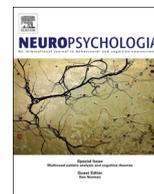




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## The cortical basis of true memory and false memory for motion



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## ABSTRACT

Behavioral evidence indicates that false memory, like true memory, can be rich in sensory detail. By contrast, there is fMRI evidence that true memory for visual information produces greater activity in earlier visual regions than false memory, which suggests true memory is associated with greater sensory detail. However, false memory in previous fMRI paradigms may have lacked sufficient sensory detail to recruit earlier visual processing regions. To investigate this possibility in the present fMRI study, we employed a paradigm that produced feature-specific false memory with a high degree of visual detail. During the encoding phase, moving or stationary abstract shapes were presented to the left or right of fixation. During the retrieval phase, shapes from encoding were presented at fixation and participants classified each item as previously “moving” or “stationary” within each visual field. Consistent with previous fMRI findings, true memory but not false memory for motion activated motion processing region MT+, while both true memory and false memory activated later cortical processing regions. In addition, false memory but not true memory for motion activated language processing regions. The present findings indicate that true memory activates earlier visual regions to a greater degree than false memory, even under conditions of detailed retrieval. Thus, the dissociation between previous behavioral findings and fMRI findings do not appear to be task dependent. Future work will be needed to assess whether the same pattern of true memory and false memory activity is observed for different sensory modalities.

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## 1. Introduction

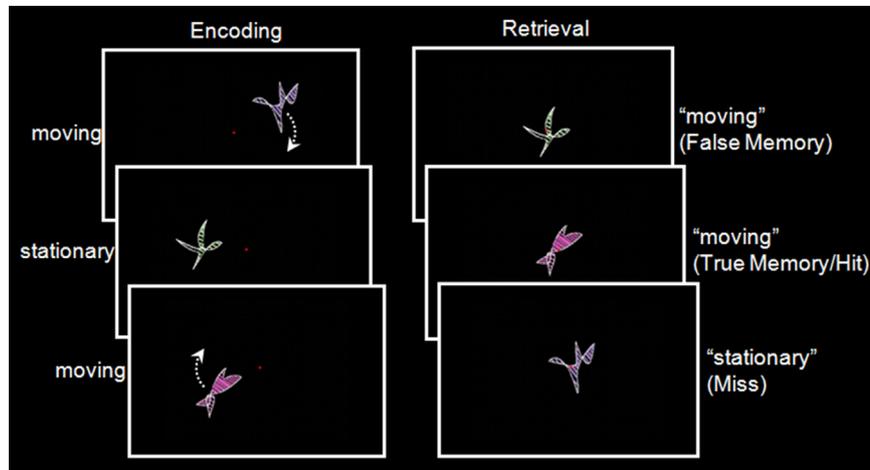
False memory can be rich in sensory detail under certain task conditions (Lampinen, Neuschatz, & Payne, 1998; Payne, Neuschatz, Lampinen, & Lynn, 1997; Porter, Yuille, & Lehman, 1999; Roediger & McDermott, 1995). For instance, Roediger and McDermott (1995) implemented a behavioral paradigm adapted from Deese (1959) in which participants heard lists of words (e.g., table, sit, legs, etc.) that were each related to a single critical nonpresented word (e.g., chair). The critical words were falsely recalled with high confidence, and “remember” judgment rates were not significantly different for true recognition of studied words and false recognition of critical nonpresented words.

By contrast, there is fMRI evidence that suggests true memories are associated with a greater degree of sensory detail as compared to false memories, as true memories have been associated with greater sensory cortical activity than false memories. In an fMRI study of memory for abstract shapes (Slotnick & Schacter, 2004), true memory activated earlier visual processing regions (BA 17, BA 18) to a greater degree than false memory, while both true

memory and false memory activated later visual processing regions (BA 19, BA 37) to a similar degree. In a more recent fMRI study (Stark, Okado, & Loftus, 2010), participants were presented with visual vignettes and, the following day, heard conflicting auditory misinformation (participants were under the impression that the auditory information was truthful). During the retrieval phase, participants were asked whether sentences accurately or inaccurately described previously presented vignettes. Consistent with previous findings (Slotnick & Schacter, 2004; see also, Garoff-Eaton, Slotnick, & Schacter, 2006), true memory produced greater activity in earlier visual processing regions (BA 17, BA 18) than false memory, while false memory for auditory misinformation produced activity in auditory/language processing regions (BA 22, BA 42). These fMRI results suggest true memory and false memory are distinct in that true memory produced greater activity than false memory in earlier visual processing regions, while true memory and false memory activated later processing regions to a similar degree.

