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Personal Semantic, General Semantic, and Episodic Memory: Shared and Unique Neural Correlates

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Abstract

One of the most common distinctions in long-term memory is that between semantic (i.e., general world knowledge) and episodic (i.e., recollection of contextually-specific events from one's past). However, emerging cognitive neuroscience data suggest a surprisingly large overlap between the neural correlates of semantic and episodic memory. Moreover, personal semantic memories (i.e., knowledge about the self and one's life) have been studied little and do not easily fit into the standard semantic-episodic dichotomy. Here we used fMRI to record brain activity while 48 participants verified statements concerning general facts, autobiographical facts, repeated events, and unique events. In multivariate analysis, all four types of memory involved activity within a common network bilaterally (e.g., frontal pole, paracingulate gyrus, medial frontal cortex, middle/superior temporal gyrus, precuneus, posterior cingulate, angular gyrus) and some areas of the medial temporal lobe. Yet the four memory types differentially engaged this network, increasing in activity from general to autobiographical facts, from autobiographical facts to repeated events, and from repeated to unique events. Our data are compatible with a component process model, in which declarative memory types rely on different weightings of the same elementary processes, such as perceptual imagery, spatial features, and self-reflection.

1 Introduction

2 One of the most fundamental distinctions in human long-term memory is that between semantic
3 and episodic (Greenberg & Verfaellie, 2010; Squire, 2009; Tulving, 1972, 1983, 2002). Semantic
4 memory refers to one's non-personal, general knowledge of the world (e.g., *I know that yoga is a*
5 *relaxing form of exercise*), whereas episodic memory concerns the recollection of contextually-
6 specific events from one's personal past (*I remember arriving quite late to my yoga class this*
7 *weekend, which made my teacher angry*). This distinction is classic (Herrmann, 1982; Renoult &
8 Rugg, 2020) and remains crucial for cognition and neuroscience today. Importantly, although
9 these two putative memory systems have long been recognized as "partially overlapping"
10 (Tulving, 1972) and interacting (Greenberg & Verfaellie, 2010), they have largely been
11 investigated via separate research traditions.

12 In recent years, however, emerging cognitive neuroscience data have suggested a
13 surprisingly large overlap between the neural correlates of semantic and episodic memory. For
14 example, when one compares the functional neuroimaging findings from the semantic memory
15 literature (a "general semantic network"; Binder, 2016; Binder et al., 2009; Binder & Desai, 2011)
16 to those from the episodic memory literature (an "episodic core recollection network"; Rugg &
17 Vilberg, 2013; Svoboda et al., 2006), it becomes evident that the two networks share the midline
18 frontal, middle temporal, parahippocampal, ventral parietal, and midline posterior regions
19 (Renoult et al., 2019). Although based on the previous literature one might expect that the
20 hippocampus would be much more strongly associated with episodic memory, and the anterior
21 temporal lobe with semantic memory (Lambon Ralph et al., 2017), recent research suggests
22 otherwise: The hippocampus can facilitate the acquisition and retrieval of a rich semantic network
23 (Blumenthal et al., 2017; Cutler et al., 2019; Klooster et al., 2020; Sheldon & Moscovitch, 2012),
24 partly through relational processing (Duff et al., 2020) or pattern completion (Solomon &
25 Schapiro, 2020). Similarly, the lateral anterior temporal lobe may also be involved in episodic
26 recollection, as shown by its recruitment when successfully learning word pairs (de Chastelaine et
27 al., 2016; Renoult et al., 2019).

28 The considerable overlap between the two has sparked a rethinking of the classic
29 semantic-episodic dichotomy (Renoult et al., 2019). A major impediment, though, has been that a
30 large proportion of the existing data come from indirect comparisons of semantic and episodic
31 memory between different experiments. As mentioned above, this is partly due to semantic and
32 episodic memory being investigated in somewhat separate fields of study: comprehension of the
33 world through language or object identification for example (Binder & Desai, 2011; Kumar, 2021;
34 Lambon Ralph et al., 2017) vs. memory retrieval to think about the past, and particularly, personal
35 events (Maguire, 2001; Svoboda et al., 2006). Memory researchers sometimes control for
36 semantic or basic linguistic processes, but rarely fully match the semantic and episodic aspects
37 or compare them. This may stem from the difficulty in minimizing any differences between
38 semantic and episodic memory on task demands, including retrieval times (Renoult & Rugg,
39 2020), and other cognitive operations (e.g., control; Vatansever et al., 2021).

40 Another critical issue is that several types of declarative memory do not fit easily into the
41 standard semantic-episodic dichotomy. This is the case for "personal semantics", which involves
42 knowledge of one's personal past (Conway, 2005; Grilli & Verfaellie, 2014, 2015; Martinelli et al.,
43 2013; Renoult et al., 2012). Personal semantics lives conceptually between (or, perhaps, across)
44 the boundaries of semantic and episodic memory. It is personal (like episodic memories), but
45 detached from its context of acquisition (like semantic memories). Personal semantics includes
46 personal factual knowledge, such as autobiographical facts (e.g., *I am adept at yoga*), and

1 knowledge of repeated personally-experienced events, including contextual details that have
2 been abstracted across several instances (e.g., *my yoga routine when going to the gym*). Many
3 early descriptions assumed that personal semantics was part of semantic memory (Cermak &
4 O'Connor, 1983; Kopelman et al., 1989), but more recent evaluations suggest that this view was
5 too simplistic: whereas some forms of personal semantics—such as autobiographical facts—
6 appear to have neural correlates similar to semantic memory, others—such as memories of
7 repeated events—have neural correlates that are more similar to those of episodic memory. For
8 instance, in amnesic patients, memories of unique and repeated episodes are often impaired
9 together, whereas knowledge of general and personal facts are typically better preserved
10 (reviewed in Renoult et al., 2012).

11 Personal semantics is an understudied form of memory relative to semantic and episodic
12 memory, even though it has been reported to be the most common form of autobiographical
13 memory elicited in free and cued recall (Barsalou, 1988), and in brain stimulation studies (Curot
14 et al., 2017). Personal semantics play an important role in the retrieval of specific events
15 (Conway, 1987; Conway & Pleydell-Pearce, 2000; Haque & Conway, 2001), and such facilitation
16 can vary with the type of personal semantics (e.g., repeated events induce a greater facilitation
17 than autobiographical facts; Sheldon et al., 2020). The conceptualization of personal semantics is
18 grounded in the close proximity between semantic and episodic memory (as reviewed above;
19 Duff et al., 2020; Renoult et al., 2019). For instance, some general semantic concepts, such as
20 knowledge about unique entities like famous individuals can be “autobiographically significant”
21 and are tightly associated with episodic memories (Lambert, 2020; Renoult et al., 2015;
22 Westmacott et al., 2004; Westmacott & Moscovitch, 2003).

23 Despite the apparent importance of personal semantics and the notable interest
24 generated by a taxonomy of personal semantics (Renoult et al., 2012), few functional
25 neuroimaging studies have directly compared personal semantics to either semantic or episodic
26 memory, and even fewer have compared different types of personal semantics to one another or
27 personal semantics to both semantic and episodic memory. On the one hand, these have
28 indicated some differences across general semantic, personal semantic, and episodic memory:
29 Autobiographical facts have been associated with greater activity in the left medial frontal cortex
30 and retrosplenial cortex than general facts (Maguire & Frith, 2003), but have not differed in lateral
31 temporal activity (Maguire & Frith, 2003; Maguire & Mummery, 1999). Repeated events have
32 elicited less activity than unique events in the frontal pole, parahippocampal gyrus, posterior
33 cingulate and precuneus (Ford et al., 2011; Holland et al., 2011; Levine et al., 2004), but not
34 differed in hippocampal activity (notably, Addis, McIntosh, et al., 2004; Addis, Moscovitch, et al.,
35 2004). On the other hand, many existing data are compatible with the idea that these different
36 types of memories involve different levels of activity within a common network. For instance,
37 several neuroimaging studies have reported a graded increase in activity across semantic
38 memories, autobiographical facts, and episodic memories in medial prefrontal, temporal polar,
39 and retrosplenial cortex (Maguire, 2001; Maguire & Frith, 2003; Maguire & Mummery, 1999). In a
40 recent event-related potential (ERP) study (Renoult et al., 2016) that compared semantic memory
41 (i.e., general facts), two types of personal semantics (i.e., autobiographical facts and repeated
42 events) and episodic memory (i.e., unique events), a similar graded pattern occurred. Both types
43 of personal semantics produced intermediate mean amplitudes for the N400, an index of
44 semantic processing (Kutas & Federmeier, 2011), and for the Late Positive Component (LPC), an
45 index of episodic processing (Rugg & Curran, 2007), compared to general facts and unique
46 events (Renoult et al., 2016). The two types of personal semantics did not differ from one another
47 in this study (Renoult et al., 2016).

Given the questions about the relation between memory types across the semantic-episodic spectrum, here we used fMRI to directly compare brain activity during general semantic, episodic, and personal semantic processing within the same participants. They indicated whether closely matched-sentences were true in four conditions: 1) facts about people in general (i.e., general facts, reflective of semantic memory), 2) personal events that happened once (i.e., unique events, reflective of episodic memory), 3) facts about themselves (i.e., autobiographical facts, a type of personal semantics), and 4) events that happened repeatedly (i.e., repeated events, a type of personal semantics). The design enabled us to make as close of a comparison as possible between memory conditions. For example, the stimuli differed minimally in wording across conditions, being adjusted only in self-reference (i.e., referring to the self in all conditions but general facts) and temporal specificity (general for both types of facts, somewhat more specific for repeated events, and very specific for unique events). Further, even though semantic and episodic retrieval typically involve different retrieval times, our comparison of these memory types is unbiased by response time differences between conditions (Renoult et al., 2016).

We leveraged multivariate analysis methods (i.e., Partial Least Squares; PLS) to compare brain activity across these four memory conditions within a single analysis in a sample of 48 participants. Our analytical approach was blind to models or hypotheses, and instead operated in a data-driven manner to extract the relations between the memory conditions that explained the most covariance between the conditions and data in the spatial and temporal domains (Krishnan et al., 2011; McIntosh et al., 2004; McIntosh & Lobaugh, 2004). Although we expected memory types to be distinguishable, we also expected that the neural correlates of autobiographical facts would appear more similar to general facts whereas the neural correlates of repeated events would appear more similar to unique events (Renoult et al., 2012). The relation between memory types would be best described as one of a continuum: They would engage predominantly a common set of regions from the core memory network, but with increased intensity from the least (i.e., general fact) to the most (i.e., unique events) contextually specific memory type. This relation would depend on the differential engagement of component processes, such as sensory-perceptual imagery, spatial and temporal features, and self-reflection, which should be observed at the cognitive and brain level. In a behavioural study, we considered three key component processes that could dissociate the four memory types: self-relevance (expecting it to be lower for general facts than all personal forms of memory), visual details (expecting a linear increase), and the integration of details within a scene (expecting it to be low for general/autobiographical facts and high for repeated/unique events). Accordingly, brain regions involved in visuo-spatial processing and imagery, like the precuneus, and in self-reflection, like the medial prefrontal cortex, should be more tightly associated with memories of unique events, and minimally associated with general factual knowledge (Renoult et al., 2012). Similarly, brain regions known to have a crucial role in spatial processing and in representing scenes, such as the hippocampus, parahippocampal cortex and retrosplenial cortex should show greater activity for memories of unique and repeated events than for autobiographical and general facts. The visual details and scene components may depend on hippocampal processes, like relational (Duff et al., 2020) or constructive processes (Hassabis & Maguire, 2007, 2009; Schacter & Addis, 2007), to some extent, as the association with a diverse source of personal information becomes stronger from general facts to unique events (Sheldon et al., 2020; Sui & Humphreys, 2015).

Results

Multivariate Analyses

Mean-centered Partial Least Squares (PLS) with Memory & Control Condition

PLS produces latent variables (LVs); in this case, LVs were variables that explained a maximum of the covariance between the four memory conditions (general facts, autobiographical facts, repeated events, unique event) and the spatiotemporal aspects of brain activity (Abdi & Williams, 2013; Krishnan et al., 2011; McIntosh et al., 2004; McIntosh & Lobaugh, 2004). The first significant LV from the PLS analysis distinguished the four memory conditions from a control condition (i.e., odd/even judgments), explaining 84.94% of the cross-block covariance ($p < .001$, see Figure 1). The inclusion of a control condition – involving little memory processes like odd/even judgments – along with memory conditions in a PLS tends to pull out the memory network because the dissociation between the control and memory conditions explains a maximum of the covariance in the data (Addis, McIntosh, et al., 2004; Burianova & Grady, 2007; Sheldon & Levine, 2013; Spreng & Grady, 2010).

Brain scores guide the interpretation of PLS results. A participant's brain score for each task is derived from the multiplication of a voxel's BOLD signal with how much it contributes to the LV (i.e., its salience); the values from all voxels at all lags are then all summed together (Krishnan et al., 2011). Brain scores indicate how well each participant expressed the brain and task relation represented by the LV for each of the memory conditions. The temporal "brain scores" show that the conditions were maximally dissociated at the seventh lag, that is the seventh brain volume after the first acquisition or 8.4 seconds post cue onset, during the response screen (see Figure 2); this also applied to most LVs (described next). The maximal dissociation suggests this lag characterizes best the LV (see figure supplements for Figures 1 and 3 to 5 and Appendix 1–Tables 2 to 5 for additional lags). At lag 7, increased activity in regions from the "core memory network" dissociated the memory conditions from the control condition, including large regions of the prefrontal cortex and parietal cortex bilaterally, the medial temporal lobe, and the left lateral temporal cortex. The voxels that contributed the most to this brain LV, named "salience", can be found in Appendix 1–Table 1 and Appendix 1–Table 2 (Abdi & Williams, 2013).

A second significant LV ($p = .028$) accounted for 6.41% of the covariance. As this LV is similar to the LV described next (i.e., general/autobiographical facts vs. repeated/unique events), we do not discuss it further. No other LVs were significant, $p > .05$.

Mean-Centered PLS (Memory & Control) - LV 1

Figure 1. This mean-centered PLS included the control task in addition to the memory conditions. The first significant LV identified activation that dissociated all memory conditions from the control task. a) Average brain score. Error bars are ± 1 S.E. of bootstrap estimates. c) Brain scores shown at each lag (i.e., each TR/1.2 sec). Error bars are ± 1 S.E. b) & d) Brain scores at lag 7 with positive saliences shown in warm colours (increased activity for the control task relative to memory conditions) and negative saliences shown in cold colours (increased activity for the memory conditions relative to the control task). Brain scores are projected onto a surface from the Human Connectome Project (S1200; Van Essen et al., 2012) using Connectome Workbench (Marcus et al., 2011) in b) and the MNI152NLin2009cAsym volume using FSLeaves (McCarthy, Paul, 2021) in d). Bootstrap ratios are thresholded at ± 3 , $p < .001$. See Figure 1—figure supplement 1 for surface images of additional lags.

Figure 2. Task structure and durations. Each of the seven runs included the four memory conditions (general facts, autobiographical facts, repeated events, unique events). Each memory block started with instructions, followed with the ten trials for that memory condition. Each trial unfolded in this order: fixation cross (0.5 s), cue (2 s), sentence (4 s), response screen (3.5 s). We presented the odd even task (range 0 to 12 s, $M = 4.6$ s, 1 number per 2 s) during the interstimulus interval.

Mean-centered PLS with Memory Conditions

This mean-centered PLS included only the four memory conditions in order to hone in their similarities and differences. This PLS produced two significant LVs ($p \leq .005$), accounting for 45.79% and 32.58% of the cross-block covariance respectively.

LV 1

The first LV distinguished facts (general or autobiographical; negative “salience”, i.e., voxels that represent best the facts vs. events portion of the LV; Krishnan et al., 2011) from events (repeated or unique; positive saliences, i.e., voxels that represent best the events vs. facts portion of the LV; see Figure 3).

General facts and autobiographical facts were associated with increased activity in the lateral occipital cortex bilaterally and in regions of the right hemisphere: the frontal pole, inferior/middle frontal gyrus, the supramarginal cortex, and superior parietal lobule (see Table 1 for lag 7 and Appendix 1–Table 3 for additional lags).

Repeated events and unique events were associated with increased activity bilaterally in regions along the cortical midline, such as the frontal pole, frontal medial cortex, paracingulate gyrus, posterior cingulate, precuneus. Additionally, repeated and unique events were associated

with increased activity in the bilateral middle/superior frontal gyrus, left parahippocampal gyrus, left hippocampus, left middle/superior temporal gyrus, and angular gyrus bilaterally.

