participants were allocated to the Immediate Scene Construction strategy group, 27 to the Gradual Scene Construction strategy group and 12 to the Other strategy group. Comparison of the strategy groups showed no differences in terms of age, FSIQ and Matrix Reasoning, but there was a difference in gender proportion (see supplementary materials Table S7).

Comparison of performance on the AI was made using a univariate ANCOVA with gender as a covariate. For internal details, no effect of strategy group or gender was found [Figure 4; S*trategy group:* $F(2,213) = 0.89$, $p = 0.41$; *Gender:* $F(1,213) = 3.02$, $p = 0.084$]. However, for vividness, a significant effect of strategy group, but not gender, was identified [Figure 4; S*trategy group* $F(2,213) = 31.27$, $p < 0.001$, $\eta^2 = 0.23$; *Gender*: $F(1,213) = 0.17$, $p = 0.68$].

Bonferroni corrected follow-up t-tests for AI vividness showed significantly higher vividness ratings for the Immediate Scene Construction strategy group in comparison to both the Gradual Scene Construction and Other strategy groups [*Immediate Scene Construction vs. Gradual Scene Construction*: mean difference = 0.77, 95% CI (0.44, 1.09), $p < 0.001$, $d = 1.17$; *Immediate Scene Construction vs. Other*: mean difference = 1.17, 95% CI (0.70, 1.65), $p < 0.001$, $d = 1.79$], but no difference between the Gradual Scene Construction and Other strategy groups [mean difference = 0.41, 95% CI (-0.15, 0.96), $p = 0.23$].

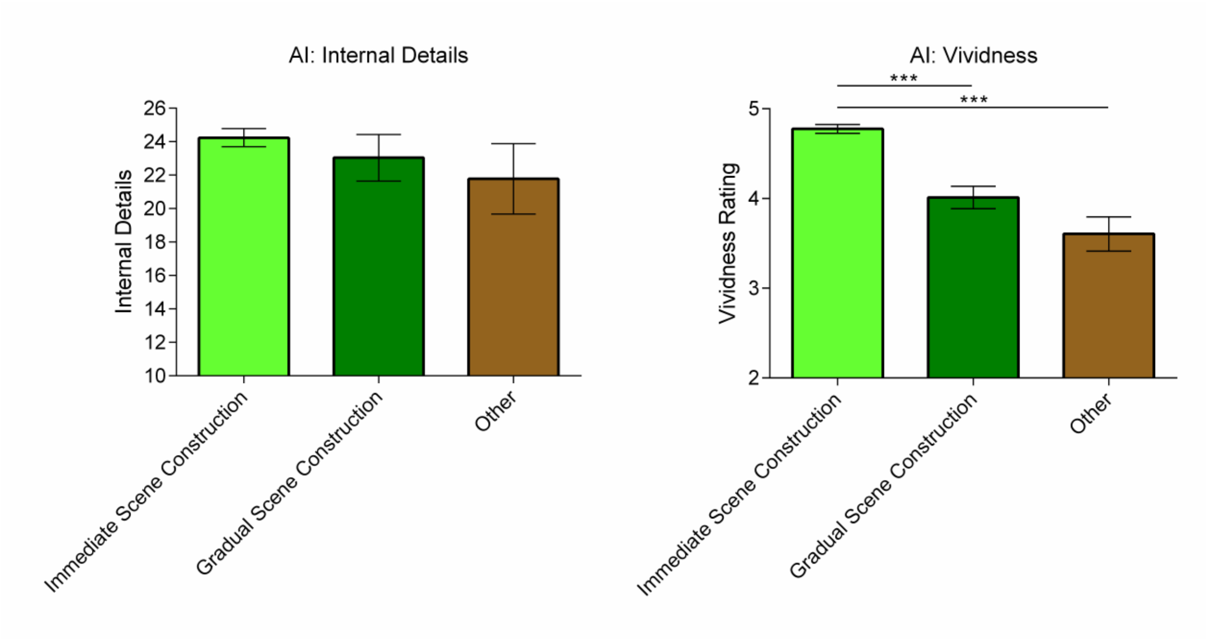

Figure 4. Mean autobiographical memory performance, as measured by the number of internal details and vividness ratings for each strategy group, with gender taken into account. Vividness ratings were on a 6 point scale from 1 (Vague memory, no recollection) to 6 (Extremely clear as if it's happening now). AI = Autobiographical Interview. $^{***}p < 0.001$, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Allocation to strategy group by the alternative method revealed a slightly different set of results. For the number of internal details, performance of the Immediate Scene Construction strategy group was significantly greater than for the Other strategy group. In relation to the vividness ratings, both the Immediate Scene Construction and Gradual Scene Construction strategy groups had higher scores than the Other strategy group (see supplementary materials, Table S8 and Figure S2 for details).

In summary, use of an Immediate Scene Construction was associated with higher autobiographical memory recall scores. For our main strategy allocation method, this was only evident for autobiographical memory vividness. For the alternative allocation method, this was observed for both internal details and vividness.

Future thinking. For the future thinking task, 66 participants were allocated to the Immediate Scene Construction strategy group, 134 to the Gradual Scene Construction strategy group and 17 to the Other strategy group. Comparison of age, gender, FSIQ and Matrix Reasoning found no differences across the strategy groups (see supplementary materials Table S9 for details).

Performance on the future thinking task was compared across the strategy groups using a univariate ANOVA, and revealed a significant effect of strategy group [Figure 5; $F(2,214) = 6.71$, $p = 0.001$, $\eta^2 = 0.059$]. Bonferroni corrected follow-up t-tests showed significant differences between the Immediate Scene Construction strategy group and the other two groups [*Immediate Scene Construction vs. Gradual Scene Construction*: mean difference = 3.19, 95% CI (0.63, 5.75), $p = 0.009$, $d = 0.60$; *Immediate Scene Construction vs. Other*: mean difference = 5.86, 95% CI (1.24, 10.49), $p = 0.008$, $d = 0.81$] with no difference between the Gradual Scene Construction and Other strategy groups [mean difference = 2.67, 95% CI (-1.71, 7.05), $p = 0.43$].

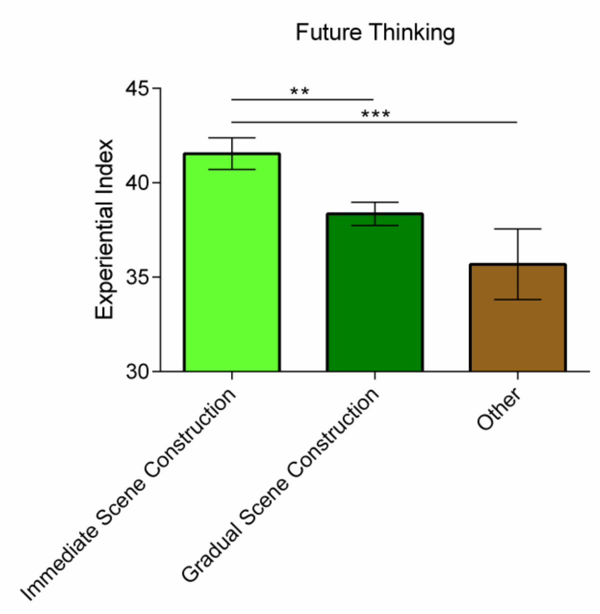

Figure 5. Mean future thinking performance for each strategy group. $^{***}p < 0.001$, $^{**}p < 0.01$, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Allocation to strategy group by the alternative method showed the same pattern of performance, with those in the Immediate Scene Construction strategy group performing better than both the Gradual Scene Construction and Other strategy groups (see supplementary materials, Table S10 and Figure S3 for details).

In summary, regardless of how participants were allocated to strategy group, individuals who used an Immediate Scene Construction strategy performed best on the future thinking task.

Navigation. For navigation, 160 participants were allocated to the Immediate Scene Construction strategy group, 49 to the Gradual Scene Construction strategy group and 8 to the Other strategy group. Comparison of the strategy groups found a difference in gender, but no differences in age, FSIQ or Matrix Reasoning (supplementary materials Table S11).

Navigation performance was compared across the strategy groups using a univariate ANCOVA with gender as a covariate, and revealed a significant effect of strategy group [Figure 6; $F(2,213) = 9.81$, $p < 0.001$, $\eta^2 = 0.084$] with no effect of gender [$F(1,212) = 0.096$, $p = 0.76$]. Bonferroni corrected follow-up t-tests showed significant differences between the Immediate Scene Construction strategy group and the other two strategy groups [*Immediate Scene Construction vs. Gradual Scene Construction*: mean difference = 22.71, 95% CI (8.67, 36.75), $p < 0.001$, $d = 0.65$; *Immediate Scene Construction vs. Other*: mean difference = 33.51, 95% CI (3.02, 63.99), $p = 0.026$, $d = 0.96$] with no difference between the Gradual Scene Construction and Other strategy groups [mean difference = 10.79, 95% CI (-20.82, 42.40), $p = 1.0$].

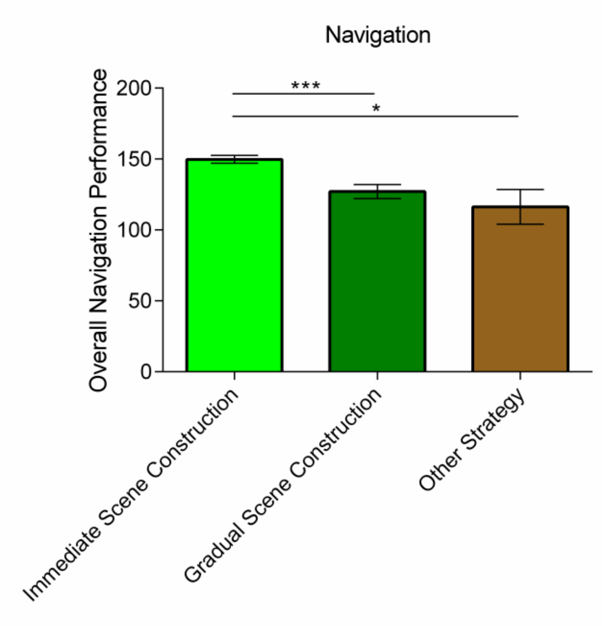

Figure 6. Mean overall navigation performance of the strategy groups, with gender taken into account. $^{***}p < 0.001$, $^{*}p < 0.05$, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Allocation to strategy group by the alternative method revealed the same pattern of performance, with those in the Immediate Scene Construction strategy group performing better than both the Gradual Scene Construction and Other strategy groups (see supplementary materials, Table S12 and Figure S4 for details).

In summary, regardless of how participants were allocated to strategy groups, the use of an Immediate Scene Construction strategy was associated with the highest performance on the navigation task.

Overall summary for strategy use and performance on the tasks of primary interest. Across all of the tasks of primary interest, there was a consistent performance advantage when using an Immediate Scene Construction strategy. This effect could not be explained by general intelligence or demographic factors, or the method by which participants were allocated to strategy groups.

Neuropsychological tasks. As described in the method section, to examine the effects of strategy use on performance, participants were allocated to one of three strategy groups, separately for each task. Given the strategy use distribution described above (see Figure 2) these were: Scene Visual Imagery strategy, Other Visual Imagery strategy or Verbal strategy.

RAVLT. For this task, 114 participants were allocated to the Scene Visual Imagery strategy group, 55 to the Other Visual Imagery strategy group and 48 to the Verbal strategy group. There were no differences in gender, FSIQ and Matrix Reasoning across the strategy groups, but differences in age were identified (see supplementary materials Table S13).

As performance scores on the RAVLT were not normally distributed, a Kruskal-Wallis test was used to compare performance, finding a significant effect of strategy group [χ^2 (2) =21.41, $p < 0.001$]. Follow-up Dunn-Bonferroni tests showed significant differences between the Scene Visual Imagery strategy group and the other two groups [*Scene Visual Imagery vs. Other Visual Imagery*: Dunn-Bonferroni = 44.67, $p < 0.001$, $r = 0.34$; *Scene Visual Imagery vs. Verbal*: Dunn-Bonferroni = 27.91, $p = 0.025$, $r = 0.21$] with no difference between the Other Visual Imagery strategy group and the Verbal Strategy group [Dunn-Bonferroni = 16.76, $p = 0.50$].

As the Kruskal-Wallis test cannot include covariates, but differences in age were identified between the groups, we also performed a regression analysis to see if age was associated with performance and consequently whether age could be affecting the results. No relationship between age and performance was identified [$F(1,215) = 1.52$, $p = 0.22$, $R^2 = 0.007$], suggesting that the differences in performance between the strategy groups were driven by the strategy used and not age.