The aim of the present study was to address the apparent discontinuity between previous behavioral results that suggest true memory and false memory can be associated with similar levels of subjective sensory detail and the fMRI results that suggest true memory is associated with a greater degree of sensory detail than false memory. Specifically, previous fMRI paradigms may

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**Fig. 1.** Stimulus paradigm and relevant event types. During encoding, moving and stationary shapes were presented to the left or right of fixation. During retrieval, shapes from encoding were presented at fixation and participants classified items as previously “moving” or “stationary” within the “left” or “right” visual field.

have produced false memory for modality-specific (e.g., visual) information without sufficient sensory detail to activate earlier visual processing regions (see Slotnick, 2004). To investigate this possibility, in the present fMRI study we employed a paradigm to produce false memory for feature-specific (motion) information with a higher degree of visual detail than in previous fMRI studies (although these false memories may not be as detailed as true memories, which is addressed below). During the encoding phase, participants were presented with moving or stationary abstract shapes to the left or right of fixation (Fig. 1, left). During the retrieval phase, shapes from encoding were presented at fixation and participants classified each item as previously “moving” or “stationary” within the “left” or “right” visual field (Fig. 1, right). True memory corresponded to a “moving” response to a previously moving item, whereas false memory corresponded to a “moving” response to a previously stationary item.

Of importance, MT+ is the primary region involved in motion perception and memory for motion (Slotnick & Thakral, 2011), and thus can be assumed to mediate earlier visual processing in the present investigation. The pattern of true memory activity and false memory activity in MT+ and later cortical processing regions will be used to evaluate two hypotheses. If true memory and false memory for motion activate MT+ to a similar degree, this would support the hypothesis that false memories in previous fMRI studies did not have sufficient detail to activate earlier visual regions (i.e., the effects are task dependent). However, if true memory for motion still produces a greater magnitude of activity in MT+ than false memory for motion (with both true memory and false memory for motion producing activity in more anterior cortical regions), this would suggest false memory does not depend on earlier sensory cortical regions (i.e., there is a dissociation between behavioral and neural effects).

## 2. Materials and methods

### 2.1. Participants

Twelve students at Boston College participated in the study (9 females, age range 19–28 years). Participants were right-handed, native English speakers, and had normal or corrected-to-normal vision. Participants were compensated \$10 for the behavioral training session and \$25/hour (approximately \$100) for fMRI. The Boston College Institutional Review Board approved the behavioral protocol and the Massachusetts General Hospital Institutional Review Board approved the fMRI protocol. Informed and written consent was obtained before each session began.