Figure 3. This mean-centered PLS included the four memory conditions and produced two significant LVs. The first LV identified activation that dissociated facts from events. a) Average brain score. Error bars are ± 1 S.E. of bootstrap estimates. c) Brain scores shown at each lag (i.e., each TR/1.2 sec). Error bars are ± 1 S.E. b) & d) Brain scores at lag 7 with positive saliences shown in warm colours (increased activity for events relative to facts) and negative saliences shown in cold colours (increased activity for facts relative to events). Brain scores are projected onto a surface from the Human Connectome Project (S1200; Van Essen et al., 2012) using Connectome Workbench (Marcus et al., 2011) in b) and the MNI152Nlin2009cAsym volume using FSLeaves (McCarthy, Paul, 2021) in d). Bootstrap ratios are thresholded at ± 3 , $p < .001$. See Figure 3—figure supplement 1 for additional lags.

Table 1. Peaks of Clusters for LV 1 of the Mean-Centered PLS (Memory only) at Lag 7

Boot- strap Ratio	Cluster Size (voxels)	X (mm)	Y (mm)	Z (mm)	Anatomical Automatic Labeling (AAL)	Atlas of Intrinsic Connectivity of Homotopic Areas (AICHA)	Harvard Oxford, Probability Atlas
Negative Saliences							
-5.57	217	40.0	45.0	25.0	Right Middle Frontal Gyrus	Right Middle Frontal Gyrus - Subpart 3	88% Right Frontal Pole
-5.31	163	57.5	12.5	12.5	Right Inferior Frontal Gyrus - Opercular Part	Right Rolandic Operculum Gyrus - Subpart 1	64% Right Inferior Frontal Gyrus Pars Opercularis; 25%

							Right Precentral Gyrus
-5.16	440	40.0	-80.0	25.0	Right Middle Occipital Gyrus	Right Middle Occipital Gyrus - Subpart 4	72% Right Lateral Occipital Cortex Superior Division
-5.15	309	67.5	-42.5	22.5	Right Superior Temporal Gyrus	No Label	19% Right Supramarginal Gyrus Posterior Division
-4.68	136	-47.5	-70.0	5.0	Left Middle Occipital Gyrus	Left Inferior Occipital Gyrus - Subpart 2	84% Left Lateral Occipital Cortex Inferior Division
-4.59	115	22.5	-70.0	55.0	Right Superior Parietal Gyrus	Right Intraparietal Sulcus - Subpart 3	69% Right Lateral Occipital Cortex Superior Division
Positive Saliences							
4.62	113	-5.0	30.0	37.5	Left Superior Frontal Gyrus - Medial	Left Cingulate Sulcus - Subpart 1	63% Left Paracingulate Gyrus; 13% Left Superior Frontal Gyrus
5.58	149	25.0	22.5	45.0	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus Subpart 5	32% Right Superior Frontal Gyrus; 31% Right Middle Frontal Gyrus
5.68	225	-5.0	-37.5	45.0	Left Middle Cingulate & Paracingulate Gyri	Left Precuneus Gyrus - Subpart 4	49% Left Cingulate Gyrus Posterior Division; 31% Left Precuneus Cortex
6.10	139	-52.5	15.0	37.5	Left Middle Frontal Gyrus	Left Inferior Frontal Sulcus - Subpart 2	54% Left Middle Frontal Gyrus; 5% Left Inferior Frontal Gyrus Pars Opercularis
6.62	114	-27.5	-40.0	-10.0	Left Parahippocampal Gyrus	Left Parahippocampal Gyrus - Subpart 5	29% Left Parahippocampal Gyrus Posterior Division; 27% Left Lingual Gyrus; 8% Left Temporal Occipital Fusiform Cortex; 7% Left Temporal Fusiform Cortex Posterior Division

6.71	112	-57.5	-5.0	-12.5	Left Middle Temporal Gyrus	Left Superior Temporal Sulcus - Subpart 2	37% Left Middle Temporal Gyrus Anterior Division; 23% Left Superior Temporal Gyrus Anterior Division; 9% Left Superior Temporal Gyrus Posterior Division
6.92	426	-20.0	30.0	45.0	Left Superior Frontal Gyrus - Dorsolateral	Left Superior Frontal Gyrus Subpart 4	45% Left Superior Frontal Gyrus; 7% Left Middle Frontal Gyrus
6.94	159	45.0	-75.0	37.5	Right Angular Gyrus	No Label	68% Right Lateral Occipital Cortex Superior Division
7.24	470	0.0	57.5	-5.0	Left Superior Frontal Gyrus - Medial Orbital	No Label	25% Right Frontal Pole; 20% Left Frontal Pole; 5% Right Frontal Medial Cortex
9.27	1161	-12.5	-62.5	20.0	Left Cuneus	Left Precuneus Gyrus - Subpart 1	44% Left Precuneus Cortex; 21% Left Supracalcarine Cortex
9.66	468	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division

Note. Thresholded at bootstrap ratio at ± 3 ($p < .001$), minimal cluster size of 80 voxels and a minimal distance of 10 voxels. Labels from AAL (Rolls et al., 2015), AICHA (Joliot et al., 2015) and Harvard-Oxford (Desikan et al., 2006) atlases came from AtlasReader (Notter et al., 2019).

LV 2

The second LV distinguished repeated events predominantly from unique events (and autobiographical facts to a lesser extent). General facts did not contribute to this LV. Only positive saliences remained after thresholding. Increased activity in the right and left occipital pole differentiated repeated events from unique events (see Figure 4, Table 2 for Lag 7, and Appendix 1–Table 4 for additional lags).

Figure 4. This mean-centered PLS included the four memory conditions and produced two significant LVs. The second LV dissociated repeated events from unique events and autobiographical facts. a) Average brain score. Error bars are ± 1 S.E. of bootstrap estimates. c) Brain scores shown at each lag (i.e., each TR/1.2 sec). Error bars are ± 1 S.E. b) & d) The positive saliences, in warm colours, reflect increased activation for repeated events compared to unique events and autobiographical facts, whereas negative saliences (in cold colours) reflect increased activation for unique events and autobiographical facts compared to repeated events. Brain scores are projected onto a surface from the Human Connectome Project (S1200; Van Essen et al., 2012) using Connectome Workbench (Marcus et al., 2011) in b) and the MNI152Nlin2009cAsym volume using FSLeyes (McCarthy, Paul, 2021) in d) Bootstrap ratios are thresholded at ± 3 , $p < .001$. See Figure 4—figure supplement 1 for additional lags.

Table 2. Peaks of Clusters for LV 2 of the Mean-Centered PLS (Memory only) at Lag 7

Boot- strap Ratio	Cluster Size (voxels)	X (mm)	Y (mm)	Z (mm)	Anatomical Automatic Labeling (AAL)	Atlas of Intrinsic Connectivity of Homotopic Areas (AICHA)	Harvard Oxford, Probability Atlas
Positive Saliences							
5.38	147	-7.5	-95.0	-5.0	Left Calcarine Fissure & Surrounding Cortex	Left Calcarine Gyrus - Subpart 3	61% Left Occipital Pole; 6% Left Intracalcarine Cortex
6.43	194	15.0	-92.5	2.5	Right Calcarine Fissure & Surrounding Cortex	Right Calcarine Gyrus - Subpart 3	58% Right Occipital Pole; 6% Right Intracalcarine Cortex

Note. Thresholded at bootstrap ratio at ± 3 ($p < .001$), minimal cluster size of 80 voxels and a minimal distance of 10 voxels. Labels from AAL (Rolls et al., 2015), AICHA (Joliot et al., 2015) and Harvard-Oxford (Desikan et al., 2006) atlases came from AtlasReader (Notter et al., 2019).

Non-Rotated PLS with A-priori Contrast

Non-rotated PLS can be used to specify theoretically relevant contrasts that may not emerge in mean-centered PLS, because it seeks to explain a maximum of the covariance and LVs must be orthogonal (McIntosh & Lobaugh, 2004). We used a non-rotated PLS to test whether a linear contrast adequately explained the relation between the four memory conditions and to explore which brain regions would track that relation. A linear contrast would be consistent with the continuum perspective of personal semantics, which would predict an increase in activity from general facts to autobiographical facts to repeated events to unique events (-2, -1, 1, 2).

This PLS produced a significant LV ($p < .001$). The regions resemble those of LV 1 (general/autobiographical facts vs repeated/unique events) of the mean centered PLS with the four memory conditions (see Figure 5). Activity increased from general to autobiographical facts, from autobiographical facts to repeated events, and from repeated to unique events bilaterally in the large regions of the frontal cortex (frontal pole, paracingulate gyrus, frontal medial cortex), precuneus, posterior cingulate cortex, retrosplenial cortex, angular gyrus, and with activity of the right middle frontal gyrus, left parahippocampal gyrus, left hippocampus, and left middle and superior temporal gyrus (see Table 3 and Appendix 1–Table 5). Activity progressively decreased from general to autobiographical facts, from autobiographical facts to repeated events, and from repeated to unique events in areas of the right frontal inferior gyrus, superior parietal lobule, supramarginal gyrus, and bilateral lateral occipital cortex. In supplementary analyses, the brain scores of each memory condition differed from one another (see Appendix 2).

Table 3. Peaks of Clusters for Non-rotated PLS (linear contrast) at Lag 7.

Bootstrap Ratio	Cluster Size (voxels)	X (mm)	Y (mm)	Z (mm)	Anatomical Automatic Labeling (AAL)	Atlas of Intrinsic Connectivity of Homotopic Areas (AICHA)	Harvard Oxford, Probability Atlas
Negative Saliences							
-5.48	160	42.5	37.5	10.0	Right Inferior Frontal Gyrus - Triangular Part	Right Inferior Frontal Sulcus, - Subpart 1	53% Right Frontal Pole; 16% Right Inferior Frontal Gyrus Pars Triangularis
-5.03	127	-47.5	-70.0	5.0	Left Middle Occipital Gyrus	Left Inferior Occipital Gyrus - Subpart 2	84% Left Lateral Occipital Cortex Inferior Division
-4.98	250	42.5	-50.0	57.5	Right Superior Parietal Gyrus	Right Intraparietal Sulcus - Subpart 2	46% Right Superior Parietal Lobule; 20% Right Angular Gyrus

-4.96	376	42.5	-77.5	5.0	Right Middle Occipital Gyrus	Right Lateral Occipital Gyrus - Subpart 5	62% Right Lateral Occipital Cortex Inferior Division
-4.86	155	57.5	10.0	12.5	Right Inferior Frontal Gyrus - Opercular Part	Right Rolandic Operculum Gyrus - Subpart 1	43% Right Inferior Frontal Gyrus Pars Opercularis; 39% Right Precentral Gyrus
-4.76	83	15.0	-60.0	57.5	Right Superior Parietal Gyrus	Right Superior Parietal Gyrus - Subpart 5	40% Right Lateral Occipital Cortex Superior Division; 12% Right Superior Parietal Lobule; 5% Right Precuneus Cortex

Positive Saliences

4.93	103	-5.0	30.0	37.5	Left Superior Frontal Gyrus - Medial	Left Cingulate Sulcus - Subpart 1	63% Left Paracingulate Gyrus; 13% Left Superior Frontal Gyrus
5.26	122	25.0	20.0	42.5	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 5	22% Right Middle Frontal Gyrus; 19% Right Superior Frontal Gyrus
6.05	230	-5.0	-37.5	42.5	Left Middle Cingulate & Paracingulate Gyri	Left Middle Cingulum Gyrus - Subpart 3	54% Left Cingulate Gyrus Posterior Division; 25% Left Precuneus Cortex
6.22	134	-52.5	15.0	37.5	Left Middle Frontal Gyrus	Left Inferior Frontal Sulcus - Subpart 2	54% Left Middle Frontal Gyrus; 5% Left Inferior Frontal Gyrus Pars Opercularis
6.57	112	-27.5	-40.0	-10.0	Left Parahippocampal Gyrus	Left Parahippocampal Gyrus - Subpart 5	29% Left Parahippocampal Gyrus Posterior Division; 27% Left Lingual Gyrus; 8% Left Temporal Occipital Fusiform Cortex; 7% Left Temporal Fusiform Cortex Posterior Division
6.74	151	45.0	-75.0	37.5	Right Angular Gyrus	No Label	68% Right Lateral Occipital Cortex Superior Division
7.02	99	-57.5	-5.0	-12.5	Left Middle Temporal Gyrus	Left Superior Temporal Sulcus - Subpart 2	37% Left Middle Temporal Gyrus Anterior Division; 23% Left Superior

							Temporal Gyrus Anterior Division; 9% Left Superior Temporal Gyrus Posterior Division
7.06	409	-20.0	17.5	47.5	Left Superior Frontal Gyrus - Dorsolateral	Left Superior Frontal Sulcus - Subpart 4	37% Left Superior Frontal Gyrus; 6% Left Middle Frontal Gyrus
7.15	630	0.0	55.0	-5.0	Left Superior Frontal Gyrus - Medial Orbital	No Label	17% Right Frontal Pole; 12% Left Frontal Pole; 9% Right Paracingulate Gyrus; 9% Right Frontal Medial Cortex; 6% Left Paracingulate Gyrus; 6% Left Frontal Medial Cortex
9.60	449	-30.0	-82.5	45.0	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	44% Left Lateral Occipital Cortex Superior Division
10.04	1125	-15.0	-62.5	22.5	Left Cuneus	Left Precuneus Gyrus - Subpart 1	54% Left Precuneus Cortex; 12% Left Supracalcarine Cortex

Note. Thresholded at bootstrap ratio at ± 3 ($p < .001$), minimal cluster size of 80 voxels and a minimal distance of 10 voxels. Labels from AAL (Rolls et al., 2015), AICHA (Joliot et al., 2015) and Harvard-Oxford (Desikan et al., 2006) atlases came from AtlasReader (Notter et al., 2019).

Figure 5. This non-rotated PLS tested a linear contrast (-2, -1, 1, 2). This LV shows regions associated with an increase in activity from general facts to autobiographical facts to repeated events to unique events. a) Average brain score. Error bars are ± 1 S.E. of bootstrap estimates. c) Brain scores shown at each lag (i.e., each TR/1.2 sec). Error bars are ± 1 S.E. b) & d) Brain scores with positive saliences shown in warm colours (increased activity from general facts to autobiographical facts to repeated events to unique events) and negative saliences shown in cold colours (decreased activity from general facts to autobiographical facts to repeated events to unique events). Brain scores are projected onto a surface from the Human Connectome Project (S1200; Van Essen et al., 2012) using Connectome Workbench (Marcus et al., 2011) in b) and the MNI152NLin2009cAsym volume using FSLeaves (McCarthy, Paul, 2021) in d). Bootstrap ratios are thresholded at ± 3 , $p < .001$. See Figure 5—figure supplement 1 for additional lags.

Behavioural Data

A separate sample of 106 participants rated their subjective experience during memory retrieval, using the same paradigm, but were not scanned. Repeated measures ANOVA showed that the main effect of Memory was significant for all dependant variables ($p_s < .001$). Self-relevance was lowest for general facts compared to all personal forms of memory, and lower for personal semantics (i.e., autobiographical facts and repeated events) than unique events (see Table 4, and Figure 6a). Additionally, the amount of visual detail increased from general facts to autobiographical facts to repeated events to unique events (see Table 4 and Figure 6b).

Table 4. T-test Values for Pairwise Comparisons of Memory Types on Self-relevance and Visual Details.

Comparison	<i>t</i> (105)	<i>p</i>	<i>g</i>	CI 95% of <i>g</i>
Self relevance				

General facts vs. Autobiographical facts	-13.94	.001*	-1.35	[-1.61, -1.08]
General facts vs. Repeated events	-12.23	.001*	-1.18	[-1.43, -0.93]
General facts vs. Unique events	-14.90	.001*	-1.44	[-1.71, -1.17]
Autobiographical facts vs. Repeated events	-0.61	.541	-0.06	[-0.25, 0.13]
Autobiographical facts vs. Unique events	-4.49	.001*	-0.44	[-0.63, -0.24]
Repeated events vs. Unique events	-4.32	.001*	-0.42	[-0.62, -0.22]
Visual details				
General facts vs. Autobiographical facts	-5.14	.001*	-0.50	[-0.70, -0.30]
General facts vs. Repeated events	-6.56	.001*	-0.64	[-0.84, -0.43]
General facts vs. Unique events	-8.98	.001*	-0.87	[-1.09, -0.64]
Autobiographical facts vs. Repeated events	-2.07	.041*	-0.20	[-0.39, -0.01]
Autobiographical facts vs. Unique events	-5.46	.001*	-0.53	[-0.73, -0.33]
Repeated events vs. Unique events	-3.45	.001*	-0.33	[-0.53, -0.14]
<i>Note.</i> *significant after correction for multiple comparisons.

