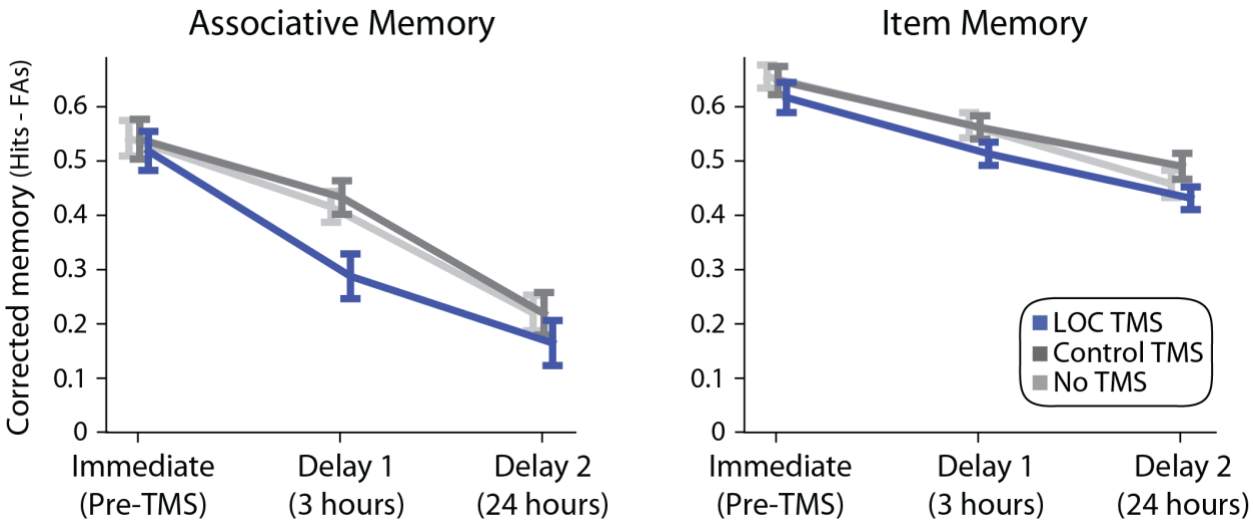

Figure S1. Corrected memory over time. Related to Figure 2.

(A) Unnormalized corrected associative memory accuracy (associative hits minus associative false alarms) for each group. No differences in Immediate associative memory were present across TMS groups (LOC vs. Control TMS, t_{56} = .35, P = .72) or between the No TMS group and TMS conditions (vs. LOC, t_{53} = .40, P = .69; vs. Control, t_{53} = .03, P = .98). During Delay 1 (same-day testing three hours later), associative memory was reduced for LOC TMS (LOC versus Control TMS, t_{56} = 2.37, P = .021; LOC TMS versus No TMS; t_{53} = 2.10, P = .04) and did not differ between control groups (Control TMS versus No TMS; t_{53} = .34, P = .74). No reliable differences were present during Delay 2 (next-day memory testing 24 hours later; LOC versus Control TMS, t_{56} = .80, P = .43; LOC TMS versus No TMS, t_{53} = .87, P = .39; Control TMS versus No TMS, t_{53} = .02, P = .98).

(B) Unnormalized corrected item memory (item hits minus false alarms). Immediate item memory accuracy did not reliably differ between TMS sites (LOC versus Control TMS, t_{56} = .70, P = .5) or between the No TMS group and either TMS group (versus LOC, t_{53} = .92, P = .37, versus Control, t_{53} = .18, P = .86). No differences in item memory were found during Delayed memory testing (Delay 1: LOC versus Control TMS, t_{56} = 1.35, P = .18; LOC versus No TMS, t_{53} = 1.39, P = .17; Control TMS versus No TMS, t_{53} = .11, P = .92; Delay 2: LOC versus Control TMS, t_{56} = 1.56, P = .12; LOC versus No TMS, t_{53} = .68, P = .50; Control TMS versus No TMS, t_{53} = .79, P = .43).