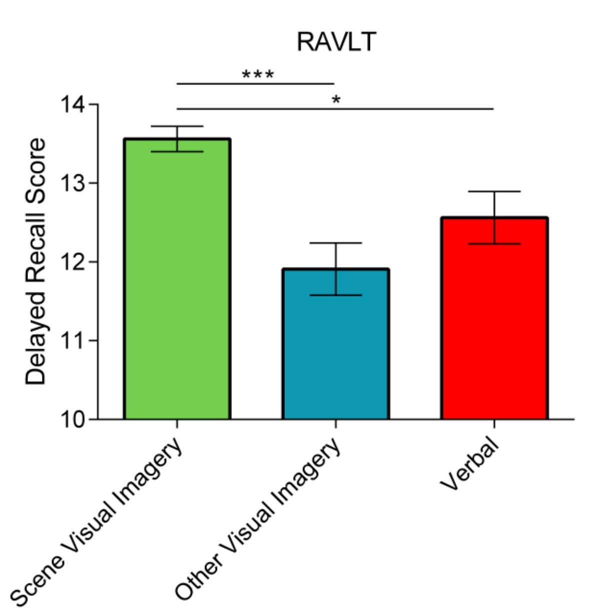

Figure 7. Mean RAVLT delayed recall scores for each strategy group. $^{***}p < 0.001$, $^{*}p < 0.05$, Dunn-Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Allocation to strategy group by the alternative method revealed the same pattern of results, with higher performance in the Scene Visual Imagery strategy group than both the Other Visual Imagery and Verbal strategy groups (see supplementary materials, Table S14 and Figure S5 for details).

In summary, regardless of how participants were allocated to a strategy group, a Scene Visual Imagery strategy was associated with better performance on the RAVLT delayed recall.

Logical Memory. For this task, 112 participants were allocated to the Scene Visual Imagery strategy group, 20 to the Other Visual Imagery strategy group and 85 to the Verbal strategy group. No differences were identified between the groups in terms of age, gender, FSIQ and Matrix Reasoning (see supplementary materials Table S15).

Comparison of performance using a univariate ANOVA found no differences between the strategy groups [Figure 8; $F(2,214) = 2.77$, $p = 0.065$].

Allocation to strategy group by the alternative method also revealed no differences in performance between the strategy groups (see supplementary materials, Table S16 and Figure S6 for details).

In summary, regardless of how participants were allocated to strategy group, strategy use did not affect performance on the Logical Memory task.

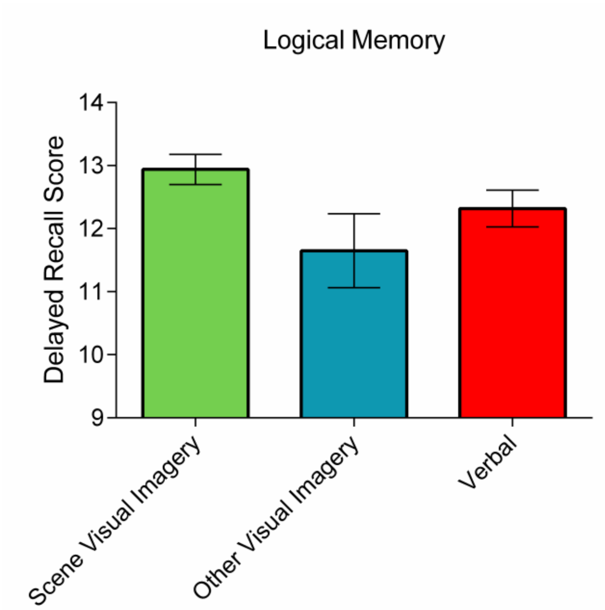

Figure 8. Mean Logical Memory delayed recall scores of the strategy groups. Error bars show the standard error of the mean.

Concrete VPA. For this task, 134 participants were allocated to the Scene Visual Imagery strategy group, 40 to the Other Visual Imagery strategy group and 43 to the Verbal strategy group. Comparisons between strategy groups showed that there were no differences in age, gender, FSIQ and Matrix Reasoning (see supplementary materials Table S17 for details).

As performance scores on the Concrete VPA task were not normally distributed, comparison of performance across the strategy groups was made using a Kruskal-Wallis test, finding no effect of strategy group [Figure 9; χ^2 (2) = 4.32, p = 0.12].

Allocation to a strategy group by the alternative method, also found no differences in performance between the strategy groups (see supplementary materials, Table S18 and Figure S7 for details).

In summary, regardless of how participants were allocated to strategy group, strategy use did not affect performance on the Concrete VPA. However, it should be borne in mind that the scores on the Concrete VPA task were close to ceiling.

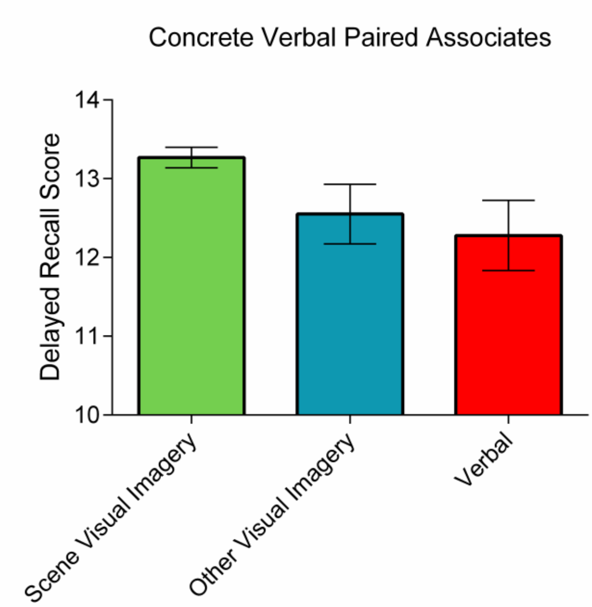

Figure 9. Mean Concrete VPA delayed recall scores for each strategy group. Error bars show the standard error of the mean.

Abstract VPA. For this task, 66 participants were allocated to the Scene Visual Imagery strategy group, 36 to the Other Visual Imagery strategy group and 115 to the Verbal strategy group. There were no differences in age, gender, FSIQ and Matrix Reasoning across the strategy groups (see supplementary materials Table S19).

Comparison of Abstract VPA performance across the strategy groups was made using a univariate ANOVA, and showed no effect of strategy group [Figure 10; $F(2,214) = 1.86$, $p = 0.16$].

Allocation to a strategy group by the alternative method also found no effect of strategy group (see supplementary materials, Table S20 and Figure S8 for details).

Overall, therefore, regardless of how participants were allocated to a strategy group, the strategy used had no bearing on Abstract VPA task performance.

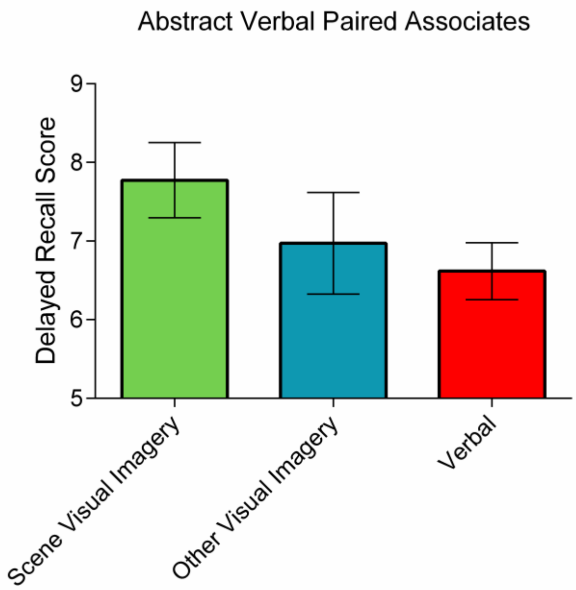

Figure 10. Mean Abstract VPA delayed recall scores for the strategy groups. Error bars show the standard error of the mean.

Rey Figure. For the Rey Figure delayed recall, 74 participants were allocated to the Scene Visual Imagery strategy group, 133 to the Other Visual Imagery strategy group and 10 to the Verbal strategy group. There were no differences between the groups for age, gender, FSIQ and Matrix Reasoning (see supplementary materials Table S21).

Comparison of performance on the Rey Figure delayed recall was made using a univariate ANOVA, and there was no effect of strategy group on performance [Figure 11; $F(2,214) = 0.23$, $p = 0.79$].

Allocation to a strategy group by the alternative method also showed the same pattern of performance, with no differences between the strategy groups (see supplementary materials, Table S22 and Figure S9 for details).

In summary, regardless of how participants were allocated to strategy group, strategy use did not seem to influence performance on the Rey Figure delayed recall.

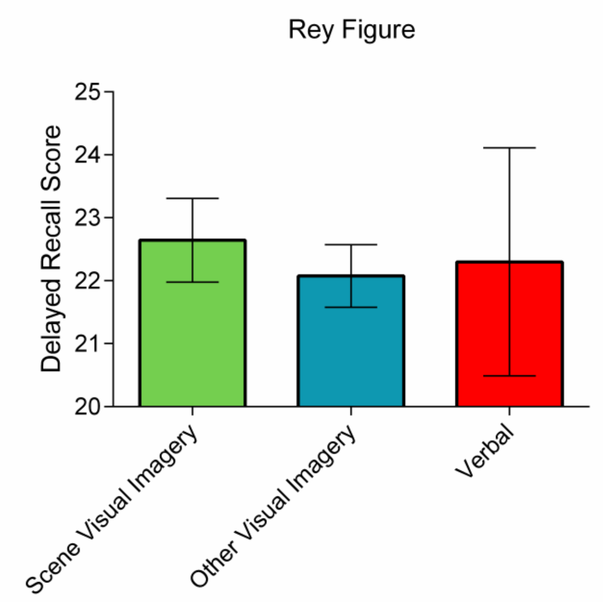

Figure 11. Mean Rey Figure delayed recall for the strategy groups. Error bars show the standard error of the mean.

Dead or Alive task. For this task, 63 participants were allocated to the Scene Visual Imagery strategy group, 41 to the Other Visual Imagery strategy group and 113 to the Verbal strategy group. There were no differences between the groups for age or FSIQ, however, differences were found in gender proportion and Matrix Reasoning scores (see supplementary materials, Table S25).

Comparison of performance on the Dead or Alive task was made using a univariate ANCOVA with gender and Matrix Reasoning as covariates, and found no significant effect of strategy group or Matrix Reasoning [Figure 12; *Strategy group*: $F(2,212) = 0.53$, $p = 0.59$; *Matrix Reasoning*: $F(1,212) = 0.89$, $p = 0.35$], however, there was a significant effect of gender [$F(1,212) = 4.40$, $p = 0.037$, $\eta^2 = 0.020$]. A follow-up t-test revealed that overall, male participants had higher scores than females [Mean proportion correct $_{\text{Males}}$ = 82.61%; Mean proportion correct $_{\text{Females}}$ = 80.05%; mean difference = 2.57, 95% CI (0.33, 4.81), $t(215) = 2.26$, $p = 0.025$, $d = 0.31$].

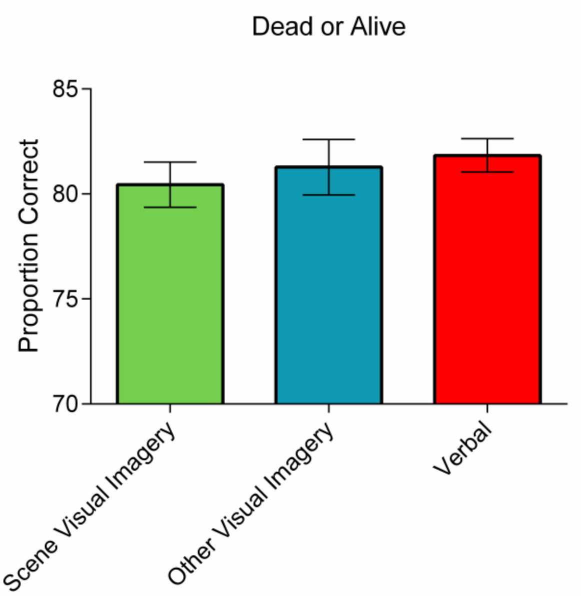

Figure 12. Mean Dead or Alive proportion correct for each strategy group, with gender and Matrix Reasoning scores taken into account. Error bars show the standard error of the mean.

Allocation to a strategy group by the alternative method, however, did result in a significant effect of strategy group, with the Verbal strategy group having higher performance than the Scene Visual Imagery strategy group (see supplementary materials, Table S24 and Figure S10 for details).

In summary, strategy use for the Dead or Alive task had a different effect on performance depending on the methodology used to allocate participants to a strategy group. When giving precedence to the Scene Visual Imagery strategy, no differences in performance were identified. However, when using the alterative allocation method, the Verbal strategy group showed higher performance than the Scene Visual Imagery strategy group.

Importantly, in line with our predictions, Scene Visual Imagery strategies did not benefit task performance regardless of the allocation method.