Figure 6. Violin plots of A) self-relevance ratings and B) visual details ratings per condition. Red points represent scores of individual participants ($N = 106$). Black lines show the median and quartiles. * $p < .05$, *** $p < .001$.

The conjunction of details within a spatial context, or a scene, is sometimes perceived as integral to the recollection of events (Hassabis & Maguire, 2009). From that perspective, visual details and scene imagery can be dissociable constructs. A smaller proportion of general facts evoked a scene compared to the three personal memory types (see Table 5 and Figure 7c). Similarly, a smaller proportion of autobiographical facts elicited images of a scene compared to repeated events and unique events. Repeated events and unique events did not differ in the proportion of memories perceived as scenes (see Appendix 3 for the statistical tests of vague/nothing and object responses).

Table 5. T-test Values for Pairwise Comparisons of Memory Types on the Proportion of Scenes

Comparison	$t(105)$	p	g	CI 95% of g
General facts vs. Autobiographical facts	-2.34	.021*	-0.23	[-0.42, -0.03]
General facts vs. Repeated events	-6.51	< .001*	-0.63	[-0.84, -0.42]
General facts vs. Unique events	-7.98	< .001*	-0.77	[-0.99, -0.56]
Autobiographical facts vs. Repeated events	-4.75	< .001*	-0.46	[-0.66, -0.26]
Autobiographical facts vs. Unique events	-6.52	< .001*	-0.63	[-0.84, -0.42]
Repeated events vs. Unique events	-1.28	.204	-0.12	[-0.31, 0.07]

Note. *significant after correction for multiple comparisons.

Figure 7. Violin plots of the proportion of yes responses that were categorized as perceived as A) nothing/vague, B) an object, C) a scene. Red points represent scores of individual participants ($N = 106$). Black lines show the median and quartiles. * $p < .05$, ** $p < .01$, *** $p < .001$.

Discussion

Recent progress in cognitive neuroscience has reignited interest in the classic semantic-episodic distinction (Renoult et al., 2019) and in memory types that may cut across it (Grilli & Verfaellie, 2014; Renoult et al., 2012). In this study, we directly compared four types of memory: one prototypical of semantic memory, one prototypical of episodic memory, and two intermediate (i.e., two types of personal semantics). We closely matched the four memory conditions: We varied the stimuli only in self-relevance (i.e., not self-relevant for general facts and self-relevant for other conditions) and temporal specificity (atemporal/general for both types of facts, more specific for repeated events, and very specific for unique events), in keeping with the distinctions across these four memory types. All conditions peaked at the same time in key fMRI analyses.

Personal semantic, general semantic, and episodic memory had both shared and unique neural correlates. The shared neural correlates were revealed when contrasting the four memory conditions with a control condition. Activity in several regions of the “core memory network” (Addis et al., 2016; Burianova & Grady, 2007; Rugg & Vilberg, 2013; Svoboda et al., 2006) dissociated the four memory conditions from the control condition, including in the inferior/middle frontal gyrus, caudate, lingual gyrus, parahippocampus, and hippocampus bilaterally, and the left middle/superior temporal gyrus.

In contrast, the unique neural correlates were evident when examining the four memory conditions on their own. Several regions from the core memory network (described above) showed increased activity for repeated/unique events relative to general/autobiographical facts, such as the precuneus, posterior cingulate, angular gyrus and middle frontal gyrus bilaterally, and left parahippocampus, left hippocampus, and left middle/superior temporal gyrus. In contrast, general/autobiographical facts were associated with increased activity predominantly in the right hemisphere, particularly the frontal pole, inferior frontal gyrus, and supramarginal cortex. A linear contrast from general facts to autobiographical facts to repeated events to unique events best explained activity in many regions associated with increased activity for memory for repeated/unique events relative to memory for general/autobiographical facts, including posterior medial and medial temporal regions. These findings are compatible with a continuum perspective of declarative memory, according to which quantitative rather than qualitative variations in brain activity are observed when comparing these memory types (Renoult et al., 2012).

The core network, also known as the default mode network, has been subdivided into an anterior temporal network linked to “entities” (Ranganath & Ritchey, 2012; Reagh & Ranganath, 2018) or “conceptual remembering” (Sheldon et al., 2019) and a posterior medial network linked to “situational models” (Ranganath & Ritchey, 2012; Reagh & Ranganath, 2018) or “perceptual remembering” (Sheldon et al., 2019). Although these networks process different kinds of information, neither is strictly dedicated to semantic or episodic memory (Reagh & Ranganath, 2018; Sheldon et al., 2019). For instance, knowledge can facilitate the search and construction of events (Irish & Piguet, 2013) and semantic memory can integrate contextual information (e.g., Greenberg et al., 2009; Sheldon & Moscovitch, 2012). Accordingly, in our study the dissociation between general/autobiographical facts and repeated/unique events did not follow a clear posterior medial to anterior temporal shift. Nevertheless, events contained greater contextual information, as suggested by the increased proportion of scenes they evoked, as compared to factual memories. Further, cues were more temporally specific for repeated/unique events than general/autobiographical facts. Consistent with this, many regions of the posterior medial networks were associated with greater activity for repeated/unique events than

1 general/autobiographical facts (similar to Ford et al., 2011; Levine et al., 2004; Maguire &
2 Mummery, 1999), and showed a linear increase from the most general type of memory (i.e.,
3 general facts) to the most specific memory (i.e., unique events).

4 Increased activity in the occipital poles distinguished repeated events primarily from
5 unique events. A visual difference in stimuli presentation, like stimuli length, could offer one
6 possible explanation. Although repeated events had longer stimuli than all other conditions (see
7 Appendix 4), a sole contribution of stimuli length would rather predict that repeated events would
8 be dissociated from all other conditions in the extent or intensity of activity in the occipital poles.
9 Instead, repeated events were predominantly dissociated from unique events, whereas
10 autobiographical and general facts made little or no contribution to this LV. Another possibility is
11 that activity in the occipital regions reflects the amount and coarseness of visual details
12 (Bainbridge et al., 2021; Bone & Buchsbaum, 2021; Buchsbaum et al., 2012; Rugg et al., 2008) in
13 episodic representations. In our behavioural study, the rating of visual details captured both the
14 overall number of objects and people and the level of detail of each object and person (per
15 instructions). Repeated events may produce stable, schema-like, representations (Ece & Gülgöz,
16 2021) that enhance some aspects of the visual representation relative to a single event. For
17 example, the visual details of unique events could be more abundant (e.g., objects, scene,
18 people) but precise only for the highly distinctive elements, whereas the multiple exposure to
19 visual details that would be inherent to repeated events could increase the precision of its stable
20 features. Future research should examine the visual characteristics of recall while comparing
21 repeated events and unique events using cues that are visually matched. In this study, a possible
22 contribution of stimuli length to neural activity in occipital poles cannot be excluded.

23 The behavioral data revealed the sentence cues induced typical phenomenological
24 experience associated with these memory types. Self-relevance was rated lowest for general
25 facts compared to all personal forms of memory, and lower for personal semantics (i.e.,
26 autobiographical facts and repeated events) than unique events. Additionally, the amount of
27 visual details increased from general facts to autobiographical facts to repeated events to unique
28 events. This is consistent with previous studies. For example, as compared to unique events,
29 repeated events are generally remembered less vividly: they are associated with reduced
30 temporal specificity, personal significance, emotionality, and amount of details (e.g., Addis,
31 Moscovitch, et al., 2004; Holland et al., 2011; Levine et al., 2004). Lastly, the four memory
32 conditions differed in the proportion of scenes that came to mind during retrieval. A smaller
33 proportion of general facts and autobiographical facts were categorized as scenes compared to
34 repeated events and unique events, which did not differ in scene responses. This is consistent
35 with the idea that both memories of unique and repeated events share a spatial organization that
36 gives them their “basic context”, as well as a 1st person perspective, detailed visual imagery
37 (Hassabis & Maguire, 2007, 2009; Nadel, 1991; Robin, 2018; Robin et al., 2016; Rubin, 2021;
38 Rubin & Umanath, 2015). Thus, scenes are thought to be a dominant and integral feature of
39 events (Hassabis & Maguire, 2007, 2009; Nadel, 1991; Robin, 2018; Robin et al., 2016; Rubin,
40 2021; Rubin & Umanath, 2015), but this has not been argued for “facts”. Although context can
41 shape semantic processing (Yee & Thompson-Schill, 2016), the representation of general and
42 experience-far autobiographical facts (Grilli & Verfaellie, 2016) may rely less on entities within a
43 context or the context itself and more or as much on the conceptual representation of individual
44 entities, such as objects and words, than repeated and unique events. Facts, in particular
45 personal facts, may evoke episodes and scenes along with them, as in autobiographically
46 significant concepts (Renoult et al., 2015; Westmacott et al., 2004; Westmacott & Moscovitch,
47 2003), for example, a person could automatically recall going to a gift store when trying to decide

1 what is their favourite gift. Nevertheless, “scenes” would not be an integral component to
2 general/autobiographical facts in the same way that they would be for repeated/unique events
3 (Rubin, 2021; Rubin et al., 2019; Rubin & Umanath, 2015). In this study, the importance of
4 visuospatial processes was not commensurate with characteristics of the stimuli, which differed
5 little across conditions and primarily increased in temporal specificity (e.g., General facts: “Most
6 people wear jeans”; Autobiographical facts: “Sometimes I wear jeans.”; Repeated events: “When
7 at work, I have worn jeans.”; Unique events: “Yesterday, I wore jeans”).

8 Taken together, our data corresponds with a continuum perspective of declarative
9 memory, with the different memory types varying in magnitude of activation within a common
10 network of brain regions. What underlies this overlap in the neural substrates of semantic and
11 episodic memory? A parsimonious explanation is that semantic and episodic memory rely on
12 similar elementary component processes (Cabeza & Moscovitch, 2013; Larsen, 1992;
13 Moscovitch, 1992; Renoult et al., 2012; Rubin, 2021). All types of memories would depend on a
14 similar network of brain regions but with different weighting of certain nodes in the network. The
15 identification of the relative contribution of different component processes is a critical next step.
16 *Some* of the characteristics that would influence differences in hippocampal activity and other
17 regions of the core memory network include: the number of details (Thakral et al., 2020), their
18 association (Duff et al., 2020; Solomon & Schapiro, 2020), their integration within a scene (Nadel,
19 1991; Robin, 2018; Robin et al., 2016; Rubin & Umanath, 2015) or within a situational model
20 (Reagh & Ranganath, 2018; Summerfield et al., 2010), their coarseness and precision (Craik,
21 2020; Ekstrom & Yonelinas, 2020), their type and modality (e.g., perceptual, spatial, temporal,
22 social; Binder & Desai, 2011; Grilli & Verfaellie, 2016; Sheldon et al., 2019), their stability (Auger
23 & Maguire, 2018), as well as their projection into a temporally-distant time (Andrews-Hanna et al.,
24 2010), the open-endedness of the representation (Sheldon & Moscovitch, 2012), the demands on
25 pattern separation to construct unique representations or identify distinguishing features (Rolls &
26 Kesner, 2006; Schapiro et al., 2017), and the likelihood of eliciting a specific event (Renoult et al.,
27 2015; Westmacott et al., 2004; Westmacott & Moscovitch, 2003). For instance, episodic memory
28 would typically rely to a greater degree than semantic memory on rich sensory-perceptual
29 imagery, complex situational models or scenes, spatial and temporal features, and self-reflection.
30 Accordingly, instead of activating different networks of brain regions, semantic and episodic
31 processes may activate a similar network but with different degrees of magnitude. How each
32 component is involved would also depend on the task at hand (e.g., Gurguryan & Sheldon, 2019).
33 Our neuroimaging data, and complementary behavioral data obtained outside the scanner, are
34 compatible with this component process view and inconsistent with strictly separated memory
35 systems. The operationalization of different types of personal semantics and their inclusion in a
36 model of declarative memory does not promote fragmentation. Rather, a taxonomy of personal
37 semantics offers an opportunity to explore what brings all forms of memory together and what can
38 sometimes pull them apart.

40 **Materials and Methods**

42 **MRI Study Participants**

43 The fifty-three participants (35 women, 18 men) were aged 24.89 years old on average ($SD =$
44 4.51; range: 19-34) and attained a mean of 16.43 years of education ($SD = 2.42$). This sample
45 size was the largest that was possible to achieve. The sample size offers a compromise between
46 the sample size of similar studies (e.g. $N \sim 12-28$; Addis et al., 2011; Burianova & Grady, 2007;

Ford et al., 2011; Holland et al., 2011) and a possible ideal to obtain stable results in multivariate analyses (e.g., $N \sim 80$; Grady et al., 2021). Participants responded to ads on university campuses and on social media. Candidates were retained if they were right-handed, native English speakers, free of any contraindication for MRI (e.g., ferromagnetic metal, back pain, claustrophobia), aged between 18 to 35 years old, and had not experienced head injury, or neurological and psychiatric disorders. We excluded three participants because of an inadvertent phase encoding switch, one for an incidental finding, and one for ineligibility. Participants received a compensation of 30 CAD. The study received REB approval at the University of Ottawa (H08-16-32), and the Royal Ottawa Mental Health Centre (ROH; 2016023).

Behavioural Study Participants

The total sample included 181 participants (143 women, 34 men, 2 non-binary; 2 missing values); they were 18.79 years old on average ($SD = 1.58$; range: 17-34; 2 missing values) and had attained a mean of 12.67 years of education ($SD = 1.02$; 3 missing values). The possible small differences between proximal memory types (e.g., Addis, Moscovitch, et al., 2004; Maguire & Mummery, 1999; Renoult et al., 2016) justified the large sample size. We recruited participants from a pool of students who received a credit towards their introductory or research methods course. The ad specified the eligibility criteria, which were the same as the fMRI study apart from those for MRI safety. We excluded participants who disclosed information that conflicted with the criteria (n for primary reason listed): 18-35 years old ($n = 1$), right-handed ($n = 2$), normal or corrected-to-normal vision ($n = 1$), no neurological or psychiatric disorder (past/present) or no loss of consciousness lasting more than 10 minutes ($n = 26$), and native English speakers ($n = 35$). We also excluded 1 participant for being inattentive during testing (i.e., looking at the cellphone during the task), and 9 for implausible data (i.e., always responding “yes”) or incomplete data (e.g., entire task or questionnaire). We included 106 participants (87 women, 19 men) with a mean age of 18.74 ($SD = 1.05$, range 18-23) and 12.67 years of education on average ($SD = 0.97$). The study received REB approval at the University of Ottawa (H08-16-32).

MRI Task and Procedure

All tasks described below were administered via E-Prime 2.0 (Psychology Software Tools, Inc, 2012). We optimized the sentence verification task used in an electrophysiological study (Foster et al., 2012; Renoult et al., 2016) for fMRI. The four experimental conditions (general facts, autobiographical facts, repeated events, unique events) consisted of the same 70 main clauses (material available in Appendix 4). The conditions differed in two aspects: 1) The tense changed from past tense for unique events, to present perfect for repeated events, to present for facts (general and autobiographical). The type of awareness associated with semantic memory is indeed thought to be centered in the present, whereas episodic recollection is oriented towards the past (Tulving, 2001, 2002). 2) We added distinct cue words that preceded each condition and gave different degrees of temporal specificity. We used 6 to 7 cues per condition. In the unique events condition, we used specific time cues (last night, last week-end, this morning, this week, today, yesterday) to promote access to specific instances of events (e.g., “Yesterday, I took a picture”). In the repeated events condition, we used script-like cues (when alone, when at a clinic, when at work, when on the bus, when on vacation, when shopping, when with friends), and constrained their temporal scope by asking participants to verify sentences by thinking about events that happened repeatedly within the last year (e.g., “When shopping, I have taken a

picture”). In the autobiographical facts condition, we used general time cues (everyday, often, rarely, sometimes, usually, very often) for participants to report what is usual for them (“Very often, I take pictures”). For the general facts condition, the first-person personal pronoun (I) and the 6 cues were replaced by 6 distinct 3rd person perspectives (everyone, few people, many people, most people, no one, some people), and participants had to report what they thought was generally true for people in their country (“Few people take pictures”). The task involved pressing one of two buttons to produce a “yes” or “no” response to indicate whether the statements were true.

The cue (e.g., last weekend) was presented for ~2 s, followed with the main clause (e.g., I went to the pharmacy) for ~4 s. Participants responded after each statement during a response screen that lasted ~3.5 s and which displayed the response options. The separate response screen minimized the contribution of response-related motor activity during the experimental tasks (see Appendix 5 for the analysis of response time). Participants completed an odd/even task during a jittered interval that lasted from 0 to 12 seconds (mean of 4.6 secs; adapted from Madore et al., 2016). Participants indicated whether a digit was even using the same response options and buttons as the main task (i.e., yes, no). Each digit was shown in letters for two seconds; thus, participants performed the task for up to six digits (see Figure 2). We obtained duration for the intervals from Optseq2, with some adaptations (Dale, 1999).