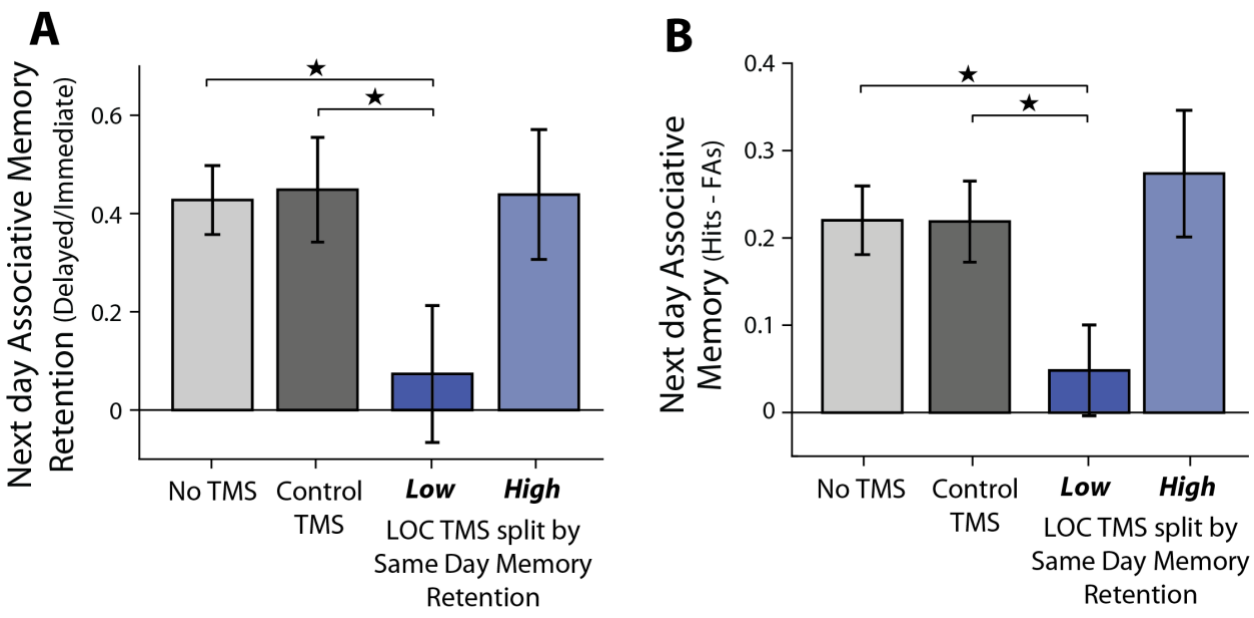

Figure S2. Split half analysis of LOC TMS next-day associative memory based on same-day retention. Related to Figure 2.

(A) Next-day associative memory retention (Delayed/Immediate memory) for the LOC TMS group based on levels of same-day associative memory retention. Low refers to participants with the lowest same-day associative memory retention (bottom half of participants) and High refers to participants with the highest same-day associative memory retention (top half of participants). Control TMS and No TMS participants are shown in gray bars. Reduced next-day associative memory retention was found for participants with the lowest level of same-day associative memory retention compared to both control groups (versus Control TMS, $t_{41} = 2.06$, P = .045; versus No TMS, $t_{38} = 2.54$, P = .015).

(B) Next-day corrected associative memory (associative hits minus associative false alarms) is shown for LOC TMS based on levels of same-day associative memory retention (Low = bottom half of same-day retention; High = top half of same-day retention), along with Control TMS and No TMS groups. Similar to normalized memory retention shown in (A), reduced next-day associative memory was found for participants with the lowest level of same-day associative memory retention compared to both control groups (versus Control TMS, $t_{41} = 2.24$, P = .031; versus No TMS, $t_{38} = 2.61$, P = .013). $^{\star}P < .05$