Overall summary for strategy use and performance on the neuropsychological tasks. For the neuropsychological tasks there was a more limited effect of strategy use on performance. For the RAVLT, the use of a Scene Visual Imagery strategy was associated with better performance, regardless of the methodology used to allocate participants to a strategy group. This is of particular interest as the RAVLT is typically thought of as a test of verbal memory not visual imagery. These results question that distinction. However, for the other neuropsychological tasks, strategy use did not affect performance when using the main method of strategy allocation. When using the alternate method, the only difference was for the Dead or Alive task, where the use of a Verbal strategy was found to be beneficial.

Discussion

The aim of this study was to examine the strategies that healthy participants described deploying when they performed a range of cognitive tasks, with a view to gaining insights into one source of individual differences. Given the lack of an in-depth, formal protocol for eliciting strategy information, we first devised such a procedure and then applied it to ten tasks. We found that across tasks, the most consistently used strategy was Scene Visual Imagery, and this was evident even for some tests that are typically regarded as verbal. The results also showed that the use of Scene Visual Imagery strategies was associated with significantly better performance on a number of tests.

For each task of primary interest – scene construction, autobiographical memory, future thinking and navigation – Scene Visual Imagery strategies, in particular the Immediate and Gradual Scene Construction strategy sub-categories, were employed significantly more often than any other type of strategy. This finding provides the first detailed evidence that

Scene Visual Imagery dominates during these hippocampal-dependent tasks, and accords with the view that the construction of Scene Visual Imagery may be one key process performed by the hippocampus (e.g. Clark et al., 2019; Clark & Maguire, in press; Hassabis & Maguire, 2007; Maguire & Mullally, 2013).

We also found that the use of an Immediate Scene Construction strategy led to the best performance on these four tasks. We note that for autobiographical memory recall, when using our main strategy allocation, it was ratings of autobiographical memory vividness rather than the number of internal details generated that were most associated with strategy use. However, when employing the alternative strategy allocation method, the Immediate Scene Construction strategy was, like the other tasks, associated with significantly higher internal detail scores as well as vividness ratings. Across the four tasks, these results were not explained by general intelligence or demographic factors, or (with the exception of AI internal details) the method by which participants were allocated to the strategy groups. These findings extend previous work that highlighted the benefits of visual imagery for autobiographical memory, future thinking and navigation (Andrews-Hanna et al., 2014; Arnold et al., 2011; Greenberg & Knowlton, 2014; Hebscher et al., 2017; Kraemer et al., 2017; Robin & Moscovitch, 2014; Robin et al., 2016; Sheldon & Chu, 2017; Szpunar & McDermott, 2008). Specifically, and in the most comprehensive manner yet with our in-depth strategy protocol, we were able to pinpoint that it is the spontaneous use of full visual scenes that is most likely to enhance performance on these tasks.

The hippocampus is not only associated with scene construction, autobiographical memory, future thinking and navigation. It has also been linked with performance on a number of neuropsychological tasks. Of particular interest are those neuropsychological tasks believed to measure verbal memory. Performance on these tasks is typically impaired following damage to the hippocampus, but it is unclear if visual imagery strategies have relevance for their performance. Here, we found that for the word list learning RAVLT, there was an approximately equal use of different strategy categories, but those participants who used a Scene Visual Imagery strategy performed significantly better at delayed recall. Similarly, for the Concrete VPA task, Scene Visual Imagery strategies were used the most, although strategy had no effect on performance (however, performance on this task was close to ceiling which may explain this finding).

These results, therefore, suggest that the RAVLT and Concrete VPA task cannot be characterised as wholly verbal tests, given the prevalence, and influence, of Visual Scene Imagery strategies in both cases. To some extent, this is also true for the Logical Memory task. Verbal strategies were more prevalent during performance of this task, and strategy use did not affect performance. However, a sizeable proportion (~38%) of the strategies used were Scene Visual Imagery strategies. This stands in contrast to the Abstract VPA – a verbal memory task specifically designed to reduce the use of imagery – where Verbal strategies predominated, and there was a much lower use (~22%) of Scene Visual Imagery strategies.

Overall, the analysis of strategy use during the verbal neuropsychological tasks accords with the view that the impaired performance observed on some verbal memory tasks in hippocampal-damaged patients may be in part related to their reduced ability to construct scene imagery rather than a primary deficit in verbal memory per se (see also Clark et al., 2018; Clark & Maguire, 2016; Maguire & Mullally, 2013).

We also examined two other neuropsychological tests – the Rey Figure and the Dead or Alive task. For the Rey Figure, the most common strategy was Other Visual Imagery, where participants used visual imagery to perform the task, but there was no sense of depth or background to the image. No relationship between strategy use and performance was identified. Recent work has highlighted that 2D spatial arrays that are not scenes are processed by the posterior hippocampus, while 3D scenes are processed by the anterior hippocampus (Dalton et al., 2018; see also Zeidman & Maguire, 2016). The Rey Figure is a clear example of a non-scene array, and our findings provide further support for these distinctions. Hence, it may be that lesions that encroach upon the posterior hippocampus in particular may lead to impaired performance on the Rey Figure delayed recall (e.g. Spiers et al., 2001).

Finally, the Dead or Alive task was included as a measure of semantic memory and, as such, is the second task (along with the Abstract VPA) thought to be hippocampal-independent that we included in the study. Verbal strategies were most common during the Dead or Alive task and, when allocating to strategy group via the alternative methodology, a beneficial effect of using Verbal over Scene Visual Imagery strategies was identified. As with the Abstract VPA task, these Dead or Alive test findings align with the suggestion that Scene Visual Imagery strategies might only be evoked when the task is hippocampal-dependent. Moreover, the use of verbal over visual strategies is in line with the semantic and episodic/autobiographical memory dichotomy, with hippocampal involvement being predominant for the latter (Binder & Desai, 2011; Binder, Westbury, McKiernan, Possing, & Medler, 2005; Svoboda, McKinnon, & Levine, 2006; Tulving, 2002; Wang, Conder, Blitzer, & Shinkareva, 2010).

In summary, our results demonstrate the value of scrutinising strategy use in relation to cognitive task performance. By collecting strategy information across four seemingly different real-world tests, which are linked by their reliance upon the hippocampus, we have shown that the use of Scene Visual Imagery is common to all of them, and that the use of an Immediate Scene Construction strategy in particular improves performance. Our results, therefore, support the notion that at least one of the key functions performed by the human hippocampus may be the construction of scene imagery. The neuropsychological task findings also illustrate that tests do not always fit into clear categories, with the RAVLT and

Concrete VPA, for example, appearing to be more visual than verbal. Measures of performance or neural activity when using these tasks may, therefore, reflect an ability to construct visual scenes rather than verbal processing. We suggest that the methodology devised and deployed here to collect strategy information could offer researchers the opportunity to obtain strategy data in a controlled and principled manner. By modifying the generalised strategy statements shown in Tables 1-3 for a task being studied, in-depth strategy information can be collected in a short addendum to the experimental procedure that might help to guide or constrain the conclusions that are drawn.

Here, we considered only Rank 1 strategies – the strategies participants indicated were the most important to them for performing the task. Future work could also investigate the interactions between different strategy ranks and the effects on performance. Cognition is often multimodal, and the effects of using strategies from multiple category groups (e.g. a Scene Visual Imagery and a Verbal strategy) would also be interesting to examine. The strategy classification system we devised reflects our interests in understanding the potential influence of scene imagery on hippocampal-dependent tasks. We acknowledge that there may be different ways to classify the strategies to permit assessment of other aspects of these data that were not under consideration here. We note that strategy use is only one possible source of individual differences, and in this study we examined strategies that could be explicitly described by participants, while acknowledging that implicit processing likely also plays a role in task performance. We also alluded throughout to task-hippocampal relationships without measuring the hippocampus itself. We felt able to do this because of the many previous findings associating (or not associating) the hippocampus with these tasks. Moreover, understanding the strategies used to perform these tasks is not reliant upon hippocampal measurement. However, directly assessing the effects of different strategy use on structural and functional measurements of the hippocampus will be an important next step.

In conclusion, here we showed that analysing strategies can illuminate our understanding of the processes underpinning widely-used cognitive tests, as well as informing individual differences and psychological theories. We advocate the interrogation of strategy use more routinely in order to increase the benefits that arise from this important dimension of cognition.

Context

The current study is part of a body of work investigating the relationships between a range of cognitive functions that have individually been associated with a brain structure called the hippocampus. There is debate about what role the hippocampus plays in the tasks tapping into these diverse aspects of cognition. Here, we conducted a detailed analysis of the explicit strategies used by participants to perform a wide range of cognitive tasks, some of which are widely held to be hippocampal-dependent. We demonstrated the consistent use of Scene Visual Imagery strategies for tasks typically associated with the hippocampus including autobiographical memory, future thinking and navigation, as well as for other tests that are often held to measure verbal rather than visuospatial memory. Future work aims to build on these findings by examining how variations in task performance and strategy use may be related to structural and functional measurements of the hippocampus and the wider brain.

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Clark et al. Supplementary Materials

Supplementary Methods

Table S1. Double scoring of the scene construction task.

	Rating				
	Spatial References	**Entities Present**	**Sensory Descriptions**	**Thoughts/ Emotions/Actions**	**Quality Ratings**
For each individual scene					
n = 308	0.90	0.96	0.94	0.90	0.90
For each individual participant (i.e. score is averaged across the seven scenes)					
n = 44	0.91	0.99	0.97	0.91	0.93

Inter-class correlation coefficients from a two way random effect model looking for absolute agreement for each content score and for the quality ratings. Four experimenters scored the whole data set (n = 217 participants, 1519 individual scenes) with double scoring performed on 20% of the data (n = 44 participants, 308 scenes) proportionally for each original experimenter.

Table S2. Double scoring of the Autobiographical Interview (AI).

	Rating					
	Internal Event	**Internal Place**	**Internal Time**	**Internal Perceptual**	**Internal Emotion**	**Internal Sum**
For each individual memory						
n = 215	0.92	0.85	0.94	0.92	0.86	**0.94**
For each individual participant (i.e. score is averaged across the five memories)						
n = 44	0.95	0.88	0.96	0.94	0.81	**0.97**

Inter-class correlation coefficients from a two way random effects model looking for absolute agreement for each score on the AI. Three experimenters scored the whole data set (n = 217 participants, 1085 individual memories) and double scoring was performed 20% of the data (n = 44 participants, 215 individual memories) proportionally for each original experimenter.

Table S3. Double scoring of the future thinking task.

	Rating				
	Spatial References	**Entities Present**	**Sensory Descriptions**	**Thoughts/ Emotions/Actions**	**Quality Ratings**
For each individual future scene					
n = 132	0.90	0.94	0.93	0.88	0.90
For each individual participant (i.e. score is averaged across the three future scenes)					
n = 44	0.94	0.95	0.96	0.88	0.92

Inter-class correlation coefficients from a two way random effects model looking for absolute agreement for each content score and for the quality ratings. Four experimenters scored the whole data set (n = 217 participants, 651 individual future scenes) with double scoring performed on 20% of the data (n = 44 participants, 132 future scenes) proportionally for each original experimenter.

Table S4. Double scoring of the navigation sketch maps.

	Rating					
	Road Segments	**Road Junctions**	**Number of Landmarks**	**Landmark Placement**	**Map Orientation**	**Map Categorisation**
n = 42	0.95	0.96	0.97	0.96	0.96	0.89

Inter-class correlation coefficients from a two way random effects model looking for absolute agreement for each score on the navigation sketch maps. Three experimenters scored the whole data set (n = 217) and double scoring was performed on 20% of the data (n = 42 participants) proportionally for each original experimenter.

Supplementary Results

Task performance and strategy use

Tasks of primary interest

Scene construction

Table S5. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for the scene construction task.

	Immediate Scene Construction	Gradual Scene Construction	Other Strategy	F(2,214) χ^2 (2)	p
Age	29.23 (27.82, 30.63)	29.10 (28.17, 30.03)	26.75 (23.15, 30.35)	1.05	0.35
FSIQ	103.0 (101.05, 104.94)	102.97 (101.73, 104.22)	98.85 (94.78, 102.92)	1.71	0.18
Matrices	12.86 (12.19, 13.54)	12.45 (12.03, 12.86)	11.58 (9.43, 13.74)	1.41	0.25
Gender	62.12%	43.88%	50%	5.95	0.051

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Scene construction alternative strategy allocation. For the scene construction task, 60 participants were allocated to the Immediate Scene Construction strategy group, 109 to the Gradual Scene Construction strategy group and 48 to the Other strategy group. Comparison of the strategy groups showed no differences in terms of age, gender proportion or Matrix Reasoning, but there was a difference in estimated full scale intelligence quotient (FSIQ, Table S6).

Comparison of performance was made using a univariate ANCOVA with FSIQ as a covariate. Significant effects of strategy group and FSIQ were identified [Figure S1; *Strategy group*: $F(2,213) = 7.50$, $p = 0.001$, $\eta^2 = 0.066$; *FSIQ*: $F(1,213) = 7.40$, $p = 0.007$, $\eta^2 = 0.034$].