We blocked the trials of a given memory condition together within each run. We selected a mixed design to minimize switch costs and to repeat the instructions briefly prior to the series of trials. We asked participants to think about what is usually true for people in general in this country (for general facts) or usually true for oneself (for autobiographical facts), and whether events happened repeatedly within the last year (for repeated events) or at a specific time within the last week (for unique events). Each of the seven runs included the four memory conditions, each comprising 10 trials. A run lasted 10.6 minutes. We attributed the stimuli to a run to maximize the likelihood of obtaining a “yes” response for each memory condition within each run. The likelihood was determined based on the frequency of yes responses per item in (Renoult et al., 2016) and pilot data. The aim of the piloting was to obtain a comparable number of yes and no responses (in other words approximately 35 in each condition; see Appendix 6 for the description and analysis of the number of responses). The attribution of stimuli to a run was fixed. All participants received the same randomized order of the memory conditions, but a different randomized order of stimuli within each memory block. The stimuli were displayed in Arial in size 30, in white colour over a black background. The task was presented visually on a mirror mounted over the head coil, and responses were made by pressing one of two buttons (for yes or no) on a MR safe response box.

All data were acquired within a single session, except for one participant who completed the study in two sessions because of a scanner issue. Participants practiced with a short version of the task outside and inside the scanner. In a post-scan interview, participants described briefly what they were thinking about during a few trials. Scanner time was 90 minutes. For the other steps, starting with consent and ending with debriefing, the study required an additional 60 minutes approximately.

Behavioural Study Task

We tested participants in groups of 1 to 4. They completed individually the sentence verification task (described above), but we replaced the control task with subjective ratings, and participants completed only two runs (i.e., 20 stimuli per memory condition). The stimuli were randomized

such that each participants received 20 randomly-selected stimuli per condition and all stimuli should be represented equally across all participants. After their yes/no response, participants performed a scene rating, details rating, and a self-relevance rating (no time limit). The order of the ratings was counterbalanced across participants. Participants indicated whether what they pictured in their mind was: 1) nothing/vague, 2) objects only, or 3) whole scene (based on Palombo et al., 2018). Participants rated the amount of visual details that came to mind from 1 (none) to 5 (a lot; based on D'Argembeau & Van der Linden, 2006). We provided examples of visual details and emphasized the distinction between scenes and details ("Note that you could remember a lot of bits and pieces about each individual object or people without putting them into an integrated whole"). We specified that participants should consider both the amount of details of individual objects or people and the overall number of objects and people. Participants also rated how closely their thoughts were related to themselves from 1 (very remote) to 5 (very close). We explained that "very close" meant that the thoughts were directly self-related, "very remote" signified those thoughts concerned strangers or people in general. Intermediate ratings applied to acquaintances. After the practice, the researcher monitored the participants' attentiveness from a control room. After task completion, participants filled the demographic questionnaire and the Center for Epidemiologic Studies Depression Scale (Radloff, 1977). The study lasted 60 minutes.

fMRI Image Acquisition

We acquired the images on a Siemens Biograph mMR (Siemens Healthineers, Erlangen, Germany; Delso et al., 2011) with a 32-channel head coil (Ceresensa, London, Canada) at the Brain Imaging Centre (BIC) of the ROH. We collected the functional data with a multiband accelerated EPI sequence from CMRR that is sensitive to BOLD [(Moeller et al., 2010; Xu et al., 2013); aligned to anterior and posterior commissure, TR = 1200 ms, TE = 33, flip angle = 65 degrees, FOV = 200 mm, voxel size = 2.5 mm³, slice thickness = 2.5 mm, 530 volumes per run, multiband factor = 6, covering the whole brain]. The phase encoding alternated between anterior to posterior (for the 1st, 3rd, 5th, 7th run) and posterior to anterior (for the 2nd, 4th, 6th run).

Due to a technical error, the TE was 40 ms instead of the intended 33 ms for the second, fourth, and sixth run of the first 28 participants. For this reason, we opted for the field map-free method for distortion correction that is implemented in FMRIPREP (Esteban et al., 2018, 2019) instead of correcting with the reverse phase encoding measurements. Moreover, the encoding phase direction was kept constant for subsequent participants (anterior to posterior) as alternating between phase encoding was originally intended for distortion correction (with reverse phase encoding), which would not be possible for the whole sample. Phase encoding or TE differences cannot explain differences between conditions. The task was divided in 7 runs which each included the four memory conditions, and the run order was randomized across all participants.

The parameters for the anatomical scan, a T1-weighted pulse sequence (MPRAGE; Deichmann et al., 2000), of the first 28 participants had the following parameters: sagittal orientation, TR = 2530 ms, TE = 3.36 ms, TI = 1100 ms, flip angle = 7 degrees, slice thickness = 1 mm, FOV = 256 mm, voxel size = 1 mm³, with an acceleration factor of 2 using GRAPPA). For the latter group of 20 participants, we acquired a T1-weighted pulse sequence (MEMPRAGE; van der Kouwe et al., 2008) to enhance the quality of the T1w: sagittal orientation, TR = 2500 ms, TE 1 = 1.69 ms, TE 2 = 3.55 ms, TE 3 = 5.41, TE 4 = 7.27, flip angle = 10 degrees, slice thickness = 1 mm, FOV = 256 mm, voxel size = 1 mm³, with an acceleration factor of 2 using GRAPPA).

fMRI Analyses

FMRIPREP pipeline

The MRI data were preprocessed using FMRIPREP (Esteban et al., 2018, 2019). The processing steps are described below verbatim as intended by FMRIPREP authors (<https://fmriprep.readthedocs.io/>; made available through CCO license).

“Results included in this manuscript come from preprocessing performed using fMRIPrep 1.2.3 (Esteban et al., 2018, 2019; RRID:SCR_016216), which is based on Nipype 1.1.6-dev (Gorgolewski et al., 2011, 2018; RRID:SCR_002502). Anatomical Data Preprocessing. The T1-weighted (T1w) image was corrected for intensity non-uniformity (INU) using N4BiasFieldCorrection (Tustison et al., 2010, ANTs 2.2.0), and used as T1w-reference throughout the workflow. The T1w-reference was then skull-stripped using antsBrainExtraction.sh (ANTs 2.2.0), using OASIS as target template. Brain surfaces were reconstructed using recon-all (FreeSurfer 6.0.1, RRID:SCR_001847, Dale et al., 1999), and the brain mask estimated previously was refined with a custom variation of the method to reconcile ANTs-derived and FreeSurfer-derived segmentations of the cortical gray-matter of Mindboggle (RRID:SCR_002438, Klein et al., 2017). Spatial normalization to the ICBM 152 Nonlinear Asymmetrical template version 2009c (Fonov et al., 2009; RRID:SCR_008796) was performed through nonlinear registration with antsRegistration (ANTs 2.2.0, RRID:SCR_004757, Avants et al., 2008), using brain-extracted versions of both T1w volume and template. Brain tissue segmentation of cerebrospinal fluid (CSF), white-matter (WM) and gray-matter (GM) was performed on the brain-extracted T1w using fast (FSL 5.0.9, RRID:SCR_002823, Zhang et al., 2001). For each of the 7 BOLD runs found per subject (across all tasks and sessions), the following preprocessing was performed. First, a reference volume and its skull-stripped version were generated using a custom methodology of fMRIPrep. A deformation field to correct for susceptibility distortions was estimated based on fMRIPrep’s fieldmap-less approach. The deformation field is that resulting from co-registering the BOLD reference to the same-subject T1w-reference with its intensity inverted (Huntenburg, 2014; Wang et al., 2017). Registration is performed with antsRegistration (ANTs 2.2.0), and the process regularized by constraining deformation to be nonzero only along the phase-encoding direction, and modulated with an average fieldmap template (Treiber et al., 2016). Based on the estimated susceptibility distortion, an unwarped BOLD reference was calculated for a more accurate co-registration with the anatomical reference. The BOLD reference was then co-registered to the T1w reference using bbgregister (FreeSurfer) which implements boundary-based registration (Greve & Fischl, 2009). Co-registration was configured with nine degrees of freedom to account for distortions remaining in the BOLD reference. Head-motion parameters with respect to the BOLD reference (transformation matrices, and six corresponding rotation and translation parameters) are estimated before any spatiotemporal filtering using mcflirt (FSL 5.0.9, Jenkinson et al., 2002). The BOLD time-series (including slice-timing correction when applied) were resampled onto their original, native space by applying a single, composite transform to correct for head-motion and susceptibility distortions. These resampled BOLD time-series will be referred to as preprocessed BOLD in original space, or just preprocessed BOLD. The BOLD time-series were resampled to MNI152NLin2009cAsym standard space, generating a preprocessed BOLD run in MNI152NLin2009cAsym space. First, a reference volume and its skull-stripped version were generated using a custom methodology of fMRIPrep. Several confounding time-series were calculated based on the *preprocessed BOLD*: framewise displacement (FD), DVARS and three region-wise global signals. FD and DVARS are calculated

for each functional run, both using their implementations in *Nipype* (following the definitions by Power et al., 2014). The three global signals are extracted within the CSF, the WM, and the whole-brain masks. Additionally, a set of physiological regressors were extracted to allow for component-based noise correction (*CompCor*, Behzadi et al., 2007). Principal components are estimated after high-pass filtering the *preprocessed BOLD* time-series (using a discrete cosine filter with 128s cut-off) for the two *CompCor* variants: temporal (tCompCor) and anatomical (aCompCor). Six tCompCor components are then calculated from the top 5% variable voxels within a mask covering the subcortical regions. This subcortical mask is obtained by heavily eroding the brain mask, which ensures it does not include cortical GM regions. For aCompCor, six components are calculated within the intersection of the aforementioned mask and the union of CSF and WM masks calculated in T1w space, after their projection to the native space of each functional run (using the inverse BOLD-to-T1w transformation). The head-motion estimates calculated in the correction step were also placed within the corresponding confounds file. The BOLD time-series, were resampled to surfaces on the following spaces: *fsnative*, *fsaverage*. All resamplings can be performed with a *single interpolation step* by composing all the pertinent transformations (i.e. head-motion transform matrices, susceptibility distortion correction when available, and co-registrations to anatomical and template spaces). Gridded (volumetric) resamplings were performed using *antsApplyTransforms* (ANTs), configured with Lanczos interpolation to minimize the smoothing effects of other kernels (Lanczos, 1964). Non-gridded (surface) resamplings were performed using *mri_vol2surf* (FreeSurfer). Many internal operations of fMRIPrep use Nilearn 0.4.2 (Abraham et al., 2014; RRID:SCR_001362), mostly within the functional processing workflow. For more details of the pipeline, see the section corresponding to workflows in fMRIPrep's documentation."

FSL

The fMRIPrep output (in MNI152NLin2009cAsym space) was spatially smoothed using a Gaussian kernel of FWHM 5mm and grand-mean intensity normalized using FEAT (FMRI Expert Analysis Tool) Version 6.00 from FSL (FMRIB's Software Library, www.fmrib.ox.ac.uk/fsl; Jenkinson et al., 2012). We did not apply slice timing correction with fMRIPrep or FSL because of the rapid multi-band acquisition.

Partial Least Squares (PLS)

We used a multivariate approach, Partial Least Squares (PLS) correlation (Krishnan et al., 2011; McIntosh et al., 2004; McIntosh & Lobaugh, 2004), implemented in the PLSgui/PLScmd toolbox for Matlab (<https://www.rotman-baycrest.on.ca/index.php?section=84>; McIntosh et al., n.d.). PLS is a technique developed for chemometrics (Krishnan et al., 2011) and widely adopted for neuroimaging use. Strengths of this analysis are that it is well suited for designs with multiple sets of measures and collinearity, and it mitigates power issues encountered in univariate analyses (O'Toole et al., 2007). It performs a singular value decomposition of the relation between two data matrices, X (brain) and Y (task design) to identify how tasks and voxels covary maximally together. PLS produces latent variables (LVs) that represent the similarities and differences in covariance patterns between the two matrices (akin to PCA eigenvectors). Salience indicates the strength of the contribution of tasks and voxels to an LV (as indexed through bootstrap values, described below).

We specified that each trial began at cue onset and comprised 12 TRs (or 14.4 seconds) to encompass the typical time-window of a BOLD response (McIntosh et al., 2004), and retained

only yes responses. We retained trials that had 3 to 6 numbers for the control task, thus lasting 6 to 12 seconds. We assessed the significance of LVs ($p < .05$) via 1000 permutations (randomizing the labels of conditions without replacement). We tested the stability of each voxel's contribution to the LV via 500 iterations of bootstrap estimation (resampling participants with replacement; Krishnan et al., 2011; McIntosh et al., 2004; McIntosh & Lobaugh, 2004). The threshold of ± 3 bootstrap ratio (equivalent to $p < .001$; as in Hirshhorn et al., 2012; Ziaei et al., 2016) was used to determine whether a voxel made a reliable contribution to the LV. A reliable voxel contributes to the overall task and brain pattern. The PLS tests the association between the task and all voxels at all TRs in a single analysis, and so does not require correction for multiple comparison (McIntosh & Lobaugh, 2004). An additional threshold of a minimum of 80 voxels with a minimum distance of 10 voxels was used to facilitate the summary of findings in the results section and the tables (for a similar cluster size, see Hirshhorn et al., 2012; Ziaei et al., 2016). The bootstrap percentile estimates were unreliable. Thus, we reported the standard error of the bootstrap estimation instead of the confidence intervals; the interpretation is similar. See Appendix 2 for a statistical comparison of brain scores between memory conditions.

Statistical Analyses of Brain Scores and Behavioural Data

We compared the four memory conditions (general facts, autobiographical facts, repeated events, unique events) on brain scores, the proportion of 'yes' responses and response time during the fMRI task, and on mean self-relevance, mean visual details and proportion of trials associated with one of the three scene categories during the behavioural task. We followed up on significant main effects with paired samples t-tests, reporting Hedges' g as the measure of effect size, and correcting each set of post-hoc tests (i.e., 6 tests) with the Holm-Bonferroni procedure (Holm, 1979). We attributed the value equivalent to $z \pm 2.58$ to bring univariate outliers closer to the mean. Scene ratings were excessively skewed (see Figure 7), but parametric tests gave similar results than nonparametric and are reported for simplicity. We applied a Greenhouse-Geisser correction (Greenhouse & Geisser, 1959) when the sphericity assumption was violated. All these analyses focused on trials associated with 'yes' responses (as in fMRI analyses) and were executed in SPSS v. 28 (IBM Corp., 2021, p. 28).

Open Science Statement

The instructions and stimuli are available in Appendix 4. End-stage data and some scripts (e.g., for preparing data for PLS, SPSS syntax) are available upon request to the corresponding authors. fMRI standards guided the reporting in this paper (Poldrack et al., 2008)

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Appendix 1

Appendix 1–Table 1. Peaks of Clusters for LV 1 of the Mean-Centered PLS (Memory and Control) at Lag 7.