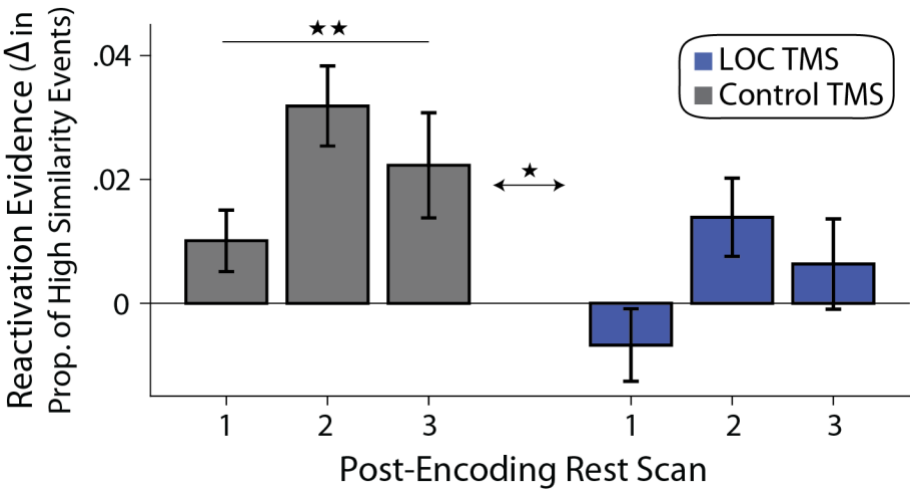

Figure S3. Reactivation evidence in LOC using a similarity-based approach. Related to Figure 3. Individual time-points during rest scans were identified as showing high similarity (correlation) with object and face patterns derived from the functional localizer scans. Reactivation evidence shows the change in the proportion of high similarity time-points from Baseline to each Post-Encoding Rest scan. In the Control TMS group, an increase in the proportion of high similarity time-points between the Baseline and Post-Encoding Rest scans was found (average across Post-Encoding scans, t_{25} = 3.61, P = .0013, Cohen's d = .71). However, no change in the proportion of high similarity time-points was found between the Baseline and Post-Encoding Rest scans across all three Post-Encoding scans (average across Post-Encoding scans, t_{25} = .83, P = .42), although a significant increase was found in the second Post-Encoding Rest scan (t_{25} = 2.20, P = .038, Cohen's d = .43). Analogous to the classification approach shown in Figure 3, greater reactivation evidence was found for Control versus LOC TMS, as indicated by a main effect of TMS ($F_{1,50}$ = 4.43, P = .04, η_p^2 = .081). $^{\star}P < .05$, $^{\star\star}P < .005$

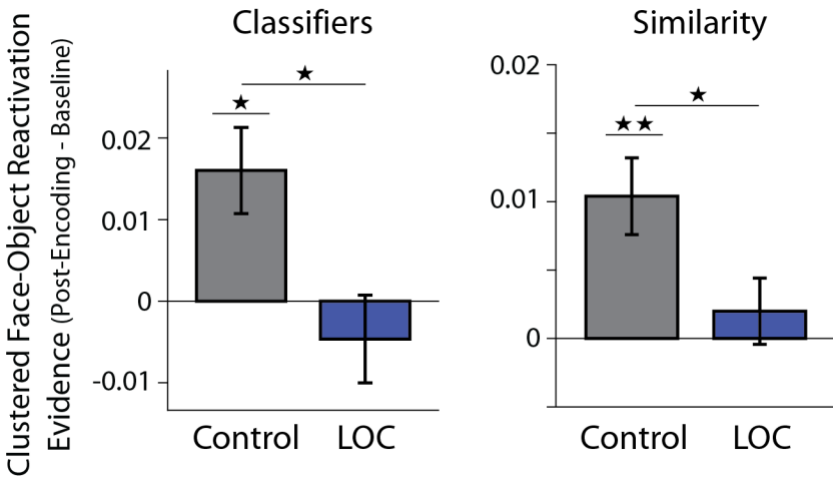

Figure S4. Evidence for temporally clustered reactivation of face and object patterns in LOC. Related to Figure 3.

Temporal clustering of face and object patterns was measured by computing the proportion of volumes with either simultaneous or immediately adjacent face and object reinstatement. Temporally clustered reactivation evidence was taken as the change in this proportion from Baseline to Post-Encoding Rest. This was assessed using classifier outputs (A) and the pattern similarity approach (B) to detect face and object pattern reinstatement during rest.

(A) Reliable temporally clustered reactivation was seen using face and object classifiers for the Control TMS group (average across Post-Encoding scans, t_{25} = 3.04, P = .0055, Cohen's d = .60) but not for the LOC TMS group (average across Post-Encoding scans, t_{25} = -.86, P = .40). Temporally clustered reactivation evidence differed between TMS groups (t_{50} = 2.74, P = .0084).

(B) Significant temporally clustered reactivation was found using the similarity approach for the Control TMS group (average across Post-Encoding scans, t_{25} = 3.72, P = .001, Cohen's d = .73) but not in the LOC TMS group (average across Post-Encoding scans, t_{25} = .82, P = .42). Temporally clustered reactivation evidence differed between TMS groups (t_{50} = 2.27, P = .028). $^{\star}P < .05$, $^{\star\star}P < .005$