Bonferroni corrected follow-up t-tests showed significantly greater experiential index scores for the Immediate Scene Construction strategy group in comparison to both the

Gradual Scene Construction and Other strategy groups [*Immediate Scene Construction vs. Gradual Scene Construction*: mean difference = 2.34, 95% CI (0.095, 4.59), p = 0.038, d = 0.40; *Immediate Scene Construction vs. Other*: mean difference = 4.34, 95% CI (1.60, 7.07), p = 0.001, d = 0.74] but no difference between the Gradual Scene Construction and Other strategy groups [mean difference = 2.0, 95% CI (-0.46, 4.45), p = 0.15].

Overall, the results here, combined with those presented in the main text, show that regardless of how participants were allocated to a strategy group, individuals using an Immediate Scene Construction strategy performed best on the scene construction task.

Table S6. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for the scene construction task.

	Immediate Scene Construction	Gradual Scene Construction	Other Strategy	F(2,214) χ^2 (2)	p
Age	29.25 (27.78, 30.72)	29.23 (28.14, 30.31)	28.21 (26.68, 29.74)	0.63	0.54
FSIQ	103.39 (101.34, 105.44)	103.46 (102.17, 104.76)	100.35 (97.96, 102.73)	3.21	0.042
Matrices	13.03 (12.38, 13.69)	12.55 (12.09, 13.02)	11.83 (10.98, 12.68)	2.88	0.059
Gender	61.67%	43.12%	50%	5.33	0.070

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

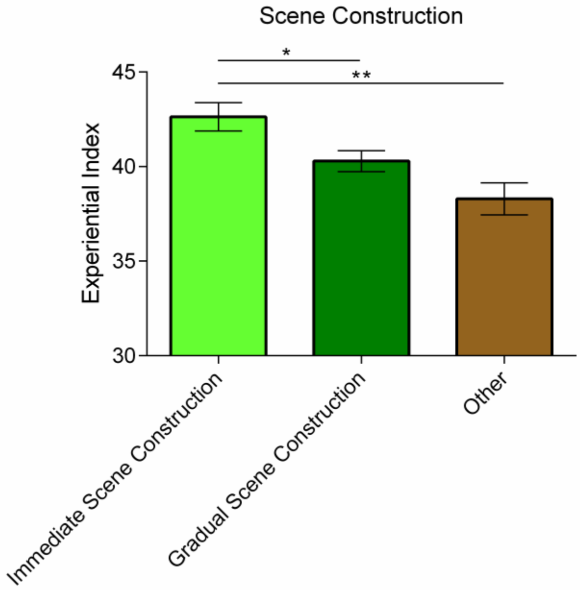

Figure S1. Mean scene construction scores by strategy group (using the alternative strategy allocation method), with FSIQ taken into account. $^{**}p < 0.01$, $^{*}p < 0.05$, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Autobiographical memory

Table S7. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for autobiographical memory.

	Immediate Scene Construction	Gradual Scene Construction	Other Strategy	F(2,214) χ^2 (2)	p
Age	28.96 (28.13, 29.79)	30.15 (28.05, 32.24)	27.17 (23.23, 31.10)	1.22	0.30
FSIQ	103.06 (101.93, 104.18)	102.0 (98.97, 105.04)	99.94 (95.89, 104.0)	1.11	0.33
Matrices	12.59 (12.20, 12.98)	12.26 (11.15, 13.37)	12.17 (10.87, 13.46)	0.31	0.74
Gender	50.56%	59.26%	16.67%	6.28	0.043

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Autobiographical memory, alternative strategy allocation. For the Autobiographical Interview, 49 participants were allocated to the Immediate Scene Construction strategy group, 51 to the Gradual Scene Construction strategy group and 117 to the Other strategy group. Comparison of the strategy groups revealed no differences in terms of age, gender or FSIQ, but there was a difference in Matrix Reasoning (Table S8).

Table S8. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for autobiographical memory.

	Immediate Scene Construction	Gradual Scene Construction	Other Strategy	F(2,214) χ^2 (2)	p
Age	29.06 (27.35, 30.77)	29.04 (27.41, 30.66)	28.97 (27.98, 29.97)	0.005	1.0
FSIQ	103.95 (101.83, 106.08)	104.08 (102.26, 105.90)	101.67 (100.22, 103.12)	2.64	0.073
Matrices	12.69 (12.03, 13.36)	13.25 (12.58, 13.93)	12.14 (11.63, 12.64)	3.47	0.033
Gender	49.0%	56.86%	47.01%	1.40	0.50

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Comparison of performance was made using univariate ANCOVAs with Matrix Reasoning as a covariate. For both the number of internal details and vividness, a significant effect of strategy group, but no effect of Matrix Reasoning, was identified [Figure S2; Internal details: *Strategy group*: F(2,213) = 3.70, p = 0.026, η^2 = 0.034; *Matrix Reasoning*: F(1,213) = 1.45, p = 0.23; Vividness: *Strategy group*: F(2,213) = 5.63, p = 0.004, η^2 = 0.050; *Matrix Reasoning*: F(1,213) = 0.069, p = 0.79].

Bonferroni corrected follow-up t-tests for the number of internal details, showed significantly higher scores in the Immediate Scene Construction strategy group in comparison to the Other strategy group [mean difference = 3.29, 95% CI (0.35, 6.23), p = 0.023, d = 0.49], but no further differences [*Immediate Scene Construction vs. Gradual Scene Construction*: mean difference = 1.87, 95% CI (-1.59, 5.32), p = 0.58; *Gradual Scene Construction vs. Other*: mean difference = 1.42, 95% CI (-1.51, 4.36), p = 0.73].

For the vividness ratings, higher ratings were observed in both the Immediate Scene Construction and Gradual Scene Construction strategy groups when compared to the Other strategy group [*Immediate Scene Construction vs. Other:* mean difference = 0.36, 95% CI (0.065, 0.66), p = 0.011, d = 0.50; *Gradual Scene Construction vs. Other:* mean difference = 0.30, 95% CI (0.004, 0.60), p = 0.045, d = 0.42], but there was no difference between the Immediate Scene Construction and Gradual Scene Construction strategy groups [mean difference = 0.061, 95% CI (-0.29, 0.41), p = 1.0].

Overall, while the specific results are slightly different depending on strategy allocation, the same conclusion can be drawn; using an Immediate Scene Construction strategy was beneficial to autobiographical memory recall.

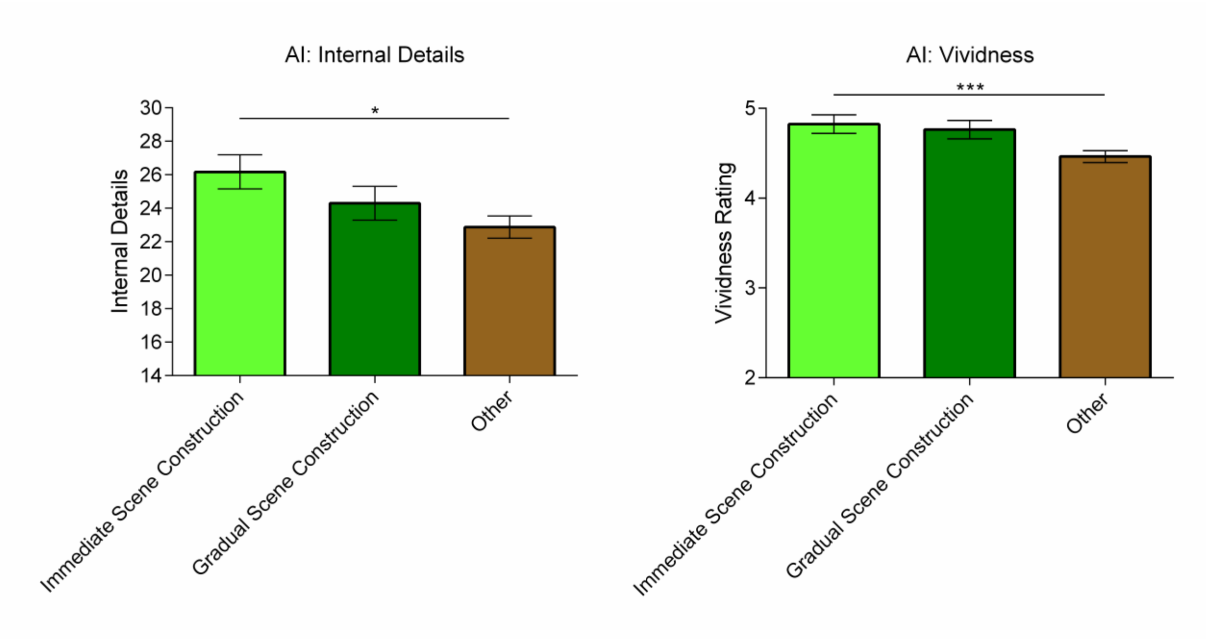

Figure S2. Mean autobiographical memory recall performance as measured by the number of internal details and vividness ratings by strategy group (using the alternative strategy allocation method) with Matrix Reasoning scores taken into account. Vividness ratings were on a 6 point scale from 1 (Vague memory, no recollection) to 6 (Extremely clear as if it's happening now). AI = Autobiographical Interview. ***p < 0.001, *p < 0.05, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Future thinking

Table S9. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for future thinking.

	Immediate Scene Construction	Gradual Scene Construction	Other Strategy	F(2,214) χ^2 (2)	p
Age	29.36 (28.01, 30.72)	28.88 (27.89, 29.87)	28.65 (26.19, 31.11)	0.20	0.82
FSIQ	103.73 (101.65, 105.80)	102.26 (101.03, 103.50)	102.82 (99.54, 106.09)	0.83	0.44
Matrices	12.59 (11.89, 13.30)	12.51 (12.07, 12.94)	12.41 (11.22, 13.60)	0.040	0.96
Gender	51.52%	50%	41.18%	0.59	0.75

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Future thinking, alternative strategy allocation. For the future thinking task, 61 participants were allocated to the Immediate Scene Construction strategy group, 103 to the Gradual Scene Construction strategy group and 53 to the Other strategy group. Comparison of the strategy groups found no differences in terms of age, gender, FSIQ or Matrix Reasoning (Table S10).

Comparison of performance was made using a univariate ANOVA, finding a significant effect of strategy group on the future thinking experiential index scores [Figure S3; $F(2,214) = 7.60$, $p = 0.001$, $\eta^2 = 0.066$].

Bonferroni corrected follow-up t-tests found significantly higher scores in the Immediate Scene Construction strategy group in comparison to the other two strategy groups [*Immediate Scene Construction vs. Gradual Scene Construction*: mean difference = 2.95, 95% CI (0.21, 5.68), p = 0.03, d = 0.42; *Immediate Scene Construction vs. Other*: mean difference = 5.08, 95% CI (1.89, 8.26), p < 0.001, d = 0.72], and no difference between the

Gradual Scene Construction and Other strategy groups [mean difference = 2.13, 95% CI (-0.74, 4.99), p = 0.22].

Overall, the results here, combined with those presented in the main text, show that regardless of how participants were allocated to a strategy group, individuals using an Immediate Scene Construction strategy performed best on the future thinking task.

Table S10. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for future thinking.

	Immediate Scene Construction	Gradual Scene Construction	Other Strategy	F(2,214) χ^2 (2)	p
Age	29.41 (28.02, 30.80)	28.87 (27.72, 30.03)	28.81 (27.37, 30.25)	0.22	0.81
FSIQ	104.05 (101.89, 106.20)	102.50 (101.16, 103.84)	101.76 (99.64, 103.89)	1.42	0.24
Matrices	12.74 (12.04, 13.44)	12.60 (12.13, 13.07)	12.13 (11.35, 12.92)	0.85	0.43
Gender	50.82%	51.5%	50.94%	0.12	0.94

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

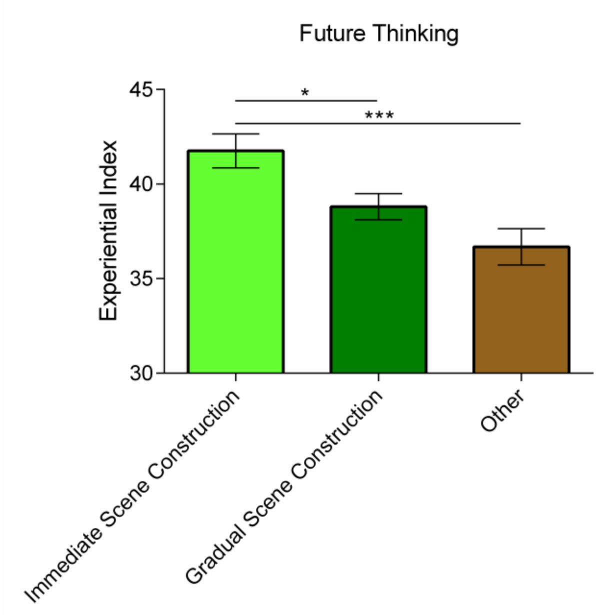

Figure S3. Mean future thinking scores by strategy group (using the alternative strategy allocation method). $^{***}p < 0.001$, $^{*}p < 0.05$, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Navigation

Table S11. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for navigation.