Boot-strap Ratio	Cluster Size (voxels)	X (mm)	Y (mm)	Z (mm)	Anatomical Automatic Labeling (AAL)	Atlas of Intrinsic Connectivity of Homotopic Areas (AICHA)	Harvard Oxford, Probability Atlas
Negative Saliences							
-19.56	9172	-5.0	-57.5	15.0	Left Precuneus	Left Precuneus Gyrus - Subpart 2	49% Left Precuneus Cortex; 8% Left Cingulate Gyrus Posterior Division
-15.77	5015	-45.0	27.5	-10.0	Left Inferior Frontal Gyrus - Pars Orbitalis	Left Inferior Frontal Gyrus - Triangular Subpart 1	67% Left Frontal Orbital Cortex; 7% Left Inferior Frontal Gyrus Pars Triangularis
-13.30	260	5.0	-55.0	-47.5	Right Cerebellum 9	No Label	No Label
-13.21	2622	-2.5	30.0	42.5	Left Superior Frontal Gyrus - Medial	Left Superior Frontal Gyrus - Medial Subpart 3	45% Left Paracingulate Gyrus; 30% Left Superior Frontal Gyrus
-12.42	364	47.5	-72.5	37.5	Right Angular Gyrus	No Label	57% Right Lateral Occipital Cortex Superior Division
-12.25	289	0.0	60.0	-10.0	Left Superior Frontal Gyrus - Medial Orbital	No Label	36% Right Frontal Pole; 31% Left Frontal Pole
-11.48	846	40.0	-75.0	-37.5	Right Cerebellum Crus 2	No Label	No Label
-8.03	805	37.5	-17.5	45.0	Right Precentral Gyrus	Right Rolando Sulcus - Subpart 2	50% Right Precentral Gyrus; 26% Right Postcentral Gyrus
-7.96	221	40.0	40.0	-10.0	Right Inferior Frontal Gyrus - Pars Orbitalis	Right Inferior Frontal Gyrus - Orbital Subpart 1	36% Right Frontal Pole; 7% Right Frontal Orbital Cortex
-5.23	130	47.5	-20.0	17.5	Right Rolandic Operculum	Right Posterior Insula Gyrus - Subpart 1	45% Right Parietal Operculum Cortex; 31% Right Central Opercular Cortex; 5% Right Postcentral Gyrus

-5.10	192	55.0	25.0	17.5	Right Inferior Frontal Gyrus - Triangular Part	Right Inferior Frontal Gyrus - Triangular Subpart 1	41% Right Inferior Frontal Gyrus Pars Triangularis; 21% Right Inferior Frontal Gyrus Pars Opercularis; 5% Right Middle Frontal Gyrus
Positive Saliences							
5.77	143	-30.0	-65.0	-22.5	Left Cerebellum 6	No Label	No Label
6.37	231	20.0	5.0	52.5	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 6	18% Right Superior Frontal Gyrus
6.84	587	7.5	-75.0	45.0	Right Precuneus	Right Precuneus Gyrus - Subpart 8	42% Right Precuneus Cortex; 17% Right Cuneal Cortex; 10% Right Lateral Occipital Cortex Superior Division
7.86	329	-27.5	-12.5	57.5	Left Precentral Gyrus	Left Precentral Sulcus - Subpart 6	39% Left Precentral Gyrus; 9% Left Superior Frontal Gyrus
7.87	224	-20.0	-75.0	-47.5	Left Cerebellum 7b	No Label	No Label
8.51	284	40.0	-10.0	-10.0	No Label	Right Anterior Insula Gyrus - Subpart 5	32% Right Planum Polare; 25% Right Insular Cortex
8.63	417	7.5	-32.5	47.5	Right Middle Cingulate & Paracingulate Gyri	Right Cingulate Sulcus - Subpart 6	30% Right Cingulate Gyrus Posterior Division; 27% Right Precentral Gyrus; 16% Right Precuneus Cortex; 9% Right Postcentral Gyrus
8.74	1477	-30.0	-65.0	12.5	No Label	No Label	No Label
9.21	536	50.0	7.5	20.0	Right Inferior Frontal Gyrus - Opercular Part	Right Precentral Sulcus - Subpart 1	35% Right Precentral Gyrus; 31% Right Inferior Frontal Gyrus Pars Opercularis
10.10	2341	-15.0	32.5	5.0	No Label	No Label	8% Left Lateral Ventricle
10.43	2352	-60.0	-32.5	52.5	No Label	No Label	20% Left Supramarginal

							Gyrus Anterior Division
12.24	1112	57.5	-35.0	52.5	Right Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	Right Supramarginal Gyrus - Subpart 6	43% Right Supramarginal Gyrus Posterior Division; 18% Right Supramarginal Gyrus Anterior Division
12.40	3966	20.0	-52.5	-25.0	Right Cerebellum 6	No Label	No Label

Note. Thresholded at bootstrap ratio at ± 3 ($p < .001$), minimal cluster size of 80 voxels and a minimal distance of 10 voxels. Labels from AAL (Rolls et al., 2015), AICHA (Joliot et al., 2015) and Harvard-Oxford (Desikan et al., 2006) atlases came from AtlasReader (Notter et al., 2019).

1 **Appendix 1–Table 2.** Peaks of Clusters for LV 1 of the Mean Centered PLS (Memory and
2 Control) at Lag 5-6 & 8-9.

Lag	Boot- strap Ratio	Cluster Size (voxels)	X (mm)	Y (mm)	Z (mm)	Anatomical Automatic Labeling (AAL)	Atlas of Intrinsic Connectivity of Homotopic Areas (AICHA)	Harvard Oxford, Probability Atlas
Negative Saliences								
5	-17.08	2903	-2.5	-57.5	17.5	Left Precuneus	Left Precuneus Gyrus - Subpart 2	74% Left Precuneus Cortex; 19% Left Cingulate Gyrus Posterior Division
5	-15.47	5464	-45.0	25.0	-10.0	Left Inferior Frontal Gyrus - Pars Orbitalis	Left Inferior Frontal Gyrus - Triangular Subpart 1	74% Left Frontal Orbital Cortex; 6% Left Frontal Operculum Cortex
5	-14.49	436	-12.5	-95.0	-5.0	Left Calcarine Fissure and Surrounding Cortex	Left Calcarine Gyrus - Subpart 3	55% Left Occipital Pole
5	-13.18	1486	-45.0	-65.0	30.0	Left Angular Gyrus	Left Angular Gyrus - Subpart 2	54% Left Lateral Occipital Cortex Superior Division; 8% Left Angular Gyrus
5	-12.36	555	-55.0	-7.5	-12.5	Left Middle Temporal Gyrus	Left Superior Temporal Sulcus - Subpart 2	28% Left Superior Temporal Gyrus Anterior Division; 24% Left Middle Temporal Gyrus Anterior Division; 14% Left Superior Temporal Gyrus Posterior Division; 5% Left Middle Temporal Gyrus Posterior Division
5	-12.16	1856	20.0	-95.0	0.0	Right Calcarine Fissure and Surrounding Cortex	Right Calcarine Gyrus - Subpart 3	44% Right Occipital Pole
5	-10.94	380	50.0	-72.5	35.0	Right Angular Gyrus	No Label	47% Right Lateral Occipital Cortex Superior Division
5	-10.07	160	37.5	40.0	-12.5	Right Middle Frontal Gyrus	Right Orbital Sulcus - Subpart 2	57% Right Frontal Pole; 11% Right Frontal Orbital Cortex

5	-8.82	416	35.0	-65.0	-30.0	Right Cerebellum Crus 1	No Label	No Label
5	-8.51	105	60.0	-5.0	-17.5	Right Middle Temporal Gyrus	Right Middle Temporal Gyrus - Subpart 1	48% Right Middle Temporal Gyrus Anterior Division; 14% Right Middle Temporal Gyrus Posterior Division; 5% Right Superior Temporal Gyrus Posterior Division
5	-8.11	134	5.0	-57.5	-50.0	Right Cerebellum 9	No Label	No Label
5	-7.17	658	47.5	-15.0	52.5	Right Precentral Gyrus	Right Rolando Sulcus - Subpart 3	44% Right Postcentral Gyrus; 23% Right Precentral Gyrus
5	-4.62	124	57.5	27.5	15.0	Right Inferior Frontal Gyrus - Triangular Part	Right Inferior Frontal Gyrus - Triangular Part 1	50% Right Inferior Frontal Gyrus Pars Triangularis; 14 % Right Inferior Frontal Gyrus Pars Opercularis
6	-19.95	7309	-2.5	-57.5	17.5	Left Precuneus	Left Precuneus Gyrus - Subpart 2	74% Left Precuneus Cortex; 19% Left Cingulate Gyrus Posterior Division
6	-16.49	7663	-45.0	27.5	-10.0	Left Inferior Frontal Gyrus - Pars Orbitalis	Left Inferior Frontal Gyrus - Triangular Part 1	67 % Left Frontal Orbital Cortex; 7% Left Inferior Frontal Gyrus Pars Triangularis
6	-13.44	675	-45.0	-72.5	35.0	Left Angular Gyrus	Left Angular Gyrus - Subpart 2	78% Left Lateral Occipital Cortex Superior Division
6	-12.30	388	50.0	-70.0	35.0	Right Angular Gyrus	Right Angular Gyrus - Subpart 3	78% Right Lateral Occipital Cortex Superior Division
6	-11.98	208	5.0	-52.5	-45.0	Right Cerebellum 9	No Label	No Label
6	-9.92	649	35.0	-65.0	-30.0	Right Cerebellum Crus 1	No Label	No Label
6	-8.61	228	37.5	40.0	-10.0	Right Inferior Frontal Gyrus - Pars Orbitalis	Right Orbital Sulcus - Subpart 2	44% Right Frontal Pole; 11% Right Frontal Orbital Cortex
6	-8.51	757	45.0	-22.5	52.5	Right Postcentral Gyrus	Right Rolando Sulcus - Subpart 3	44% Right Postcentral Gyrus; 5% Right Precentral Gyrus

6	-8.42	135	60.0	-5.0	-17.5	Right Middle Temporal Gyrus	Right Middle Temporal Gyrus - Subpart 1	48% Right Middle Temporal Gyrus Anterior Division; 14% Right Middle Temporal Gyrus Posterior Division; 5% Right Superior Temporal Gyrus Posterior Division
6	-4.73	95	57.5	25.0	20.0	Right Inferior Frontal Gyrus - Triangular Part	Right Inferior Frontal Gyrus - Triangular Part 1	40% Right Inferior Frontal Gyrus Pars Triangularis; 16% Right Inferior Frontal Gyrus Pars Opercularis; 7% Right Middle Frontal Gyrus
8	-17.60	11337	-5.0	-55.0	17.5	Left Precuneus	Left Precuneus Gyrus - Subpart 2	51% Left Precuneus Cortex; 20% Left Cingulate Gyrus Posterior Division
8	-14.98	8569	-45.0	27.5	-10.0	Left Inferior Frontal Gyrus - Pars Orbitalis	Left Inferior Frontal Gyrus - Triangular Part 1	67% Left Frontal Orbital Cortex; 7% Left Inferior Frontal Gyrus Pars Triangularis
8	-13.29	299	5.0	-52.5	-45.0	Right Cerebellum 9	No Label	No Label
8	-11.48	315	50.0	-70.0	37.5	Right Angular Gyrus	No Label	59 % Right Lateral Occipital Cortex Superior Division
8	-8.13	135	-10.0	-30.0	-30.0	No Label	No Label	97% Brain-Stem
8	-7.75	238	35.0	25.0	-2.5	Right Insula	Right Anterior Insula Gyrus - Subpart 3	40% Right Insular Cortex; 36% Right Frontal Orbital Cortex; 5% Right Frontal Operculum Cortex
8	-7.45	93	-10.0	7.5	17.5	Left Caudate Nucleus	No Label	58% Left Lateral Ventricle; 41% Left Caudate
8	-7.06	285	45.0	-25.0	17.5	Right Rolandic Operculum	Right Posterior Insula Gyrus - Subpart 1	76% Right Parietal Operculum Cortex; 6% Right Planum Temporale; 5% Right Heschl's Gyrus (includes H1 and H2)
8	-7.02	788	37.5	-15.0	45.0	Right Precentral Gyrus	Right Rolando Sulcus - Subpart 2	61% Right Precentral Gyrus; 13% Right Postcentral Gyrus

8	-5.23	157	-2.5	-12.5	62.5	Left Supplementary Motor Area	Left Cingulate Sulcus - Subpart 4	50% Left Juxtapositional Lobule Cortex; 34% Left Precentral Gyrus
8	-4.85	96	-35.0	-32.5	22.5	Left Insula	Left Posterior Insula Gyrus - Subpart 1	44% Left Parietal Operculum Cortex
9	-17.53	11252	-22.5	-80.0	-7.5	Left Fusiform Gyrus	Left Fusiform Gyrus - Subpart 7	43% Left Occipital Fusiform Gyrus; 13% Left Lingual Gyrus
9	-14.91	9678	-47.5	40.0	-5.0	Left Inferior Frontal Gyrus - Pars Orbitalis	Left Inferior Frontal Gyrus - Triangular Part 1	70% Left Frontal Pole; 8% Left Inferior Frontal Gyrus Pars Triangularis; 5% Left Frontal Orbital Cortex
9	-14.14	332	7.5	-52.5	-45.0	Right Cerebellum 9	No Label	No Label
9	-9.50	728	-60.0	-45.0	-5.0	Left Middle Temporal Gyrus	Left Middle Temporal Gyrus - Subpart 3	33% Left Middle Temporal Gyrus Temporooccipital Part; 18% Left Middle Temporal Gyrus Posterior Division
9	-9.11	251	50.0	-70.0	37.5	Right Angular Gyrus	No Label	59% Right Lateral Occipital Cortex Superior Division
9	-8.04	581	37.5	-17.5	12.5	Right Insula	Right Posterior Insula Gyrus - Subpart 1	69% Right Insular Cortex; 9% Right Heschl's Gyrus (includes H1 and H2)
9	-7.82	210	40.0	42.5	-10.0	Right Inferior Frontal Gyrus - Pars Orbitalis	Right Middle Frontal Gyrus - Orbital Subpart 2	47% Right Frontal Pole
9	-6.74	120	17.5	5.0	17.5	Right Caudate Nucleus	Right Caudate Nucleus - Subpart 6	72% Right Caudate
9	-6.15	195	37.5	-15.0	42.5	Right Precentral Gyrus	Right Rolando Sulcus - Subpart 2	57% Right Precentral Gyrus; 16% Right Postcentral Gyrus
9	-6.06	262	-37.5	-30.0	22.5	Left Rolandic Operculum	Left Posterior Insula Gyrus - Subpart 1	53% Left Parietal Operculum Cortex; 6% Left Central Opercular Cortex

9	-5.81	105	55.0	20.0	7.5	Right Inferior Frontal Gyrus - Triangular Part	Right Inferior Frontal Gyrus - Triangular Subpart 1	47% Right Inferior Frontal Gyrus Pars Opercularis; 25% Right Inferior Frontal Gyrus Pars Triangularis
9	-5.73	302	25.0	-25.0	70.0	Right Precentral Gyrus	Right Rolando Sulcus - Subpart 4	45% Right Precentral Gyrus; 15% Right Postcentral Gyrus

Positive Saliences

5	7.42	671	42.5	47.5	15.0	Right Middle Frontal Gyrus	Right Middle Frontal Gyrus - Subpart 1	78% Right Frontal Pole
5	7.64	380	-35.0	-50.0	-30.0	Left Cerebellum 6	No Label	No Label
5	8.93	189	-22.5	-75.0	-52.5	Left Cerebellum 7b	No Label	No Label
5	10.12	1257	42.5	5.0	0.0	Right Insula	Right Rolandic Operculum Gyrus - Subpart 1	71% Right Insular Cortex; 7% Right Central Opercular Cortex
5	13.79	5490	25.0	-55.0	-20.0	Right Cerebellum 6	No Label	No Label
5	16.45	11000	-42.5	-17.5	60.0	Left Precentral Gyrus	Left Rolando Sulcus - Subpart 3	46% Left Precentral Gyrus; 15% Left Postcentral Gyrus
6	6.87	84	-15.0	-27.5	37.5	No Label	Left Cingulate Sulcus - Subpart 6	23% Left Precentral Gyrus; 18% Left Cingulate Gyrus Posterior Division; 5% Left Precuneus Cortex
6	7.61	318	-35.0	-50.0	-30.0	Left Cerebellum 6	No Label	No Label
6	7.95	672	45.0	47.5	15.0	Right Middle Frontal Gyrus	Right Middle Frontal Gyrus - Subpart 1	88% Right Frontal Pole
6	9.13	132	10.0	-35.0	45.0	Right Middle Cingulate and Paracingulate Gyri	Right Cingulate Sulcus - Subpart 6	39% Right Cingulate Gyrus Posterior Division; 32% Right Precuneus Cortex; 5% Right Postcentral Gyrus; 5% Right Precentral Gyrus
6	10.23	1203	40.0	-10.0	-7.5	Right Insula	Right Anterior Insula Gyrus - Subpart 5	55% Right Insular Cortex; 20% Right Planum Polare