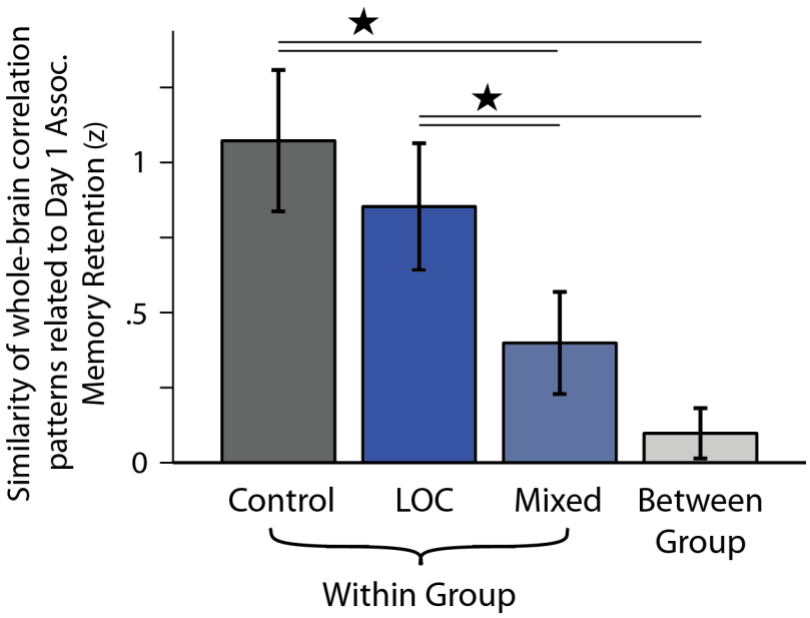

Figure S5. Distinct patterns of hippocampal interactions were related to same-day memory retention across Control versus LOC TMS conditions. Related to Figure 6.

Similar to Figure 6B, subsampling was performed to repeatedly estimate patterns of hippocampal functional connectivity changes (from Baseline to Post-Encoding Rest) that were related to same-day memory retention. Patterns of correlations between hippocampal functional connectivity changes and same-day associative memory retention were estimated for random subsets of each TMS group (N=20) as well as in for a mixed group of participants from both TMS conditions (N=10 from each group). Greater similarity was found for the Control and LOC TMS groups (left-most bars) compared to the similarity of patterns between groups (Control TMS vs. between-group, $t_{36} = 17.8$, $P < 10^{-10}$; LOC TMS versus between-group, $t_{36} = 14.6$, $P < 10^{-10}$) and the mixed group (Control TMS versus mixed-group, $t_{36} = 10.5$, $P < .001$; LOC TMS versus mixed-group, $t_{36} = 7.1$, $P < .001$). Bars show the mean Fisher Z-transformed similarity and error bars show the standard deviation of the Fisher Z-transformed similarity across subsampled iterations. $^{\star}P < .001$

	Immediate	Delay 1	Delay 2
Control (No TMS)	.542 ± .039	.416 ± .034	.220 ± .039
Control TMS	.540 ± .043	.433 ± .037	.219 ± .046
LOC TMS	.512 ± .043	.288 ± .049	.165 ± .049

Table S1. Unnormalized associative memory over time. Related to Figure 2. Corrected associative memory (proportion of associative hits minus associative false alarms). Values are mean ± standard error of the mean.

	Immediate	Delay 1	Delay 2
Control (No TMS)	.656 ± .025	.566 ± .028	.458 ± .030
Control TMS	.648 ± .031	.562 ± .025	.490 ± .028
LOC TMS	.617 ± .033	.513 ± .026	.432 ± .025

Table S2. Unnormalized item memory over time. Related to Figure 2.
Corrected item memory (proportion of item hits minus false alarms). Values are mean ± standard error of the mean.

	% of time	Participants with stimulus-related thoughts	% of thoughts labeled as intentional	% of thoughts labeled as spontaneous
Control TMS	6.8%	20/29	11.4%	88.6%
LOC TMS	12.1%	27/29	8.8%	91.2%
Average	9.5%	23.5/29	9.9%	90.1%

Table S3. Stimulus-related mentation during Post-Encoding Rest. Related to Results, Questionnaires and STAR Methods, Method Details.
Percent (%) of time column refers to the average percent of the total Post-Encoding Rest period in which stimulus-related thoughts or mentation was reported to occur. Participants with stimulus-related thoughts column refers to the total number of participants in each TMS group that reported any stimulus-related mentation during Post-Encoding Rest. Percent (%) of thoughts labeled as intentional refers to the average percent of total stimulus-related mentation that was reported to be intentional in nature (i.e. participants were retrieving stimuli in preparation for an upcoming memory testing). Percent (%) of thoughts labeled as spontaneous refers to the average percent of total stimulus-related mentation that was reported to be spontaneous in nature (i.e. stimuli just popped into their mind in a random, non-strategic fashion).