	Immediate Scene Construction	Gradual Scene Construction	Other Strategy	F(2,214) χ^2 (2)	p
Age	28.95 (28.08, 29.82)	29.57 (27.91, 31.23)	26.75 (22.42, 31.26)	0.91	0.41
FSIQ	102.60 (101.41, 103.78)	103.59 (101.48, 105.71)	100.70 (94.14, 107.26)	0.63	0.53
Matrices	12.58 (12.16, 13.0)	12.45 (11.76, 13.14)	11.88 (10.06, 13.69)	0.30	0.74
Gender	58.75%	26.53%	12.5%	20.19	< 0.001

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Navigation, alternative strategy allocation. For Navigation, 17 participants were allocated to the Immediate Scene Construction strategy group, 1 to the Gradual Scene Construction strategy group and 199 to the Other strategy group. Comparison of the strategy groups found no differences in terms of age, gender or FSIQ, but there was a difference in Matrix Reasoning (Table S12).

Comparison of performance was made using a univariate ANCOVA with Matrix Reasoning as a covariate, finding significant effects of both strategy group and Matrix Reasoning [Figure S4; *Strategy group*: F(2,213) = 6.54, p = 0.002, η^2 = 0.058; *Matrix Reasoning*: F(1,213) = 16.07, p < 0.001, η^2 = 0.070].

Bonferroni corrected follow-up t-tests showed significantly greater scores for the Immediate Scene Construction strategy group in comparison to the Other strategy group [mean difference = 29.63, 95% CI (8.84, 50.42), p = 0.002, d = 0.88], but no further differences [*Immediate Scene Construction vs. Gradual Scene Construction*: mean difference = 65.06, 95% CI (-17.87, 147.98), p = 0.18; *Gradual Scene Construction vs. Other*: mean difference = -35.43, 95% CI (-116.06, 45.21), p = 0.87].

Table S12. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for navigation.

	Immediate Scene Construction	Gradual Scene Construction	Other Strategy	F(2,214) χ^2 (2)	p
Age	29.71 (27.54, 31.87)	21.0	28.99 (28.19, 29.79)	1.16	0.32
FSIQ	104.94 (101.22, 108.66)	106.8	102.55 (101.49, 103.60)	0.93	0.40
Matrices	14.41 (13.18, 15.65)	12.0	12.37 (12.01, 12.73)	5.0	0.008
Gender	70.59%	100%	47.74%	4.29	0.12

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

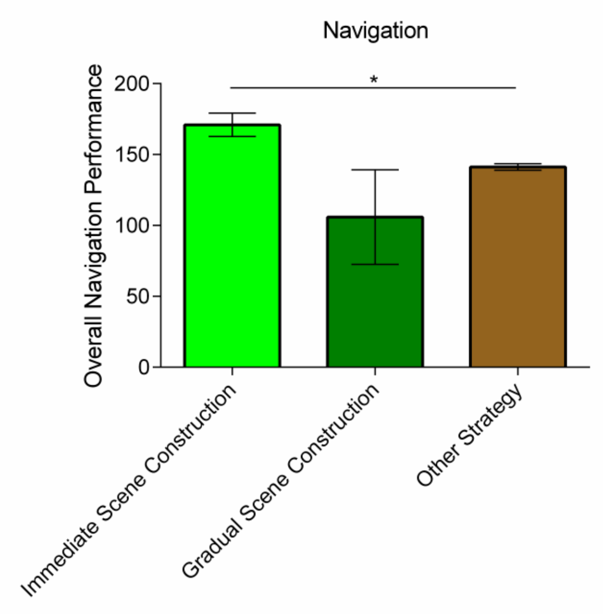

Figure S4. Mean overall navigation performance by strategy group (using the alternative strategy allocation method), with Matrix Reasoning scores taken into consideration. *p < 0.05, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

As only 1 participant was allocated to the Gradual Scene Construction strategy group, we performed the analyses again with this participant excluded to ensure that they were not affecting the results. Comparison of the Immediate Scene Construction and Verbal strategy groups found no differences in terms of age, gender or FSIQ, but there was a difference in Matrix Reasoning. Comparison of performance using a univariate ANCOVA with Matrix Reasoning as a covariate, found significant effects of both strategy group and Matrix Reasoning [*Strategy group*: $F(1,213) = 11.83$, $p = 0.001$, $\eta^2 = 0.053$; *Matrix Reasoning*: $F(1,213) = 16.07$, $p < 0.001$, $\eta^2 = 0.070$], with the Immediate Scene Construction strategy group reporting higher scores [mean performance = 170.94 (95% CI = 154.66, 187.21) than the Other strategy group [mean performance = 141.31 (95% CI = 136.64, 145.97)].

Overall, the results presented here, in combination with those presented in the main text, show that regardless of how participants were allocated to strategy groups, individuals using an Immediate Scene Construction strategy performed best on the navigation task.

Neuropsychological tasks

Rey Auditory Verbal Learning Task (RAVLT)

Table S13. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for RAVLT delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.36 (28.32, 30.40)	29.95 (28.42, 31.47)	27.10 (25.58, 28.63)	3.87	0.022
FSIQ	103.39 (102.11, 104.68)	100.99 (98.61, 103.38)	103.25 (101.17, 105.33)	2.03	0.13
Matrices	12.50 (12.02, 12.98)	12.18 (11.49, 12.87)	12.98 (12.20, 13.76)	1.21	0.30
Gender	49.12%	54.55%	45.83%	0.82	0.66

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

RAVLT, alternative strategy allocation. For the RAVLT, 77 participants were allocated to the Scene Visual Imagery strategy group, 42 to the Other Visual Imagery strategy group and 98 to the Verbal strategy group. Comparison of the strategy groups revealed no differences in age, gender, FSIQ or Matrix Reasoning (Table S14).

As performance scores on the RAVLT were not normally distributed, a Kruskal-Wallis test was used to compare performance, finding a significant effect of strategy group [Figure S5; χ^2 (2) = 20.10, p < 0.001]. Dunn-Bonferroni follow-up tests identified significantly higher scores in the Scene Visual Imagery strategy group in comparison to both the Other Visual Imagery strategy group [Dunn-Bonferroni = 49.04, p < 0.001, r = 0.38] and the Verbal strategy group [Dunn-Bonferroni = 31.24, p = 0.003, r = 0.25]. No differences were seen between the Other Visual Imagery and Verbal strategy groups [Dunn-Bonferroni = 17.80, p = 0.35].

Overall, the results presented here, combined with those in the main text, suggest that regardless of how participants were allocated to strategy group, a Scene Visual Imagery strategy was the most beneficial strategy for RAVLT delayed recall.

Table S14. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for RAVLT delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.60 (28.29, 30.91)	30.14 (28.40, 31.88)	28.06 (26.98, 29.14)	2.73	0.067
FSIQ	103.34 (101.78, 104.89)	100.68 (97.94, 103.42)	103.18 (101.70, 104.67)	1.99	0.14
Matrices	12.42 (11.84, 12.99)	12.14 (11.29, 13.0)	12.78 (12.25, 13.30)	0.97	0.38
Gender	46.75%	54.76%	50.0%	0.70	0.70

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

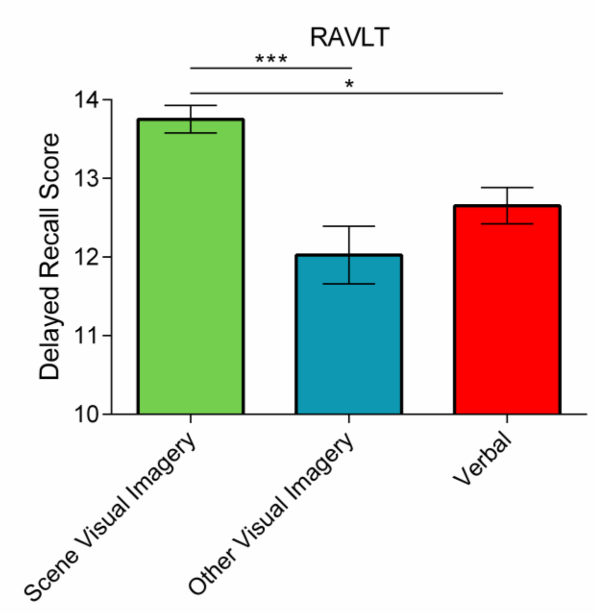

Figure S5. Mean RAVLT delayed recall scores by strategy group (using the alternative strategy allocation method). ***p < 0.001, *p < 0.05, Dunn-Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Logical Memory

Table S15. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for Logical Memory delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.66 (28.58, 30.74)	29.45 (26.83, 32.07)	28.05 (26.91, 29.18)	2.09	0.13
FSIQ	103.02 (101.72, 104.32)	99.08 (94.99, 103.16)	103.26 (101.57, 104.96)	2.69	0.070
Matrices	12.67 (12.19, 13.15)	11.35 (9.92, 12.78)	12.61 (12.07, 13.16)	2.27	0.11
Gender	45.54%	65.0%	51.76%	2.79	0.25

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Independent samples t-tests were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Logical Memory, alternative strategy allocation. For the Logical Memory task, 83 participants were allocated to the Scene Visual Imagery strategy group, 5 to the Other Visual Imagery strategy group and 129 to the Verbal strategy group. No differences between the groups were identified for FSIQ or Matrix Reasoning, but there were differences in age and gender (Table S16).

Comparison of performance between the strategy groups, found no effect of strategy group or age [Figure S6; *Strategy group:* $F(2,212) = 1.87$, $p = 0.16$, *Age:* $F(1,212) = 1.96$, $p = 0.16$]. However, there was an effect of gender [$F(1,212) = 5.08$, $p = 0.025$, $\eta^2 = 0.023$], with female participants performing better than males.

Overall, the results presented here, combined with those in the main text, suggest that regardless of how participants were allocated to strategy groups, strategy use had no effect on performance on the Logical Memory task. Instead, female participants were found to perform best.

Table S16. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for Logical Memory delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	30.33 (29.05, 31.60)	30.60 (23.12, 38.08)	28.10 (27.18, 29.02)	4.32	0.015
FSIQ	102.68 (101.17, 104.18)	95.22 (87.31, 103.13)	103.09 (101.72, 104.47)	2.67	0.071
Matrices	12.52 (11.94, 13.09)	10.80 (5.36, 16.24)	12.60 (12.16, 13.04)	1.14	0.32
Gender	38.55%	80.0%	55.81%	7.89	0.019

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Independent samples t-tests were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

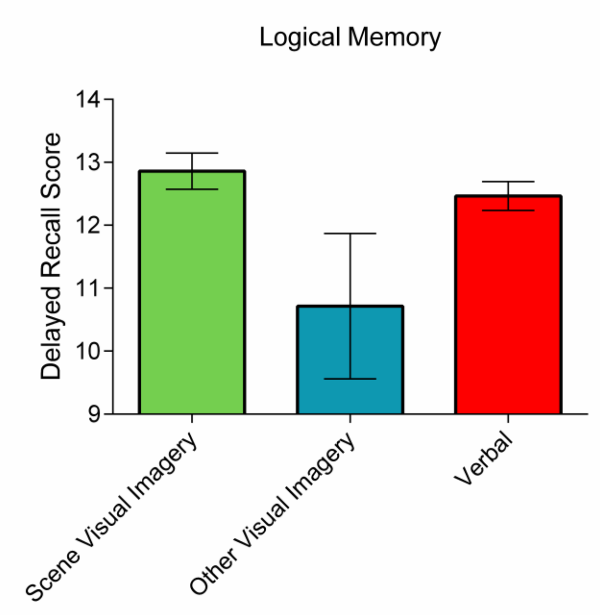

Figure S6. Mean Logical Memory delayed recall scores by strategy group (using the alternative strategy allocation method), with age and gender taken into account. Error bars show the standard error of the mean.

Concrete Verbal Paired Associates (VPA)

Table S17. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for Concrete VPA delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.67 (28.70, 30.64)	28.33 (26.64, 30.01)	27.58 (25.91, 29.26)	2.67	0.071
FSIQ	102.70 (101.47, 103.93)	104.04 (101.41, 106.66)	101.73 (99.29, 104.17)	0.98	0.38
Matrices	12.51 (12.07, 12.96)	12.28 (11.51, 13.04)	12.79 (11.90, 13.68)	0.41	0.67
Gender	49.25%	57.5%	44.19%	1.51	0.47

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Concrete VPA, alternative strategy allocation. For the Concrete VPA, 112 participants were allocated to the Scene Visual Imagery strategy group, 30 to the Other Visual Imagery strategy group and 75 to the Verbal strategy group. There were no differences in age, gender or Matrix Reasoning across the strategy groups, but there was a difference in FSIQ (Table S18).