6	13.30	945	15.0	-65.0	-45.0	Right Cerebellum 8	No Label	No Label
6	13.58	10698	-50.0	-35.0	50.0	Left Inferior Parietal Gyrus, Excluding Supramarginal and Angular Gyri	Left Intraparietal Sulcus - Subpart 1	36% Left Supramarginal Gyrus Anterior Division; 23% Left Postcentral Gyrus; 14% Left Superior Parietal Lobule
6	15.35	4346	17.5	-55.0	-17.5	Right Cerebellum 6	No Label	No Label
8	5.27	123	22.5	5.0	60.0	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 6	43% Right Superior Frontal Gyrus
8	5.35	132	-25.0	-62.5	32.5	Left Middle Occipital Gyrus	Left Intraparietal Sulcus - Subpart 3	24% Left Lateral Occipital Cortex Superior Division
8	6.13	322	-45.0	-70.0	-7.5	Left Inferior Occipital Gyrus	Left Inferior Occipital Gyrus - Subpart 2	75% Left Lateral Occipital Cortex Inferior Division
8	6.45	271	15.0	-62.5	-45.0	Right Cerebellum 8	No Label	No Label
8	6.71	140	-22.5	-75.0	-52.5	Left Cerebellum 7b	No Label	No Label
8	7.23	90	-32.5	-92.5	-5.0	Left Middle Occipital Gyrus	Left Lateral Occipital Gyrus - Subpart 2	53% Left Occipital Pole; 21% Left Lateral Occipital Cortex Inferior Division
8	7.35	331	12.5	-65.0	40.0	Right Precuneus	Right Precuneus Gyrus - Subpart 8	43% Right Precuneus Cortex
8	7.99	230	-17.5	-5.0	30.0	No Label	No Label	No Label
8	8.04	159	5.0	-27.5	45.0	Right Middle Cingulate & Paracingulate Gyri	Right Middle Cingulum - Subpart 3	62% Right Cingulate Gyrus Posterior Division; 15% Right Precentral Gyrus; 7% Right Precuneus Cortex
8	8.10	331	45.0	45.0	10.0	Right Middle Frontal Gyrus	Right Middle Frontal Gyrus - Subpart 1	87% Right Frontal Pole
8	8.14	455	50.0	7.5	22.5	Right Inferior Frontal Gyrus - Opercular Part	Right Precentral Sulcus - Subpart 1	41% Right Precentral Gyrus; 33% Right Inferior Frontal Gyrus Pars Opercularis
8	8.52	384	-25.0	-55.0	15.0	No Label	No Label	10% Left Lateral Ventricle

8	9.08	840	-55.0	-35.0	52.5	Left Inferior Parietal Gyrus, Excluding Supramarginal and Angular Gyri	Left Supramarginal Gyrus - Subpart 4	48% Left Supramarginal Gyrus Anterior Division
8	9.84	1103	-17.5	32.5	5.0	No Label	Left Caudate Nucleus - Subpart 2	6% Left Lateral Ventricle
8	11.53	3742	57.5	-37.5	55.0	Right Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	22% Right Supramarginal Gyrus Posterior Division
9	5.45	152	22.5	7.5	60.0	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 6	40% Right Superior Frontal Gyrus; 6% Right Middle Frontal Gyrus
9	6.37	131	-22.5	-75.0	-47.5	Left Cerebellum 7b	No Label	No Label
9	7.02	444	-55.0	-37.5	55.0	Left Inferior Parietal Gyrus, Excluding Supramarginal and Angular Gyri	No Label	33% Left Supramarginal Gyrus Anterior Division; 8% Left Supramarginal Gyrus Posterior Division
9	7.02	123	7.5	-32.5	47.5	Right Middle Cingulate & Paracingulate Gyri	Right Cingulate Sulcus - Subpart 6	30% Right Cingulate Gyrus Posterior Division; 27% Right Precentral Gyrus; 16% Right Precuneus Cortex; 9% Right Postcentral Gyrus
9	7.70	150	-17.5	-7.5	30.0	No Label	No Label	No Label
9	7.89	284	45.0	45.0	10.0	Right Middle Frontal Gyrus	Right Middle Frontal Gyrus - Subpart 1	87% Right Frontal Pole
9	8.30	532	-25.0	-55.0	15.0	No Label	No Label	10% Left Lateral Ventricle
9	9.07	714	-12.5	30.0	2.5	No Label	No Label	12% Left Lateral Ventricle
9	9.20	433	42.5	10.0	30.0	Right Inferior Frontal Gyrus - Opercular Part	Right Inferior Frontal Sulcus - Subpart 2	25% Right Precentral Gyrus; 21% Right Middle Frontal Gyrus; 17% Right Inferior Frontal Gyrus Pars Opercularis

9	9.23	553	-30.0	-92.5	-5.0	Left Middle Occipital Gyrus	Left Lateral Occipital Gyrus - Subpart 2	46% Left Occipital Pole; 14% Left Lateral Occipital Cortex Inferior Division
9	10.06	2805	55.0	-37.5	52.5	Right Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	Right Supramarginal Gyrus - Subpart 6	64% Right Supramarginal Gyrus Posterior Division; 11% Right Supramarginal Gyrus Anterior Division
9	10.78	840	32.5	-95.0	-7.5	Right Inferior Occipital Gyrus	Right Occipital Pole Gyrus - Subpart 1	62% Right Occipital Pole; 10% Right Lateral Occipital Cortex Inferior Division

Note. Thresholded at bootstrap ratio at ± 3 ($p < .001$), minimal cluster size of 80 voxels and a minimal distance of 10 voxels. Labels from AAL (Rolls et al., 2015), AICHA (Joliot et al., 2015) and Harvard-Oxford (Desikan et al., 2006) atlases came from AtlasReader (Notter et al., 2019).

1

2 **Appendix 1–Table 3.** Peaks of Clusters for LV 1 of the Mean Centered PLS (Memory only) at
 3 Lag 5-6 & 8-9.

Lag	Boot- strap Ratio	Cluster Size (voxels)	X (mm)	Y (mm)	Z (mm)	Anatomical Automatic Labeling (AAL)	Atlas of Intrinsic Connectivity of Homotopic Areas (AICHA)	Harvard Oxford, Probability Atlas
Negative Saliences								
5	-5.63	117	57.5	10.0	12.5	Right Inferior Frontal Gyrus – Opercular Part	Right Rolandic Operculum Gyrus – Subpart 1	43% Right Inferior Frontal Gyrus Pars Opercularis; 39% Right Precentral Gyrus
6	-7.64	170	60.0	10.0	12.5	Right Inferior Frontal Gyrus – Opercular Part	Right Rolandic Operculum Gyrus – Subpart 1	39% Right Precentral Gyrus; 28% Right Inferior Frontal Gyrus Pars Opercularis
6	-5.72	357	45.0	-47.5	55.0	Right Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	Right Inferior Parietal Gyrus – Subpart 1	26% Right Angular Gyrus; 18% Right Supramarginal Gyrus Posterior Division; 17% Right Superior Parietal Lobule
6	-5.06	182	-55.0	-47.5	25.0	Left Supramarginal Gyrus	Left Superior Temporal Sulcus – Subpart 4	37% Left Supramarginal Gyrus Posterior Division; 11% Left Angular Gyrus; 5% Left Parietal Operculum Cortex
6	-4.91	300	52.5	-75.0	-2.5	Right Inferior Occipital Gyrus	Right Inferior Occipital Gyrus – Subpart 2	80% Right Lateral Occipital Cortex Inferior Division
6	-4.83	177	47.5	45.0	15.0	Right Middle Frontal Gyrus	Right Inferior Frontal Sulcus – Subpart 1	75% Right Frontal Pole
6	-4.75	128	-57.5	-25.0	32.5	Left Supramarginal Gyrus	Left Supramarginal Gyrus – Subpart 3	40% Left Supramarginal Gyrus Anterior Division; 33% Left Postcentral Gyrus
6	-4.55	123	-52.5	15.0	12.5	Left Inferior Frontal Gyrus – Opercular Part	Left Inferior Frontal Gyrus – Subpart 1	70% Left Inferior Frontal Gyrus Pars Opercularis; 6% Left Precentral Gyrus

6	-4.42	152	-47.5	-70.0	2.5	Left Middle Occipital Gyrus	Left Inferior Occipital Gyrus – Subpart 2	87% Left Lateral Occipital Cortex Inferior Division
8	-5.16	107	45.0	37.5	10.0	Right Inferior Frontal Gyrus – Triangular Part	Right Inferior Frontal Sulcus – Subpart 1	54% Right Frontal Pole; 21% Right Inferior Frontal Gyrus Pars Triangularis
8	-4.89	264	47.5	-77.5	7.5	Right Middle Occipital Gyrus	Right Middle Occipital Gyrus – Subpart 2	70% Right Lateral Occipital Cortex Inferior Division; 7% Right Lateral Occipital Cortex Superior Division
9	-5.59	492	27.5	-82.5	30.0	Right Superior Occipital Gyrus	Right Lateral Occipital Gyrus – Subpart 5	74% Right Lateral Occipital Cortex Superior Division

Positive Saliences

5	5.61	133	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division
5	6.10	214	-27.5	12.5	52.5	Left Middle Frontal Gyrus	Left Superior Frontal Sulcus - Subpart 5	42% Left Middle Frontal Gyrus; 12 % Left Superior Frontal Gyrus
5	6.12	393	-15.0	-60.0	20.0	Left Cuneus	Left Precuneus Gyrus - Subpart 1	54% Left Precuneus Cortex; 12% Left Supracalcarine Cortex
5	6.33	107	-12.5	-95.0	0.0	Left Middle Occipital Gyrus	Left Calcarine Gyrus- Subpart 3	55% Left Occipital Pole
6	5.81	286	-5.0	57.5	-10.0	Left Superior Frontal Gyrus - Medial Orbital	Left Frontal Gyrus - Medial Orbital Subpart 2	61% Left Frontal Pole; 24% Left Frontal Medial Cortex
6	5.81	98	25.0	25.0	45.0	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 5	35% Right Middle Frontal Gyrus; 34% Right Superior Frontal Gyrus
6	5.84	80	17.5	-95.0	0.0	Right Calcarine Fissure & Surrounding Cortex	Right Calcarine Gyrus - Subpart 3	50% Right Occipital Pole
6	5.85	149	-30.0	-35.0	-15.0	Left Fusiform Gyrus	Left Parahippocampal Gyrus - Subpart 5	49% Left Parahippocampal Gyrus Posterior Division; 29% Left Temporal

								Fusiform Cortex Posterior Division
6	5.96	84	-12.5	-95.0	-2.5	Left Calcarine Fissure & Surrounding Cortex	Left Calcarine Gyrus - Subpart 3	62% Left Occipital Pole
6	6.61	105	45.0	-75.0	40.0	Right Angular Gyrus	No Label	51% Right Lateral Occipital Cortex Superior Division
6	7.28	333	-22.5	15.0	50.0	Left Superior Frontal Gyrus - Dorsolateral	Left Superior Frontal Sulcus - Subpart 5	40% Left Superior Frontal Gyrus; 14% Left Middle Frontal Gyrus
6	8.68	266	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division
6	8.96	847	-15.0	-62.5	22.5	Left Cuneus	Left Precuneus Gyrus - Subpart 1	54% Left Precuneus Cortex; 12% Left Supracalcarine Cortex
8	4.75	93	-2.5	30.0	37.5	Left Superior Frontal Gyrus - Medial	Left Cingulate Sulcus - Subpart 1	77% Left Paracingulate Gyrus; 11% Left Superior Frontal Gyrus
8	4.77	93	-52.5	17.5	35.0	Left Middle Frontal Gyrus	Left Inferior Frontal Sulcus - Subpart 2	51% Left Middle Frontal Gyrus; 11 % Left Inferior Frontal Gyrus Pars Opercularis
8	5.57	186	25.0	30.0	50.0	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 4	43% Right Superior Frontal Gyrus; 18% Right Middle Frontal Gyrus
8	5.98	135	45.0	-75.0	37.5	Right Angular Gyrus	No Label	68% Right Lateral Occipital Cortex Superior Division
8	6.66	91	-57.5	-5.0	-12.5	Left Middle Temporal Gyrus	Left Superior Temporal Sulcus - Subpart 2	37% Left Middle Temporal Gyrus Anterior Division; 23% Left Superior Temporal Gyrus Anterior Division; 9% Left Superior Temporal Gyrus Posterior Division
8	6.78	263	-2.5	-35.0	45.0	Left Middle Cingulate &	Left Middle Cingulum - Subpart 3	60% Left Cingulate Gyrus Posterior Division;

						Paracingulate Gyri		25 % Left Precuneus Cortex
8	7.10	452	-22.5	27.5	45.0	Left Superior Frontal Gyrus	Left Superior Frontal Sulcus - Subpart 4	44 % Left Superior Frontal Gyrus; 23% Left Middle Frontal Gyrus
8	10.12	1097	-5.0	-62.5	15.0	Left Precuneus	Left Precuneus Gyrus - Subpart 2	42% Left Precuneus Cortex; 16% Left Intracalcarine Cortex; 12% Left Supracalcarine Cortex
8	10.21	424	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division
8	10.44	786	-2.5	50.0	-7.5	Left Superior Frontal Gyrus - Medial Orbital	Left Frontal Gyrus - Medial Orbital Subpart 2	43% Left Frontal Medial Cortex; 38% Left Paracingulate Gyrus
9	5.08	129	25.0	25.0	52.5	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 5	50% Right Superior Frontal Gyrus; 21% Right Middle Frontal Gyrus
9	5.80	274	-7.5	27.5	45.0	Left Superior Frontal Gyrus - Medial	Left Superior Frontal Gyrus - Medial Subpart 3	25 % Left Superior Frontal Gyrus; 6% Left Paracingulate Gyrus
9	7.27	986	0.0	57.5	-5.0	Left Superior Frontal Gyrus - Medial Orbital	No Label	25% Right Frontal Pole; 20% Left Frontal Pole; 5% Right Frontal Medial Cortex
9	7.77	541	-27.5	27.5	45.0	Left Middle Frontal Gyrus	Left Superior Frontal Sulcus - Subpart 4	46% Left Middle Frontal Gyrus; 16% Left Superior Frontal Gyrus
9	8.44	1076	0.0	-62.5	25.0	Left Precuneus	No Label	74 % Left Precuneus Cortex; 16% Right Precuneus Cortex
9	10.45	271	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division

Note. Thresholded at bootstrap ratio at ± 3 ($p < .001$), minimal cluster size of 80 voxels and a minimal distance of 10 voxels. Labels from AAL (Rolls et al., 2015), AICHA (Joliot et al., 2015) and Harvard-Oxford (Desikan et al., 2006) atlases came from AtlasReader (Notter et al., 2019).

1 **Appendix 1–Table 4.** Peaks of Clusters for LV 2 of the Mean Centered PLS (Memory only) at
2 Lag 5-6 & 8-9.

Lag	Boot- strap Ratio	Cluster Size (voxels)	X (mm)	Y (mm)	Z (mm)	Anatomical Automatic Labeling (AAL)	Atlas of Intrinsic Connectivity of Homotopic Areas (AICHA)	Harvard Oxford, Probability Atlas
Negative Saliences								
5	-4.64	119	-5.0	22.5	42.5	Left Superior Frontal Gyrus - Medial	Left Cingulate Sulcus - Subpart 2	69% Left Paracingulate Gyrus; 9% Left Superior Frontal Gyrus
9	-4.66	105	-37.5	-55.0	45.0	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	Left Intraparietal Sulcus - Subpart 2	21% Left Angular Gyrus; 16% Left Superior Parietal Lobule; 13% Left Lateral Occipital Cortex Superior Division; 7% Left Supramarginal Gyrus Posterior Division
Positive Saliences								
5	7.26	367	-10.0	-95.0	-5.0	Left Calcarine Fissure & Surrounding Cortex	Left Calcarine Gyrus - Subpart 3	58% Left Occipital Pole
5	8.15	441	17.5	-92.5	2.5	Right Calcarine Fissure & Surrounding Cortex	Right Calcarine Gyrus - Subpart 3	53% Right Occipital Pole; 5% Right Intracalcarine Cortex
6	6.86	199	-10.0	-95.0	-5.0	Left Calcarine Fissure & Surrounding Cortex	Left Calcarine Gyrus - Subpart 3	58% Left Occipital Pole
6	7.93	192	15.0	-92.5	0.0	Right Calcarine Fissure & Surrounding Cortex	Right Calcarine Gyrus - Subpart 3	52% Right Occipital Pole
8	5.07	83	-17.5	-95.0	0.0	Left Middle Occipital Gyrus	Left Lateral Occipital Gyrus - Subpart 1	46% Left Occipital Pole

Note. Thresholded at bootstrap ratio at ± 3 ($p < .001$), minimal cluster size of 80 voxels and a minimal distance of 10 voxels. Labels from AAL (Rolls et al., 2015), AICHA (Joliot et al., 2015) and Harvard-Oxford (Desikan et al., 2006) atlases came from AtlasReader (Notter et al., 2019).

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2 **Appendix 1–Table 5.** Peaks of Clusters for Non-rotated PLS (linear contrast) at Lag 5-6 & 8-9.