As performance scores on the Concrete VPA were not normally distributed, a Kruskal-Wallis test was used to compare performance, finding no effect of strategy group [Figure S7; $\chi 2$ (2) = 3.55, p = 0.17].

However, as Kruskall-Wallis tests can not include covariates, but differences in FSIQ between the strategy groups were observed, we also investigated if FSIQ was affecting performance, finding a significant positive association between FSIQ and Concrete VPA delayed recall scores [F(1,215) = 35.43, p < 0.001, R^2 = 0.14]. Relating this back to the strategy and performance data, FSIQ scores were found only to be higher in the Other Visual Imagery strategy group compared to the Verbal strategy group [mean difference = 3.93 (95%

CI = 0.034, 7.82), p = 0.047]. Consequently, the effect of FSIQ is unlikely to be masking any differences in performance between the strategy groups, as it would serve only to inflate performance in the Other Visual Imagery strategy group, where performance is already higher than the Verbal strategy group, but not significantly so.

Overall, therefore, regardless of the strategy allocation method, strategy use did not affect performance on the Concrete VPA task. However, a higher FSIQ score does seem to boost performance.

Table S18. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for Concrete VPA delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.88 (28.81, 30.94)	28.30 (26.36, 30.24)	28.0 (26.73, 29.27)	2.84	0.061
FSIQ	103.08 (101.78, 104.39)	105.20 (102.27, 108.14)	101.28 (99.43, 103.12)	3.19	0.043
Matrices	12.61 (12.14, 13.07)	12.43 (11.51, 13.36)	12.44 (11.78, 13.10)	0.11	0.89
Gender	48.21%	56.67%	49.33	0.69	0.71

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

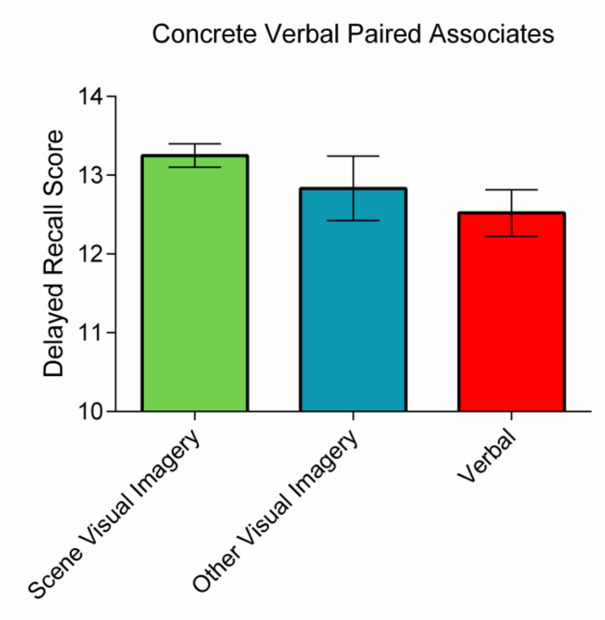

Figure S7. Mean Concrete VPA delayed recall scores by strategy group (using the alternative strategy allocation method). Error bars show the standard error of the mean.

Abstract VPA

Table S19. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for Abstract VPA delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.61 (28.24, 30.97)	28.28 (26.29, 30.26)	28.90 (27.87, 29.92)	0.70	0.50
FSIQ	103.11 (101.56, 104.65)	101.66 (98.69, 104.62)	102.89 (101.45, 104.34)	0.47	0.63
Matrices	12.33 (11.73, 12.94)	12.69 (11.81, 13.58)	12.58 (12.08, 13.08)	0.28	0.76
Gender	54.55%	58.33%	44.35%	3.01	0.22

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Abstract VPA, alternative strategy allocation. For the Abstract VPA, 38 participants were allocated to the Scene Visual Imagery strategy group, 16 to the Other Visual Imagery strategy group and 163 to the Verbal strategy group. There were no differences in age, Matrix

Reasoning or gender across the strategy groups, but there was a difference in FSIQ (Table S20).

Comparison of performance was made using a univariate ANCOVA with FSIQ as a covariate, finding no effect of strategy group [Figure S8; $F(2,213) = 0.008$, $p = 0.99$]. However, there was a significant positive effect of FSIQ [$F(1,213) = 47.23$, $p < 0.001$, $\eta^2 = 0.18$].

Overall, therefore, as with the Concrete VPA task, regardless of the strategy allocation method, strategy use did not affect performance on the Abstract VPA task. However, a higher FSIQ was found to increase performance.

Table S20. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for Abstract VPA delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.61 (27.79, 31.42)	28.31 (24.66, 31.97)	28.94 (28.09, 29.80)	0.35	0.71
FSIQ	103.71 (101.73, 105.68)	97.27 (94.47, 100.07)	103.07 (101.85, 104.28)	4.84	0.009
Matrices	12.11 (11.25, 12.96)	12.63 (11.03, 14.22)	12.61 (12.21, 13.01)	0.59	0.55
Gender	57.89%	56.25%	47.24%	1.69	0.43

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

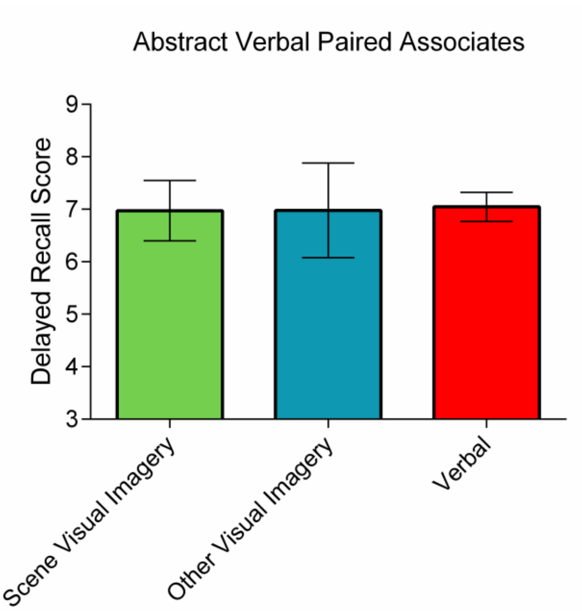

Figure S8. Mean Abstract VPA delayed recall scores by strategy group (using the alternative strategy allocation method), with FSIQ taken into consideration. Error bars show the standard error of the mean.

Rey Figure delayed recall

Table S21. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for the Rey Figure delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.08 (27.69, 30.47)	28.94 (28.02, 29.86)	29.40 (25.04, 33.76)	0.040	0.96
FSIQ	101.75 (99.87, 103.63)	103.32 (102.10, 104.53)	102.63 (96.10, 109.16)	1.02	0.36
Matrices	12.28 (11.71, 12.85)	12.67 (12.20, 13.13)	12.40 (10.67, 14.13)	0.53	0.59
Gender	56.76%	48.12%	20.0%	5.14	0.077

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Rey Figure delayed recall, alternative strategy allocation. For the Rey Figure delayed recall, 70 participants were allocated to the Scene Visual Imagery strategy group, 118 to the Other Visual Imagery strategy group and 29 to the Verbal strategy group. No differences in age, gender, FSIQ or Matrix Reasoning were identified across the strategy groups (Table S22).

Comparison of performance (via a univariate ANOVA) found no effect of strategy group [Figure S9; F(2,214) = 0.69, p = 0.50].

Overall, therefore, the results presented here, combined with those presented in the main text, suggest that regardless of how participants were allocated to strategy group, strategy use did not affect performance on the Rey Figure delayed recall.

Table S22. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the alternative strategy allocation method) for the Rey Figure delayed recall.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.14 (27.69, 30.59)	29.42 (28.46, 30.39)	27.0 (24.70, 29.03)	2.23	0.11
FSIQ	101.95 (100.0, 103.90)	103.50 (102.17, 104.83)	101.66 (99.03, 104.28)	1.29	0.28
Matrices	12.39 (11.80, 12.97)	12.59 (12.11, 13.08)	12.59 (11.48, 13.69)	0.15	0.86
Gender	58.57%	46.61%	41.38%	3.46	0.18

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

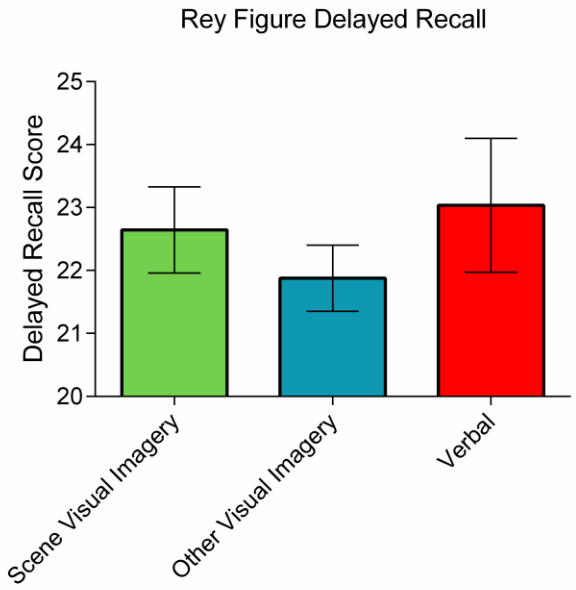

Figure S9. Mean Rey Figure delayed recall by strategy group (using the alternative strategy allocation method). Error bars show the standard error of the mean.

Dead or Alive task

Table S23. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (using the main strategy allocation method) for the proportion correct on the Dead or Alive task.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	29.32 (27.95, 30.68)	28.07 (26.28, 29.86)	29.18 (28.12, 30.24)	0.72	0.49
FSIQ	101.75 (99.95, 103.55)	101.52 (98.98, 104.05)	103.76 (102.36, 105.16)	2.14	0.12
Matrices	11.89 (11.15, 12.63)	12.44 (11.60, 13.28)	12.91 (12.48, 13.35)	3.19	0.043
Gender	61.90%	36.59%	47.79%	6.74	0.034

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Dead or Alive, alternative strategy allocation. For the Dead or Alive task (via the reverse strategy allocation), 26 participants were allocated to the Scene Visual Imagery strategy group, 16 to the Other Visual Imagery strategy group and 175 to the Verbal strategy group. There were no differences in age, FSIQ or Matrix Reasoning across the strategy groups, but differences in gender were identified (Table S24).

Table S24. Means and 95% confidence intervals of age, FSIQ and Matrix Reasoning scores, and gender proportion by strategy group (allocated via the reverse strategy allocation) for the proportion correct on the Dead or Alive task.

	Scene Visual Imagery	Other Visual Imagery	Verbal	F(2,214) χ^2 (2)	p
Age	30.15 (27.88, 32.43)	26.94 (24.19, 29.69)	29.03 (28.19, 29.87)	1.65	0.20
FSIQ	102.05 (99.87, 104.22)	100.79 (97.52, 104.06)	103.04 (101.86, 104.22)	0.78	0.46
Matrices	12.19 (11.25, 13.13)	12.06 (10.54, 13.59)	12.62 (12.22, 13.01)	0.57	0.57
Gender	53.85%	18.75%	52%	6.68	0.035

Note. FSIQ = Full Scale Intelligence Quotient, estimated from the Test of Premorbid Functioning. Matrices = Matrix Reasoning scaled scores. Gender is the percentage of male participants in the group. Separate one way ANOVAs were used to compare age, FSIQ and Matrix Reasoning. A Chi Squared test was used to compare gender.

Comparison of performance was made using a univariate ANCOVA with gender as a covariate, finding a significant effect of both strategy group and gender [Figure S10; *Strategy Group*: F(2,213) = 3.10, p = 0.047, η^2 = 0.028; *Gender*: F(1,213) = 5.36, p = 0.022, η^2 = 0.025].

Follow-up Bonferroni corrected t-tests showed higher performance scores in the Verbal strategy group than the Scene Visual Imagery strategy group [mean difference = 4.32, 95% CI (0.12, 8.52), p = 0.042, d = 0.52], but no other differences [Scene Visual Imagery vs. Other Imagery: mean difference = -4.23, 95% CI (-10.65, 2.20), p = 0.34; Other Imagery vs Verbal: mean difference = -0.092, 95% CI (-5.39, 5.39), p = 1.0]. Comparison of male and female participants found that males performed better than females [mean difference = 2.57 (95% CI = 0.33, 4.81), t(215) = 2.26, p = 0.025].

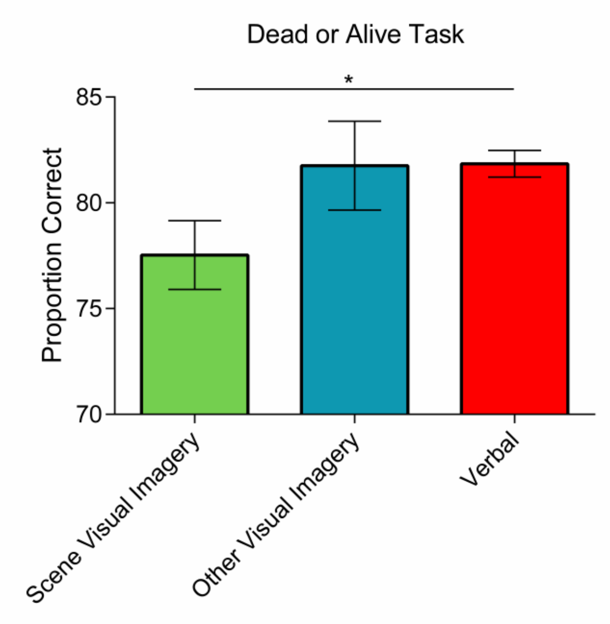

Figure S10. Mean Dead or Alive proportion correct by strategy group (using the alternative strategy allocation method), with gender taken into consideration. $^{*}p < 0.05$, Bonferroni corrected for multiple comparisons. Error bars show the standard error of the mean.

Overall, therefore, strategy use on the Dead or Alive task had a different effect on performance depending on the methodology used to allocate to group. When allocating to the Scene Visual Imagery strategy group first, no differences in performance were identified. However, when using the alternative allocation method, the Verbal strategy group showed higher performance than the Scene Visual Imagery strategy group. Importantly, in line with our predictions, Scene Visual Imagery strategies did not benefit task performance regardless of the allocation method.

Strategies for each task

The specific strategies presented to the participants for each task are shown below. Note that for each task the participant saw only the list of potential strategies. The strategy sub-category information is included for information purposes only; participants were not aware of these distinctions.

For each strategy, participants were asked to respond either “Yes” (that they used the strategy) or “No” (that they did not). It was made clear that selecting one strategy did not preclude the selection of any of the others, as more than one strategy can be deployed during a task. For all tasks, the option “Other” with space to describe a new strategy was also available.

The tasks and strategy selection were presented in two orders (with half the participants doing each order) to reduce the possibility of order effects. For order 1 the task order was: Logical Memory, Rey Figure, Concrete VPA, Autobiographical memory, Abstract VPA, Navigation, RAVLT, Dead or Alive, Scene Construction, Future Thinking. The strategies were listed with the visual imagery strategies first, followed by the verbal strategies. For order 2, the task order was the reverse of order 1, and the strategies were listed starting with the verbal strategies first followed by the visual imagery strategies.

Scene construction

Strategy sub-category	Scene construction strategies
Immediate Scene Construction	I had an immediate visual image of the scene in my mind, with details appearing all at once as a coherent whole. It almost felt like I was really there.
Gradual Scene Construction	I had a visual image of the scene which I imagined in a piece-by-piece manner, adding details to gradually form a coherent whole. I had a static 2D visual image of the scene in my mind, like looking at a photograph. When describing part of the scene to the experimenter, my visual focus was only on that specific section and I did not visualise the rest of the scene around it.
Simple Visual Imagery	I had separate visual images of individual objects I would typically expect to find in the scene, but did not picture the scene as a coherent whole with all the objects together.
Verbal Cohesion	I verbally thought about the scene overall, in words or sentences alone, so that the description of the scene I gave was a continuous narrative describing the scene as a coherent whole. I did this without involving visual imagery.
Verbal Subgroups	I verbally thought about the scene in sections, using words or sentences alone, so that I built up an overall description gradually piece-by-piece. There was no visual imagery involved in doing this.
Simple Verbal	I verbally listed, using words and sentences alone, individual objects that I would expect to typically find in the scene, without combining them into a whole. There was no visual imagery involved in doing this.
Visualising Words	I visualised words for possible objects that I would expect to find in the scene as though written in the air. I visualised sentences that describe the scene, as though written in the air.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Future thinking

Strategy sub-category	Future thinking strategies
Immediate Scene Construction	I had an immediate visual image of the scene in my mind, with details appearing all at once as a coherent whole. It almost felt like I was really there.
Gradual Scene Construction	I had a visual image of the scene which I imagined in a piece-by-piece manner, adding details to gradually form a coherent whole. I had a static 2D visual image of the scene in my mind, like looking at a photograph. When describing part of the scene to the experimenter, my visual focus was only on that specific section and I did not visualise the rest of the scene around it
Simple Visual Imagery	I had separate visual images of individual objects I would typically expect to find in the scene, but did not picture the scene as a coherent whole with all the objects together.
Verbal Cohesion	I verbally thought about the scene overall, in words or sentences alone, so that the description of the scene I gave was a continuous narrative describing the scene as a coherent whole. I did this without involving visual imagery.
Verbal Subgroups	I verbally thought about the scene in sections, using words or sentences alone, so that I built up an overall description gradually piece-by-piece. There was no visual imagery involved in doing this.
Simple Verbal	I verbally listed, using words and sentences alone, individual objects that I would expect to typically find in the scene, without combining them into a whole. There was no visual imagery involved in doing this.
Visualising Words	I visualised words for possible objects that I would expect to find in the scene as though written in the air. I visualised sentences that describe the scene, as though written in the air.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Autobiographical memory

Strategy sub-category	Autobiographical memory strategies
Immediate Scene Construction	I had an immediate, fully-formed visual image of a scene or scenes from my memory that was quite immersive, like a movie playing out.
Gradual Scene Construction	I had an immediate, fully-formed visual image of my memory, with details appearing all at once as a coherent scene, as though looking at a photograph. I reconstructed a visual image of the memory, by adding details in a piece-by-piece manner to gradually form a coherent whole scene.
Simple Visual Imagery	I had separate visual images of various individual features and/or people involved in the memory in isolation, but did not picture them all together within a scene or the wider context of the overall memory. I focused on one image of a particular feature/person involved in the memory in isolation, and described my memory using that as a reference.
Verbal Cohesion	I verbally described, using words or sentences alone, the whole memory as a coherent story, without using visual imagery. I verbally described, using words or sentences alone, each main element of the memory, and combined the individual elements to form a coherent story without using visual imagery.
Simple Verbal	I verbally listed, using words or sentences alone, single facts about the memory, although not in a coherent or chronological order. I thought of the word for a single element, fact or detail in particular that stood out.
Visualising Words	I imagined written in my mind the dates/numbers/short facts in regards to the memory. I imagined written in my mind sentences that described the memory
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Navigation clip recognition

Strategy sub-category	Navigation clip recognition strategies
Immediate Scene Construction	I created a visual image of the overall layout of the town over the course of watching the films, as though having a bird's eye view looking down at the whole town with both routes combined. I replayed the videos of the routes in my mind, and combined the routes to create an overall visual layout in my mind's eye.
Gradual Scene Construction	I replayed in my mind's eye the videos of each route separately, but could not picture how they crossed over. I visualised in my mind scenes containing landmarks, all connected in the order in which they appear within the overall layout of the town.
Complex Non-Scene Visual Imagery	I visualised in my mind images of individual landmarks connected in the order in which they appeared, but without visualising other surrounding details such as the background and foreground details, so it was not scene-like.
Simple Visual Imagery	I had visual images in my mind of individual landmarks, imagining each separately and was not able to connect them together or imagine them within a scene. I focused on specific features of landmarks (e.g. a shop name, the colour of a building) and tried to form a visual image of them in my mind.
Verbal Cohesion	I verbally described to myself, using words or sentences alone, how to navigate from start to finish through the town, combining both routes and describing the relative locations of the landmarks.
Verbal Subgroups	I verbally described to myself, using words or sentences alone, how to navigate from start to finish along each route separately, but without combining the routes. I said to myself, using words or sentences alone, whereabouts along the routes the landmarks occurred (such as the start, middle or end). I had a sense of the time taken to travel along the route, and the time that passed between landmarks, but this sense of time did not come from visual imagery in my mind.
Simple Verbal	I verbally noted, using words or sentences alone, the names of individual landmarks and road names, but I could not connect them together. I verbally noted, using words or sentences alone, particular features of landmarks.

Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. I compared this to the clips. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Navigation scene recognition

Strategy sub-category	Navigation scene recognition strategies
Immediate Scene Construction	I visually replayed parts of the route in my mind to see if the scene on the screen matched any of my mental images of the films.
Gradual Scene Construction	I had visual mental snapshots of scenes from the routes, in order to see if the scene on the screen matched any of my mental images.
Screen Scenes	I imagined the videos being replayed on the computer screen, so that the visual image in my mind was of seeing the screen with the video playing. This helped me to see if I recognised each scene.
Simple Visual Imagery	I had visual images in my mind of individual, isolated landmarks, without visualising other surrounding details such as the background and foreground details, to see if any matched the scene. I pictured in my mind specific features of isolated landmarks (e.g. a shop name, the colour of a building) to see if they matched the scene.
Verbal Cohesion	I verbally described the route to myself, using words or sentences alone, from start to finish to see if the scene matched any point on the route description.
Simple Verbal	I verbally thought, using words and sentences alone, of the names of individual isolated landmarks and road names, to see if they were in the scene on the screen. I verbally recalled, using words or sentences alone, particular features of landmarks to see if they were in the scene on the screen.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. I compared this to the scenes on the screen. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Navigation proximity

Strategy sub-category	Navigation proximity strategies
Immediate Scene Construction	I had an overall visual mental map of the layout of the town as though having a bird's eye view looking down at the whole town with both routes combined, and this helped me to judge the proximity of the landmarks. I replayed the videos of the routes in my mind as though I was re-experiencing the videos and travelling through the town, and this helped me to judge the proximity of the landmarks; I could also visually imagine how the two routes crossed over.
Gradual Scene Construction	I replayed the videos of each route separately, and could not imagine how they crossed over – so, I could judge distances between landmarks when they were in the same route, but it was more difficult when they existed in different routes. I visualised mental snapshots of landmarks placed within scenes along the routes to help me to judge the proximity of the landmarks.
Screen Scenes	I imagined the videos being replayed on the computer screen, so that the visual image in my mind was of seeing the screen with the video playing. This helped me to judge the proximity of the landmarks.
Complex Non-Scene Visual Imagery	I visualised in my mind images of individual landmarks connected in the order in which they appeared but without visualising other surrounding details such as the background and foreground details. This helped me to judge the proximity of the landmarks.
Simple Visual Imagery	I had visual images in my mind of isolated and unconnected landmarks, without visualising other surrounding details or in a particular order. This helped me to judge the proximity of the landmarks.
Verbal Cohesion	I verbally described, using words or sentences alone, how to navigate from start to finish through the town, combining both routes, to judge distances between the landmarks. There was no visual imagery involved when I did this.
Verbal Subgroups	I described to myself, using words or sentences alone, how to navigate from start to finish along each route separately, without combining the routes – so, I could judge distances between landmarks when they were in the same route, but it was more difficult when they existed in different routes. There was no visual imagery involved when I did this. I verbally described to myself, using words or sentences alone, the relative positions of landmarks to help me to judge the proximity of the landmarks, and I did this without visual imagery. I had a sense of the time taken to travel along the route and the time that passed between landmarks, and this helped me to judge the proximity of the landmarks. This sense of time did not come from visual imagery in my mind.

Simple Verbal	I verbally thought, using words or sentences alone, of the names of individual isolated landmarks, and this helped me to do the task. I verbally recalled, using words or sentences alone, particular features of landmarks, and this helped me to do the task.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. This helped me to judge the proximity of landmarks. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Navigation route knowledge

Strategy sub-category	Navigation route knowledge strategies
Immediate Scene Construction	I had an overall visual mental map of the layout of the town as though having a bird's eye view looking down at the whole town with both routes combined, in order to identify the correct order of the images. I replayed the videos of the routes in my mind as though I was re-experiencing the videos and travelling through the town, in order to identify the correct order of the images; I could also visually imagine how the two routes crossed over.
Gradual Scene Construction	I replayed the videos of each route separately, and could not imagine how they crossed over – so, I could work out the order of landmarks when they were in the same route, but it was more difficult when they existed in different routes. I visualised mental snapshots of scenes containing landmarks, all in order along the routes, and this helped me to work out the order.
Screen Scenes	I imagined the videos being replayed on the computer screen, so that the visual image in my mind was of seeing the screen with the video playing, and this helped me to judge the order of the landmarks.
Complex Non-Scene Visual Imagery	I visualised in my mind images of landmarks connected in the order in which they appeared but without visualising other surrounding details such as the background and foreground details.
Simple Visual Imagery	I had visual images in my mind of isolated and unconnected landmarks, without visualising other surrounding details, and this helped me to judge the order of the landmarks.
Verbal Cohesion	Using words or sentences alone I verbally described how to navigate from start to finish through the town, combining both routes. This helped me to identify the correct order of the images, and I did this without visual imagery.
Verbal Subgroups	I described to myself, using words or sentences alone, how to navigate from start to finish along each route separately, without combining the routes – so, I could work out the order of landmarks when they were in the same route, but it was more difficult when they existed in different routes. There was no visual imagery when I did this. I verbally described to myself, using words or sentences alone, the relative positions of landmarks in order to work out the order of the landmarks. There was no visual imagery when I did this. I had a sense of the time taken to travel along the route and the time that passed between landmarks, and this helped me to judge the order of the landmarks. This sense of time did not come from visual imagery in my mind.