Lag	Boot- strap Ratio	Cluster Size (voxels)	X (mm)	Y (mm)	Z (mm)	Anatomical Automatic Labeling (AAL)	Atlas of Intrinsic Connectivity of Homotopic Areas (AICHA)	Harvard Oxford, Probability Atlas
Negative Saliences								
6	-6.84	135	60.0	10.0	12.5	Right Inferior Frontal Gyrus – Opercular Part	Right Rolandic Operculum Gyrus – Subpart 1	39% Right Precentral Gyrus; 28% Right Inferior Frontal Gyrus Pars Opercularis
6	-5.40	311	47.5	-37.5	55.0	Right Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	Right Intraparietal Sulcus – Subpart 1	43% Right Supramarginal Gyrus Posterior Division; 7% Right Superior Parietal Lobule; 7% Right Postcentral Gyrus; 5% Right Supramarginal Gyrus Anterior Division
6	-5.05	229	45.0	-82.5	15.0	Right Middle Occipital Gyrus	Right Middle Occipital Gyrus – Subpart 1	46% Right Lateral Occipital Cortex Superior Division; 18% Right Lateral Occipital Cortex Inferior Division
6	-4.77	108	47.5	45.0	15.0	Right Middle Frontal Gyrus	Right Inferior Frontal Sulcus, - Subpart 1	75% Right Frontal Pole
6	-4.74	133	-55.0	-47.5	25.0	Left Supramarginal Gyrus	Left Superior Temporal Sulcus – Subpart 4	37% Left Supramarginal Gyrus Posterior Division; 11% Left Angular Gyrus; 5% Left Parietal Operculum Cortex
6	-4.55	107	-67.5	-25.0	35.0	No Label	No Label	5% Left Supramarginal Gyrus Anterior Division
6	-4.39	93	-50.0	5.0	2.5	Left Rolandic Operculum	Left Rolandic Operculum Gyrus – Subpart 1	44% Left Central Opercular Cortex; 18% Left Precentral Gyrus; 5% Left Frontal Operculum Cortex; 5% Left Inferior Frontal Gyrus Pars Opercularis
6	-4.35	96	-50.0	-70.0	5.0	Left Middle Temporal Gyrus	Left Inferior Temporal Gyrus – Subpart 5	82% Left Lateral Occipital Cortex Inferior division

8	-5.15	214	45.0	-82.5	17.5	Right Middle Occipital Gyrus	Right Middle Occipital Gyrus – Subpart 1	59% Right Lateral Occipital Cortex Superior Division
9	-5.41	420	50.0	-77.5	10.0	Right Middle Temporal Gyrus	Right Middle Occipital Gyrus – Subpart 2	69% Right Lateral Occipital Cortex Inferior Division; 9% Right Lateral Occipital Cortex Superior Division
9	-5.34	119	32.5	-47.5	60.0	Right Superior Parietal Gyrus	Right Superior Parietal Gyrus – Subpart 4	55% Right Superior Parietal Lobule

Positive Saliences

5	5.54	139	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division
5	5.75	154	17.5	-52.5	7.5	Right Calcarine Fissure & Surrounding Cortex	Right Parieto-occipital Sulcus - Subpart 1	56% Right Precuneus Cortex; 9% Right Cingulate Gyrus Posterior division
5	5.93	213	-25.0	27.5	47.5	Left Middle Frontal Gyrus	Left Superior Frontal Sulcus - Subpart 4	39% Left Superior Frontal Gyrus; 28% Left Middle Frontal Gyrus
5	6.30	230	-12.5	-60.0	20.0	Left Cuneus	Left Precuneus Gyrus - Subpart 1	49% Left Precuneus Cortex; 11% Left Supracalcarine Cortex
6	5.35	80	25.0	25.0	45.0	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 5	35% Right Middle Frontal Gyrus; 34% Right Superior Frontal Gyrus
6	6.35	164	-30.0	-35.0	-15.0	Left Fusiform Gyrus	Left Parahippocampal Gyrus - Subpart 5	49% Left Parahippocampal Gyrus Posterior Division; 29% Left Temporal Fusiform Cortex Posterior Division
6	6.85	364	-5.0	50.0	-2.5	Left Anterior Cingulate & Paracingulate Gyri	Left Anterior-Rostral Sulcus - Subpart 1	67% Left Paracingulate Gyrus; 15% Left Frontal Medial Cortex; 5% Left Frontal Pole
6	6.87	324	-22.5	15.0	50.0	Left Superior Frontal Gyrus - Dorsolateral	Left Superior Frontal Sulcus - Subpart 5	40% Left Superior Frontal Gyrus; 14% Left Middle Frontal Gyrus

6	7.01	106	45.0	-75.0	37.5	Right Angular Gyrus	No Label	68% Right Lateral Occipital Cortex Superior Division
6	8.77	237	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division
6	9.60	856	-15.0	-62.5	22.5	Left Cuneus	Left Precuneus Gyrus - Subpart 1	54% Left Precuneus Cortex; 12% Left Supracalcarine Cortex
8	4.72	96	-2.5	30.0	37.5	Left Superior Frontal Gyrus - Medial	Left Cingulate Sulcus - Subpart 1	77% Left Paracingulate Gyrus; 11% Left Superior Frontal Gyrus
8	5.05	161	25.0	30.0	50.0	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 4	43% Right Superior Frontal Gyrus; 18% Right Middle Frontal Gyrus
8	5.97	119	45.0	-75.0	37.5	Right Angular Gyrus	No Label	68% Right Lateral Occipital Cortex Superior Division
8	6.80	264	-2.5	-35.0	45.0	Left Middle Cingulate & Paracingulate Gyri	Left Middle Cingulum Gyrus - Subpart 3	60% Left Cingulate Gyrus Posterior Division; 25% Left Precuneus Cortex
8	7.05	84	-57.5	-5.0	-12.5	Left Middle Temporal Gyrus	Left Superior Temporal Sulcus - Subpart 2	37% Left Middle Temporal Gyrus Anterior Division; 23% Left Superior Temporal Gyrus Anterior Division; 9% Left Superior Temporal Gyrus Posterior Division
8	7.56	447	-22.5	27.5	45.0	Left Superior Frontal Gyrus - Dorsolateral	Left Superior Frontal Sulcus - Subpart 4	44% Left Superior Frontal Gyrus; 23% Left Middle Frontal Gyrus
8	9.93	870	-2.5	50.0	-7.5	Left Superior Frontal Gyrus - Medial Orbital	Left Frontal Gyrus - Medial Orbital Subpart 2	43% Left Frontal Medial Cortex; 38% Left Paracingulate Gyrus
8	10.59	383	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division
8	10.87	1092	-5.0	-62.5	15.0	Left Precuneus	Left Precuneus Gyrus - Subpart 2	42% Left Precuneus Cortex; 16% Left Intracalcarine Cortex;

								12% Left Supracalcarine Cortex
9	4.60	101	25.0	20.0	42.5	Right Superior Frontal Gyrus - Dorsolateral	Right Superior Frontal Sulcus - Subpart 5	22% Right Middle Frontal Gyrus; 19% Right Superior Frontal Gyrus
9	5.96	209	-2.5	-35.0	42.5	Left Middle Cingulate & Paracingulate Gyri	Left Middle Cingulum Gyrus - Subpart 3	81% Left Cingulate Gyrus Posterior Division; 16% Left Precuneus Cortex
9	6.10	232	-7.5	27.5	45.0	Left Superior Frontal Gyrus - Medial	Left Superior Frontal Gyrus - Medial Subpart 3	25% Left Superior Frontal Gyrus; 6% Left Paracingulate Gyrus
9	7.18	967	0.0	55.0	-2.5	Left Superior Frontal Gyrus - Medial Orbital	No Label	16% Right Paracingulate Gyrus; 15% Right Frontal Pole; 13% Left Paracingulate Gyrus; 12% Left Frontal Pole; 5% Right Frontal Medial Cortex
9	8.32	521	-27.5	27.5	45.0	Left Middle Frontal Gyrus	Left Superior Frontal Sulcus - Subpart 4	46% Left Middle Frontal Gyrus; 16% Left Superior Frontal Gyrus
9	8.51	867	-5.0	-65.0	15.0	Left Calcarine Fissure & Surrounding Cortex	Left Parieto-Occipital Sulcus - Subpart 1	31% Left Precuneus Cortex; 23% Left Supracalcarine Cortex; 21% Left Intracalcarine Cortex
9	10.21	292	-32.5	-82.5	42.5	Left Inferior Parietal Gyrus, Excluding Supramarginal & Angular Gyri	No Label	65% Left Lateral Occipital Cortex Superior Division

Note. Thresholded at bootstrap ratio at ± 3 ($p < .001$), minimal cluster size of 80 voxels and a minimal distance of 10 voxels. Labels from AAL (Rolls et al., 2015), AICHA (Joliot et al., 2015) and Harvard-Oxford (Desikan et al., 2006) atlases came from AtlasReader (Notter et al., 2019).

Appendix 2

Comparison of Memory Conditions on Brain Scores

Mean-centered PLS with Memory Conditions: LV1

We entered the participants' brain scores in a repeated-measures ANOVA with the four memory conditions (general facts, autobiographical facts, repeated events, unique events) as a within-subject factor. The main effect of Memory was significant, $F(2.36, 110.72) = 185.31, p < .001, \eta_p^2 = .80$. Follow-up paired t-tests showed that general facts did not differ from autobiographical facts, $t(47) = -1.63, p = .111, g = -0.23, CI\ 95\% [-.52, .05]$, but all other comparisons were significant (general facts vs. repeated events: $t(47) = -15.79, p < .001, g = -2.26, CI\ 95\% = -2.79, -1.72$; general facts vs. unique events: $t(47) = -15.69, p < .001, g = -2.25, CI\ 95\% = -2.78, -1.71$; autobiographical facts vs. repeated events: $t(47) = -14.83, p < .001, g = -2.12, CI\ 95\% = -2.63, -1.61$; autobiographical facts vs. unique events: $t(47) = -15.57, p < .001, g = -2.23, CI\ 95\% = -2.76, -1.70$; repeated events vs. unique events: $t(47) = -2.40, p = .020, g = -0.34, CI\ 95\% = -0.63, -0.05$). Thus, general facts and autobiographical facts expressed the "facts" LV similarly, and the unique events condition contributed more to the "events" LV than repeated events.

Mean-centered PLS with Memory Conditions: LV2

A repeated-measures ANOVA with the brain scores as the dependent variable showed that the main effect of Memory was significant, $F(2.36, 110.76) = 112.82, p < .001, \eta_p^2 = .71$. Paired t-tests indicated that all memory conditions differed from one another: general facts vs. autobiographical facts = $t(47) = 2.78, p = .008, g = 0.40, CI\ 95\% [0.10, 0.69]$; general facts vs. repeated events = $t(47) = -9.08, p < .001, g = -1.30, CI\ 95\% [-1.68, -0.91]$; general facts vs. unique events = $t(47) = 9.03, p < .001, g = 1.29, CI\ 95\% [0.91, 1.67]$; autobiographical facts vs. repeated events = $t(47) = -12.84, p < .001, g = -1.84, CI\ 95\% [-2.30, -1.37]$; autobiographical facts vs. unique events = $t(47) = 7.10, p < .001, g = 1.02, CI\ 95\% [0.67, 1.36]$; repeated events vs. unique events = $t(47) = 13.87, p < .001, g = 1.99, CI\ 95\% [1.49, 2.47]$.

Non-Rotated PLS with A-priori Contrast

The main effect of Memory, tested with a repeated-measures ANOVA, was significant, $F(2.33, 109.61) = 201.54, p < .001, \eta_p^2 = .81$. Paired t-tests with brain scores as the dependent variable indicated that all memory conditions differed from one another: general facts vs. autobiographical facts = $t(47) = -5.10, p < .001, g = -0.73, CI\ 95\% [-1.04, -0.41]$; general facts vs. repeated events = $t(47) = -16.63, p < .001, g = -2.38, CI\ 95\% [-2.93, -1.82]$; general events vs. unique events = $t(47) = -17.26, p < .001, g = -2.47, CI\ 95\% [-3.04, -1.90]$; autobiographical facts vs. repeated events = $t(47) = -13.62, p < .001, g = -1.95, CI\ 95\% [-2.43, -1.46]$; autobiographical facts vs. unique events = $t(47) = -15.88, p < .001, g = -2.27, CI\ 95\% [-2.81, -1.73]$; repeated events vs. unique events = $t(47) = -4.71, p < .001, g = -0.67, CI\ 95\% [-0.98, -0.36]$. Thus, unique events was more robustly associated with activity as described above than repeated events, and repeated events compared to autobiographical facts, and autobiographical facts compared to general facts.

Appendix 3

Comparison of Memory Conditions on Nothing/Vague and Object Response

Scene Rating: Nothing/vague

The four memory conditions differed in their proportion of memory that elicited nothing or a vague image, $F(2.79, 293.34) = 6.82, p < .001, \eta_p^2 = .06$ (see Figure 7). A greater proportion of general facts ($M = 0.16, SE = 0.02$) evoked nothing or something vague compared to repeated events ($M = 0.10, SE = 0.01$), $t(105) = 3.86, p < .001, g = 0.37, CI\ 95\% [0.18, 0.57]$, and unique events ($M = 0.10, SE = .01$), $t(105) = 3.14, p = .002, g = 0.30, CI\ 95\% [0.11, 0.50]$. Similarly, a greater proportion of autobiographical facts ($M = 0.14, SE = 0.02$) were associated with nothing or a vague image compared to repeated events, $t(105) = 2.94, p = .004, g = 0.29, CI\ 95\% [0.09, 0.48]$. No other comparisons were significant after correction: general facts vs. autobiographical facts, $t(105) = 1.47, p = .144, g = 0.14, CI\ 95\% [-0.05, 0.33]$; autobiographical facts vs. unique events, $t(105) = 2.20, p = .030, g = 0.21, CI\ 95\% [0.02, 0.40]$, and repeated events vs. unique events, $t(105) = -0.24, p = .814, g = -0.02, CI\ 95\% [-0.21, 0.17]$.

Scene Rating: Object

The four memory conditions differed in the proportion of memory perceived as an object during retrieval, $F(3, 315) = 17.11, p < .001, \eta_p^2 = .14$ (see Figure 7). A greater proportion of general facts ($M = 0.44, SE = 0.02$) and autobiographical facts ($M = 0.42, SE = 0.02$) were perceived as objects compared to repeated events ($M = 0.34, SE = 0.02$) and unique events ($M = 0.30, SE = 0.02$): general facts vs. repeated events, $t(105) = 4.17, p < .001, g = 0.40, CI\ 95\% [0.21, 0.60]$; general facts vs. unique events, $t(105) = 5.94, p < .001, g = 0.57, CI\ 95\% [0.37, 0.78]$; autobiographical facts vs. repeated events, $t(105) = 3.36, p = .001, g = 0.33, CI\ 95\% [0.13, 0.52]$; autobiographical facts vs. unique events, $t(105) = 5.53, p < .001, g = 0.54, CI\ 95\% [0.33, 0.74]$. General facts did not differ from autobiographical facts, $t(105) = 1.22, p = .226, g = 0.12, CI\ 95\% [-0.07, 0.31]$, and repeated events did not differ from unique events, $t(105) = 1.82, p = .071, g = 0.18, CI\ 95\% [-0.02, 0.37]$. Therefore, facts were more frequently associated with the visualization of isolated objects than events.

Appendix 4

Appendix 4–Table 1. Practice Trials

Unique Events (UE) “Please respond (Yes or No) if the following events happened to you.” ¹			Repeated Events (RE) “Please respond (Yes or No) if the following events have happened to you repeatedly in the last year.”		Autobiographical Facts (AF) “Please respond (Yes or No) according to what is usually true for you.”		General Facts (GF) “Please respond (Yes or No) according to what is usually true for people in this country.”	
Stimuli ID	Cue	Sentence	Cue	Sentence	Cue	Sentence	Cue	Sentence
Ex. 1	Yesterday	I bought a lottery ticket.	When with friends	I have bought a lottery ticket.	Often	I buy lottery tickets.	Few people	buy lottery tickets
Ex. 2	Last weekend	I attended a wedding.	When on vacation	I attended a wedding.	Usually	I attend weddings.	Everyone	attends weddings.

Note. Participants practised the task outside and inside the scanner using the trials listed in Table S7. The researcher explained the task: “This task is going to present four kinds of statements to which you will answer yes or no. These statements are presented on a timer, so if you answer and the slide doesn’t change right away, that’s ok. You will be asked to answer questions in 1 one of 4 ways.

- For the first one, please answer yes or no according to what happened to you once. For example, it could say: This morning, I paid bills. If that happened once, you would say yes.
- For the second one, please answer yes or no accord to what happened to you repeatedly in the last year. For example, it could say: When at work, I paid bills. The key word is “repeatedly”. If that happened repeatedly, you would say yes.
- For the third one, please yes or no according to what is usually true to you. For example, it could say: Often, I pay bills. If that were true for you, you would say yes.
- Lastly, please answer yes or no according to what you think is true of most people in this country. For example, a statement could be: Everyone pays bills. If you agree with this, you would say yes.”