Simple Verbal	I verbally thought of the names of individual isolated landmarks using words or sentences alone, which helped me to judge the order of the landmarks. I verbally recalled, using words or sentences alone, particular features of landmarks, which helped me to judge the order of the landmarks.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. This helped me to judge the order of the landmarks. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Navigation sketch map

Strategy sub-category	Navigation sketch map strategies
Immediate Scene Construction	I had an overall visual mental map of the layout of the town as though having a bird's eye view looking down at the whole town with both routes combined, and drew this mental map. I replayed the videos of the routes in my mind as though I was re-experiencing the videos and travelling through the town, in order to create an overall mental layout combining both routes and drew this.
Gradual Scene Construction	I replayed the videos of each route separately and could draw the individual routes, but I struggled to draw how they crossed over. I visualised mental snapshots of landmarks placed within scenes in order along the routes, and drew the map based upon this.
Screen Scenes	I imagined the videos being replayed on the computer screen, so that the visual image in my mind was of seeing the screen with the video playing, helping me to draw the sketch map.
Complex Non-Scene Visual Imagery	I visualised in my mind images of landmarks connected in the order in which they appeared to help me draw the sketch map, but without visualising other surrounding details such as the background and foreground details.
Simple Visual Imagery	I had visual images in my mind of isolated landmarks, imagining each separately and I found it difficult to imagine where they were located on a map in relation to one another. I imagined specific parts of landmarks in isolation (e.g. a shop name, the colour of a building), and I found it difficult to imagine where they were located on a map.
Verbal Cohesion	I verbally described, using words and sentences alone, how to navigate from start to finish through the town, combining both routes in order, and drew the map from this description. I did not have visual imagery when I did this.
Verbal Subgroups	I verbally described to myself how to navigate from start to finish along each route separately, using words and sentences alone, and without combining the routes – so, I could draw individual routes, but struggled to draw how they crossed over. I did not have visual imagery when I did this. I knew factually whereabouts along the routes the landmarks occurred (such as the start, middle or end), and drew the map from there. There was no visual imagery involved when I did this. I had a sense of the time taken to travel along the route and the time that passed between landmarks, and drew the map from that. This sense of time did not come from visual imagery.

Simple Verbal	I verbally thought of the names of individual isolated landmarks and road names using words and sentences alone, but I found it difficult to imagine where they were located on a map. I verbally recalled particular features of landmarks using words or sentences alone, and used this to help with the sketch map.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. I used this to help me draw the sketch map. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either "Yes" or "No". Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

RAVLT

Strategy sub-category	RAVLT strategies
Immediate Scene Construction	I recalled a fully-formed visual scene or story that incorporated all/most of the words, and this visual scene came to mind all at once.
Gradual Scene Construction	I gradually recalled a single visual scene or story that incorporated all/most of the words, where my visual image appeared piece-by-piece. I recalled visual pairs or groups of objects – seeing them as multiple mini scenes.
Screen Scenes	I recalled a visual list of the words in my mind as though I had written them down on a piece of paper.
Complex Non-Scene Visual Imagery	I recalled visual pairs or groups of objects, with no other visual imagery, including no background or context.
Simple Visual Imagery	I recalled an individual object for each word, visualising each object on its own with no background or context and each object was not placed within a scene.
Verbal Cohesion	I verbally recalled a story, using words or sentences alone that linked all/most of the words together.
Verbal Subgroups	I verbally recalled pairs or groups of words together, using words or sentences alone.
Visualising Words	I visualised each word in my mind as though it was written in the air. I visually recalled the image of a list of the words I created during learning as though written out as a list in the air.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly, which I compared to how I felt when previously learning the words. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Aural	I recalled the rhythm of the words, and this did not involve any visual imagery. I recalled the rhythm of the words, and this then caused me to experience related visual imagery. The visual imagery that was evoked could be described as something: scene-like comprising single objects (not a scene) I recalled the sounds and syllables in the words, and this did not involve any visual imagery. I recalled the sounds and syllables in the words, and this then caused me to experience related visual imagery. The visual imagery that was evoked could be described as something: scene-like comprising single objects (not a scene)

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either "Yes" or "No". Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Logical Memory

Strategy sub-category	Logical Memory strategies
Immediate Scene Construction	I recalled an immediate, fully-formed visual image that incorporated all/most of the facts from the story from start to finish – this was a vivid moving scene like watching a movie playing out.
Gradual Scene Construction	I recalled immediate, fully-formed visual snapshots of different scenes from the story, as though looking at photographs.
Screen Scenes	I recalled the words from the story as though written down on a piece of paper, on a TV screen or on newspaper.
Simple Visual Imagery	I recalled visual images of individual objects and/or people from the story in isolation, and did not picture them within a scene with a background and further details.
Verbal Cohesion	I verbally recalled, using words or sentences alone, facts from the story in a coherent order, without involving visual imagery to do this.
Verbal Subgroups	I verbally recalled, using words or sentences alone, groups of facts from the story. I did not have any visual imagery to do this.
Simple Verbal	I recalled only key words from the story to myself.
Visualising Words	I visually recalled words from the stories in my mind as though they were written in the air.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. This helped me to recall the story My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image
Aural	I recalled a list of facts from the story, as though replaying an audio recording of the experimenter and this did not involve any visual imagery. I recalled a list of facts from the story, as though replaying an audio recording of the experimenter, and this then caused me to experience related visual imagery. The visual imagery that was evoked could be described as something: scene-like comprising single objects (not a scene)

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Concrete VPA

Strategy sub-category	Concrete VPA strategies
Immediate Scene Construction	I recalled a single visual image that I had created during learning which incorporated all/most of the word pairs as they were read out – seeing them all together as objects within a single scene or story. I recalled a visual representation of all the words in different locations that I had created during learning.
Gradual Scene Construction	For each word pair, I recalled a visual image of the objects within one single scene. I recalled groups of multiple word pairs in one go, and I had a visual image of each of these groupings as objects within scenes. I recalled a word pair as one single object in a particular setting or scene.
Screen Scenes	I recalled visual images of the word as though written down on a piece of paper or on a computer screen.
Complex Non-Scene Visual Imagery	I recalled a visual image of a word pair as one single object to represent the pair in isolation. I did not visualise any other contextual information or background. I recalled visual images of many of the word pairs as objects grouped together. I did not have any visual imagery other than the groups of objects, including no background or context.
Simple Visual Imagery	I recalled a visual image of each word as a separate object, visualising each object on its own with no background or context and each object was not placed within a scene. I recalled a visual image of a word pair as one single object on its own with no background or context and each object was not placed within a scene.
Verbal Cohesion	I verbally recalled a single story to incorporate all/most of the word pairs. There was no visual imagery involved. I verbally recalled a story that grouped multiple word pairs. There was no visual imagery involved. I verbally recalled a story or sentence that linked the two words in the pair. There was no visual imagery involved.
Simple Verbal	I verbally recalled of a jumble of single words and tried to match the words up verbally. There was no visual imagery involved. I verbally recalled a single word that linked each word pair. There was no visual imagery involved.
Visualising Words	I recalled the two words in a pair as though they were written in the air. I visually recalled the overall form and shape of words.

Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image
Aural	I recalled the sounds and syllables in the words. This did not elicit any visual imagery. I recalled the sounds and syllables in the words. This then caused me to experience related visual imagery. The visual imagery that was evoked could be described as something: scene-like comprising single objects (not a scene)

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Abstract VPA

Strategy sub-category	Abstract VPA strategies
Immediate Scene Construction	I recalled a single visual image that I had created during learning which incorporated all/most of the word pairs as they were read out – seeing them all together as objects within a single scene or story. I recalled a visual representation of all the words in different locations that I had created during learning.
Gradual Scene Construction	For each word pair, I recalled a visual image of the objects within one single scene. I recalled groups of multiple word pairs in one go, and I had a visual image of each of these groupings as objects within scenes. I recalled a word pair as one single object in a particular setting or scene.
Screen Scenes	I recalled visual images of the word as though written down on a piece of paper or on a computer screen.
Complex Non-Scene Visual Imagery	I recalled a visual image of a word pair as one single object to represent the pair in isolation. I did not visualise any other contextual information or background. I recalled visual images of many of the word pairs as objects grouped together. I did not have any visual imagery other than the groups of objects, including no background or context.
Simple Visual Imagery	I recalled a visual image of each word as a separate object, visualising each object on its own with no background or context and each object was not placed within a scene. I recalled a visual image of a word pair as one single object on its own with no background or context and each object was not placed within a scene.
Verbal Cohesion	I verbally recalled a single story to incorporate all/most of the word pairs. There was no visual imagery involved. I verbally recalled a story that grouped multiple word pairs. There was no visual imagery involved. I verbally recalled a story or sentence that linked the two words in the pair. There was no visual imagery involved.
Simple Verbal	I verbally recalled of a jumble of single words and tried to match the words up verbally. There was no visual imagery involved. I verbally recalled a single word that linked each word pair. There was no visual imagery involved.
Visualising Words	I recalled the two words in a pair as though they were written in the air. I visually recalled the overall form and shape of words.

Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image
Aural	I recalled the sounds and syllables in the words. This did not elicit any visual imagery. I recalled the sounds and syllables in the words. This then caused me to experience related visual imagery. The visual imagery that was evoked could be described as something: scene-like comprising single objects (not a scene)

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Rey Figure

Strategy sub-category	Rey Figure strategies
Immediate Scene Construction	I thought about how the figure resembled an overall scene, where the different elements resembled objects within that scene.
Screen Scenes	I had a visual image in my mind of the whole figure on the card, so I reimagined how the figure was presented originally to me by the experimenter.
Complex Non-Scene Visual Imagery	I had an immediate visual mental image of the whole figure all at once and drew it from this mental image. I had a visual mental image of a basic outline and other individual features, and combined them in my mind to form a coherent whole image which I then drew.
Simple Visual Imagery	I had a visual image in my mind of separate elements in isolation, and not a single image of how they all fit together. I had a visual image in my mind of objects that I thought the different elements resembled, and then drew each element.
Verbal Cohesion	I remembered a verbal story that described the figure and its components, using words or sentences alone rather than visual imagery. I remembered the names for the features and verbally linked them together, using words or sentences alone rather than involving visual imagery.
Simple Verbal	I verbally recalled names or labels for elements separately using words or sentences alone, without linking them together.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. This helped me to recall the figure. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either “Yes” or “No”. Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.

Dead or Alive

Strategy sub-category	Dead or Alive strategies
Gradual Scene Construction	I recalled a visual image of a media report featuring the individual within a particular scene or context. I had a visual image in my mind that depicted a scene from when I heard about or discussed the individual.
Screen Scenes	I visualised in my mind printed or written information about the individual, such as picturing a page in a newspaper or webpage on a screen, as though it was there in front of me.
Simple Visual Imagery	I had a visual image in my mind of the individual, with no background, context or scene around them. I imagined separate objects and/or items that I associate with the individual, without imagining these items within a scene.
Verbal Cohesion	I verbally thought through a media story about the individual using words or sentences alone, as though retelling the story to myself. I verbally thought through, using words or sentences alone, a time when I heard about or discussed the individual.
Simple Verbal	The verbal idea of whether the individual was "dead" or "alive" came to mind immediately without me having to bring to mind further contextual or visual information or images. I listed single items, objects or facts associated with the individual, using words or sentences alone, to logically work out whether the person was living or dead.
Visualising Words	I visualised in my mind words associated with the individual as though written or printed in the air.
Vague Visual	I had a very vague or fleeting sense of a visual image in my mind, which was really unclear and hazy – it was more the idea of an image in my mind than actually seeing an image itself clearly. My very vague impression is that the image: was scene-like (in that I had a sense of a space or context, albeit very vague) had multiple elements but was not a scene involved single isolated objects I cannot describe the image

	I recalled sound snippets or sections of audio from a news item or from a conversation about the individual or from the individual themselves. This did not elicit any visual imagery.
Aural	I recalled sound snippets or sections of audio from a news item or from a conversation about the individual or from the individual themselves. This then caused me to experience related visual imagery. The visual imagery that was evoked could be described as something: scene-like comprising single objects (not a scene)

Note. Participants were presented only with a list of the strategies and were not aware of the strategy categories. The strategy category information is included for information purposes only. Participants were asked to respond to each of the possible strategies with either "Yes" or "No". Half of the participants saw the visual strategies first, the other half saw the verbal strategies first.