Appendix 4–Table 2. Stimuli List

Unique Events (UE) “Please respond (Yes or No) if the following events happened to you.” ¹				Repeated Events (RE) “Please respond (Yes or No) if the following events have happened to you repeatedly in the last year.”			Autobiographical Facts (AF) “Please respond (Yes or No) according to what is usually true for you.”			General Facts (GF) “Please respond (Yes or No) according to what is usually true for people in this country.”		
Stimuli ID	Run	Cue	Sentence	Run	Cue	Sentence	Run	Cue	Sentence	Run	Cue	Sentence
1	B	Yesterday	I wore white socks.	G	When shopping	I have worn white socks.	F	Usually	I wear white socks.	C	Everyone	wears white socks.
2	E	Last night	I took a shower.	F	When on vacation	I have taken a shower.	D	Often	I take showers.	D	Most people	take showers.
3	C	Last night	I used a computer.	E	When at work	I have used a computer.	B	Very often	I use a computer.	G	Few people	use a computer.
4	D	Today	I ate breakfast.	F	When with friends	I have eaten breakfast.	F	Usually	I eat breakfast.	F	Some people	skip breakfast.
5	G	This morning	I made my bed.	F	When with friends	I have made my bed.	F	Every day	I make my bed.	B	Few people	make their bed.
6	G	Last week-end	I drove on a highway.	B	When going to a clinic	I have driven on a highway.	G	Rarely	I drive on a highway.	G	Most people	drive on the highway.
7	A	Yesterday	I ate a chocolate.	E	When shopping	I have eaten a chocolate.	D	Rarely	do I eat chocolate.	A	Most people	eat chocolate.
8	G	This week	I read a book.	A	When on the bus	I have read books.	G	Rarely	I read books.	C	Few people	read books.

9	C	This week	I ate at a restaurant.	C	When alone	I have eaten at a restaurant.	G	Often	I eat at restaurants.	G	No one	eats at restaurants.
10	E	Last night	I watched tv.	A	When at work	I have watched TV.	G	Very often	I watch TV.	C	Everyone	watches TV.
11	E	This week	I went shopping.	B	When on vacation	I have gone shopping.	C	Very often	I go shopping.	F	Few people	go shopping.
12	D	This morning	I drank coffee.	E	When shopping	I have drunk coffee.	D	Every day	I drink coffee.	C	Many people	drink coffee.
13	D	Today	I talked on the phone.	A	When on the bus	I have talked on the phone.	E	Very often	I talk on the phone.	F	Everyone	talks on the phone.
14	E	Last night	I ate pizza.	E	When shopping	I have eaten pizza.	F	Every day	I eat pizza.	A	Most people	eat pizza.
15	A	This week	I went to the movies.	C	When alone	I have gone to the movies.	G	Sometimes	I go to the movies.	D	Many people	go to the movies.
16	A	Today	I read a newspaper.	G	When on the bus	I have read a newspaper.	A	Rarely	I read a newspaper.	B	Everyone	reads a newspaper.
17	A	Today	I spent money.	C	When at work	I have spent money.	C	Every day	I spend money.	D	No one	spends money.
18	D	Last week-end	I rented a movie.	C	When alone	I have rented a movie.	F	Rarely	I rent movies.	G	Some people	rent movies.
19	A	Yesterday	I read a magazine.	F	When with friends	I have read a magazine.	B	Often	I read magazines.	G	Most people	read magazines.
20	B	Yesterday	I listened to music.	C	When at work	I have listened to music.	D	Often	I listen to music.	G	Most people	listen to music.
21	B	Yesterday	I washed dishes.	A	When at work	I have washed dishes.	D	Every day	I wash the dishes.	G	No one	washes the dishes.
22	E	This week	I talked to a family member.	D	When at a clinic	I have talked to a family member.	C	Often	I talk to a family member.	D	Most people	talk to family members.
23	F	Yesterday	I wore jeans.	A	When at work	I have worn jeans.	A	Sometimes	I wear jeans.	E	Most people	wear jeans.
24	C	Last night	I slept well.	A	When alone	I have slept well.	C	Usually	I sleep well.	C	No one	sleeps well.
25	F	This morning	I woke up early.	G	When on vacation	I have woken up early.	D	Usually	I wake up early.	C	No one	wakes up early.
26	F	Today	I had chicken.	D	When at work	I have eaten chicken.	F	Sometimes	I eat chicken.	C	Everyone	eats chicken.
27	G	Today	I listened to the radio.	D	When at a clinic	I have listened to the radio.	C	Every day	I listen to the radio.	F	Few people	listen to the radio.
28	F	Last night	I went to bed early.	F	When with friends	I have gone to bed early.	B	Usually	I go to bed early.	A	Some people	go to bed early.
29	F	Yesterday	I took a nap.	E	When on vacation	I have taken naps.	A	Often	I take naps.	E	No one	takes naps.
30	B	Last night	I cooked dinner.	F	When with friends	I have cooked dinner.	G	Rarely	I cook dinner.	F	Many people	cook dinner.
31	C	Last week-end	I went dancing.	C	When alone	I have gone dancing.	E	Often	I go dancing.	D	Few people	go dancing.
32	D	This week	I watched sports.	D	When alone	I have watched sports.	B	Often	I watch sports.	D	Everyone	watches sports.
33	G	This morning	I checked my email.	D	When on the bus	I have checked my email.	G	Often	I check my email.	G	Everyone	checks their email.
34	B	This week	I played with a dog.	C	When alone	I have played with a dog.	G	Rarely	I play with dogs.	D	Some people	play with dogs.
35	C	This week	I bought a CD.	G	When on vacation	I have bought CDs.	C	Rarely	I buy CDs.	D	No one	buys CDs.
36	D	This week	I ate fries.	B	When on the bus	I have eaten fries.	F	Rarely	I eat fries.	C	Many people	eat fries.
37	G	Last week-end	I went to the mall.	B	When on vacation	I have gone to the mall.	C	Often	I go to the mall.	E	No one	goes to the mall.

38	F	This morning	I drank juice.	C	When shopping	I have drunk juice.	A	Very often	I drink juice.	B	Many people	drink juice.
39	G	Today	I went on a walk.	A	When alone	I have gone on a walk.	A	Sometimes	I go on walks.	F	Some people	go on walks.
40	F	Yesterday	I ate candy.	D	When at work	I have eaten candy.	B	Rarely	I eat candy.	E	Some people	eat candy.
41	B	This morning	I went to the bank.	G	When with friends	I have gone to the bank.	G	Sometimes	I go to the bank.	A	Few people	go to the bank.
42	C	Last week-end	I played a video game.	C	When alone	I have played a video game.	D	Very often	I play video games.	D	Most people	play video games.
43	B	This week	I worked out.	E	When on vacation	I have worked out.	E	Very often	I work out.	C	Some people	work out.
44	G	Last week-end	I did my laundry.	E	When with friends	I have done my laundry.	B	Very often	I do my laundry.	F	Everyone	does their laundry.
45	E	Last week-end	I ate pancakes.	G	When with friends	I have eaten pancakes.	E	Sometimes	I eat pancakes.	B	Some people	eat pancakes.
46	D	Yesterday	I logged on to Facebook.	D	When at work	I have logged on to Facebook.	C	Very often	I log on to Facebook.	A	Everyone	logs on to Facebook.
47	F	Yesterday	I sent a text message.	D	When on the bus	I have sent a text message.	D	Every day	I send text messages.	A	Some people	send text messages.
48	A	This week	I ate a sandwich.	B	When at work	I have eaten a sandwich.	F	Rarely	I eat sandwiches.	B	Some people	eat sandwiches.
49	A	Last week-end	I hugged a friend.	F	When on vacation	I have hugged a friend.	E	Sometimes	I hug a friend.	E	Many people	hug friends.
50	F	Last week-end	I watered a plant.	G	When on vacation	I have watered a plant.	G	Often	I water a plant.	A	Many people	water plants.
51	A	Last night	I sang a tune.	E	When shopping	I have sung a tune.	F	Sometimes	I sing a tune.	F	No one	sings tunes.
52	A	This morning	I kissed somebody.	B	When on vacation	I have kissed somebody.	B	Every day	I kiss somebody.	B	Most people	kiss others.
53	A	Last week-end	I bought a gift.	F	When with friends	I have bought a gift.	D	Rarely	I buy gifts.	E	Everyone	buys gifts.
54	E	This morning	I went to the gym.	B	When on vacation	I have been to the gym.	E	Sometimes	I go to the gym.	B	Few people	go to the gym.
55	C	Today	I missed a meeting.	A	When at work	I have missed a meeting.	D	Often	I miss a meeting.	A	No one	misses meetings.
56	B	Last night	I had a drink.	C	When alone	I have had a drink.	A	Very often	I have a drink.	B	Many people	have a drink.
57	D	Yesterday	I took a picture.	F	When shopping	I have taken a picture.	A	Very often	I take pictures.	E	Few people	take pictures.
58	D	Today	I went to a pharmacy.	B	When on vacation	I have been to the pharmacy.	A	Rarely	I go to the pharmacy.	C	Everyone	goes to the pharmacy.
59	C	This morning	I prayed.	F	When with friends	I have prayed.	A	Sometimes	I pray.	A	Few people	pray.
60	F	Last night	I heard jokes.	E	When shopping	I have heard jokes.	C	Every day	I hear jokes.	F	Everyone	hears jokes.
61	C	This week	I gave to a charity.	E	When shopping	I have given to charity.	E	Usually	I give to charity.	B	Few people	give to charity.
62	E	Last week-end	I visited a museum.	G	When with friends	I have visited a museum.	B	Rarely	I visit a museum.	D	Many people	visit museums.
63	G	Yesterday	I took a course.	G	When on vacation	I have taken a course.	A	Every day	I take a course.	E	Many people	take a course.
64	E	Last week-end	I had a cold.	G	When on vacation	I have had a cold.	B	Rarely	I have a cold.	B	Many people	have a cold.
65	D	This week	I went swimming.	A	When at work	I have gone swimming.	B	Sometimes	I go swimming.	E	No one	goes swimming.
66	B	Today	I checked the news online.	D	When at a clinic	I have checked the news online.	E	Every day	I check the news online.	F	Few people	check the news online.

67	B	Last night	I drove my car.	A	When going to a clinic	I have driven my car.	F	Very often	I drive my car.	G	Most people	drive their car.
68	G	Yesterday	I brushed my teeth.	D	When at a clinic	I brushed my teeth.	E	Very often	I brush my teeth.	E	Everyone	brushes their teeth.
69	E	Yesterday	I ate fruit.	B	When shopping	I ate fruit.	C	Every day	I eat fruits.	A	Most people	eat fruit.
70	C	Today	I washed my face.	B	When alone	I washed my face.	E	Usually	I wash my face.	G	No one	washes their face.

Note. ¹ Brief instructions displayed at the beginning of each block within each run.; ² The memory order within each run was based on the Latin Square technique. Run A & G: RE, UE, AF, GF; Run B & D: UE, AF, GF, RE; Run C: AF, GF, RE, UE; Run E & F: GF, RE, UE, AF. Run order was randomized for each participant. Stimuli were randomized within each block per participant.

Appendix 5

fMRI Study: Response Time

We entered response time in a repeated-measures ANOVA with Memory (general facts, autobiographical facts, repeated events, unique events) and Response (yes, no) as factors. Participants were faster to respond yes ($M = 730.97$, $SE = 24.58$) than to respond no ($M = 757.38$, $SE = 27.25$), $F(1, 47) = 6.21$, $p = .016$, $\eta_p^2 = .12$. We followed-up on a main effect of Memory, $F(3, 141) = 3.38$, $p = .020$, $\eta_p^2 = .07$, with paired samples t-tests corrected with a Holm-Bonferroni procedure. We computed the mean of yes and no responses for each condition prior to that step. Unique events ($M = 724.35$, $SE = 25.85$) had a faster response time than repeated events ($M = 750.55$, $SE = 26.21$), $t(47) = 2.93$, $p = .005$, $g = 0.42$, CI 95% [0.13, 0.71], and general facts ($M = 753.92$, $SE = 25.43$), $t(47) = 2.75$, $p = .009$, $g = 0.39$, CI 95% [0.10, 0.68], but not autobiographical facts ($M = 747.89$, $SE = 27.21$), $t(47) = 2.15$, $p = .037$, $g = 0.31$, CI 95% [0.02, 0.59]. None of the other comparisons were significant: general facts vs. autobiographical facts: $t(47) = .62$, $p = .541$, $g = 0.09$, CI 95% [-0.19, 0.37]; general facts vs. repeated events: $t(47) = 0.31$, $p = .758$, $g = 0.04$, CI 95% [-0.24, 0.33]; and autobiographical facts vs. repeated events: $t(47) = -0.25$, $p = .804$, $g = -0.04$, CI 95% [-0.32, 0.25]. The interaction between Memory and Response was not significant, $F(3, 141) = 0.97$, $p = .411$, $\eta_p^2 = .02$. Nevertheless, as we included only yes responses in the fMRI analyses, we repeated the ANOVA with yes responses and keeping only the Memory factor. The main effect of Memory was not significant, $F(2.56, 120.09) = 1.23$, $p = .302$, $\eta_p^2 = .03$, suggesting that all memory conditions produced similar response times when considering yes responses only. Even though seemingly similar to Renoult et al. (Renoult et al., 2016) for yes responses, participants waited until a response screen to produce their response and their speed does not reflect a true reaction time.

Appendix 6

fMRI Study: Proportion of Yes Responses

We entered the proportion of yes responses in a repeated-measures ANOVA with Memory as a factor (general facts, autobiographical facts, repeated events, unique events). The main effect of Memory was significant, $F(2.01, 94.45) = 41.50$, $p < .001$, $\eta_p^2 = .47$ (see Appendix 5 —figure 1). We followed up with paired-sample t-tests that were corrected using a Holm-Bonferroni procedure. All t-tests were significant. As expected and as in (Renoult et al., 2016), unique events ($M = .42$, $SE = .01$) had a smaller proportion of yes responses than general facts ($M = .55$, $SE = .01$), $t(47) = 10.03$, $p < .001$, $g = 1.44$, CI 95% [1.03, 1.84], autobiographical facts ($M = .59$, $SE = .01$), $t(47) = 14.09$, $p < .001$, $g = 2.02$, CI 95% [1.52, 2.51], and repeated events ($M = .50$, $SE = .02$) $t(47) = 5.29$, $p < .001$, $g = 0.76$, CI 95% [0.44, 1.07]. Further, repeated events had a smaller proportion of yes responses than general facts, $t(47) = 2.22$, $p = .031$, $g = 0.32$, CI 95% [0.03, 0.61], and autobiographical facts, $t(47) = 4.24$, $p < .001$, $g = 0.61$, CI 95% [0.30, 0.91]. The proportion of yes responses was larger for autobiographical facts than general facts, $t(47) = -3.24$, $p = .002$, $g = -0.46$, CI 95% [-0.76, -0.17]. In raw numbers, this translates into a M of 37.06 trials ($SE = .77$, range from 22 to 51) for general facts, M of 39.81 trials ($SE = .76$, range from 24 to 56) for autobiographical facts, M of 33.77 trials ($SE = 1.34$, range from 14 to 57) for repeated events, and M of 28.02 trials ($SE = .70$, range from 18 to 38) for unique events.

1 **Appendix 5 —figure 1.** Proportion of yes responses relative to the total number of responses a participant
2 made. Red points represent scores of individual participants ($N = 48$). Black lines show the median and
3 quartiles. * $p < .05$, ** $p < .01$, *** $p < .001$.

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4 **Figure 1—figure supplement 1.** Brain scores for the LV 1 of the mean-centered PLS that comprised the
5 control task and the memory conditions, projected onto a surface template from the Human Connectome
6 Project (Van Essen et al., 2012) using Connectome Workbench (Marcus et al., 2011).

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3 **Figure 3—figure supplement 1.** Brain scores for the LV 1 of the mean-centered PLS that comprised the
 4 memory conditions only, projected onto a surface template from the Human Connectome Project (Van
 5 Essen et al., 2012) using Connectome Workbench (Marcus et al., 2011).

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3 **Figure 4—figure supplement 1.** Brain scores for the LV 2 of the mean-centered PLS that comprised the
 4 memory conditions only, projected onto a surface template from the Human Connectome Project (Van
 5 Essen et al., 2012) using Connectome Workbench (Marcus et al., 2011).

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3 **Figure 5—figure supplement 1.** Brain scores for the linear contrast tested with the non-rotated PLS,
 4 projected onto a surface template from the Human Connectome Project (Van Essen et al., 2012) using
 5 Connectome Workbench (Marcus et al., 2011).