### 2.2. Stimuli and paradigm

Participants completed a behavioral training session, which included a one-quarter length run and two full-length runs, and six runs during fMRI. They were instructed to always maintain fixation and to remember whether each shape was moving or stationary and its spatial location (i.e., the left or right visual field). During the encoding phase of each run, 24 abstract shapes spanning 4° of visual angle were presented in the left or right visual field along an arc spanning  $\pm 45^\circ$  of polar angle from the horizontal meridian with the nearest edge 2° of visual angle from fixation. The shapes were designed to minimize verbal encoding strategies (for details on shape construction, see Slotnick & Schacter, 2004). Each shape was presented for 2.5 s with an inter-trial-interval of 3.0 s. Shape sets were repeated three times during encoding with each shape set randomized and presented sequentially. An equal number of shapes were stationary, at one of six equally spaced locations along the stimulation arc within each hemifield, or moving, smoothly traversing the entire stimulation arc in each hemifield with either upward or downward motion. In each run, all spatial locations and movement directions were presented equally often. Immediately before the retrieval phase, an instruction screen was presented for 8 s that reminded participants to maintain fixation and displayed the previously learned response mappings. During the retrieval phase of each run, the 24 shapes from encoding were presented in random order at fixation for 3.5 s with an inter-trial-interval of 7–10 s. Participants pressed response buttons with the fingers of their left hand to classify each shape as “previously in motion in the right visual field”, “previously in motion in the left visual field”, “previously stationary in the right visual field”, or “previously stationary in the left visual field”. Participants also made a subsequent “remember”–“know” response to characterize their subjective experience, but these responses were collapsed in the fMRI analysis to maximize power. During both encoding and retrieval, no more than three shapes of a given type were presented sequentially. Shapes were never repeated across runs. Sets of shapes (moving-right, moving-left, stationary-right, and stationary-left) were counterbalanced across participants using a Latin Square design.

### 2.3. Data acquisition and analysis

A Siemens 3 T Trio Scanner (Erlangen, Germany) with a standard head coil was used to acquire data. To acquire functional images, an echo planar imaging sequence was used (TR=2000 ms, TE=20 ms, flip angle=90°, field-of-view=256 × 256 mm<sup>2</sup>, acquisition matrix=64 × 64, slices=33, slice thickness=4 mm, 4 mm isotropic resolution). To acquire anatomic images, a magnetized prepared rapid gradient echo sequence was used (TR=30 ms, TE=3.3 ms, flip angle=40°, field-of-view=256 × 256 mm<sup>2</sup>, acquisition matrix=256 × 256, slices=128, slice thickness=1.33 mm, 1.33 × 1 × 1 mm resolution). Analysis was conducted using Brain Voyager QX (Brain Innovation B.V., Maastricht, The Netherlands). Pre-processing included slice-time correction, motion correction, and temporal filtering by removal of linear trends and components at or below 2 cycles per run length (using a general linear model to remove low frequency Fourier basis sets). To maximize spatial resolution, spatial smoothing was not conducted. Functional and anatomic images were transformed into Talairach space.

A random-effect general linear model was conducted. To produce each hemodynamic response model, a canonical hemodynamic response function was convolved with the protocol of each event for each participant (i.e., a square wave defined by each event onset and the subsequent behavioral response). It was

assumed that encoding trials had durations of 2.5 s and no-response trials had durations of 3.5 s. This produced the following event types: encoding type (moving or stationary) in the left or the right visual field, accurate memory for motion and spatial location, accurate memory for motion and inaccurate memory for spatial location, inaccurate memory for motion and spatial location, no response, and a constant. As we were only interested in memory for motion and it has been shown that MT+ is not modulated as a function of spatial location (Slotnick & Thakral, 2011), we collapsed over spatial location to maximize power.

Cortical regions associated with motion were identified by contrasting moving shapes at encoding > stationary shapes at encoding. Of relevance, motion processing region MT+ is known to be located within the ascending limb of the inferior temporal sulcus (Beauchamp, Yasar, Kishan, & Ro, 2007; Dukelow et al., 2001; Huk, Dougherty, & Heeger, 2002; Smith, Wall, Williams, & Singh, 2006; Watson et al., 1993). An individual voxel threshold of  $p < 0.001$  was enforced for all contrasts, false discovery rate corrected for multiple comparisons to  $p < 0.05$ . Activations were localized on the group average anatomic volume (Talairach coordinates are provided in the tables), and were projected onto a representative inflated cortical surface for display purposes (for segmentation and reconstruction procedures, see Slotnick, 2005). Event-related activity was extracted in regions-of-interest (significant voxels within a 7 mm cube centered at each selected coordinate) from  $-2$  to 12 s after stimulus onset (baseline corrected from  $-2$  to 0 s). Statistical analysis was based on the peak amplitude of activity from 6 to 8 s after stimulus onset, the expected maximum of the hemodynamic response, to avoid violation of independence.

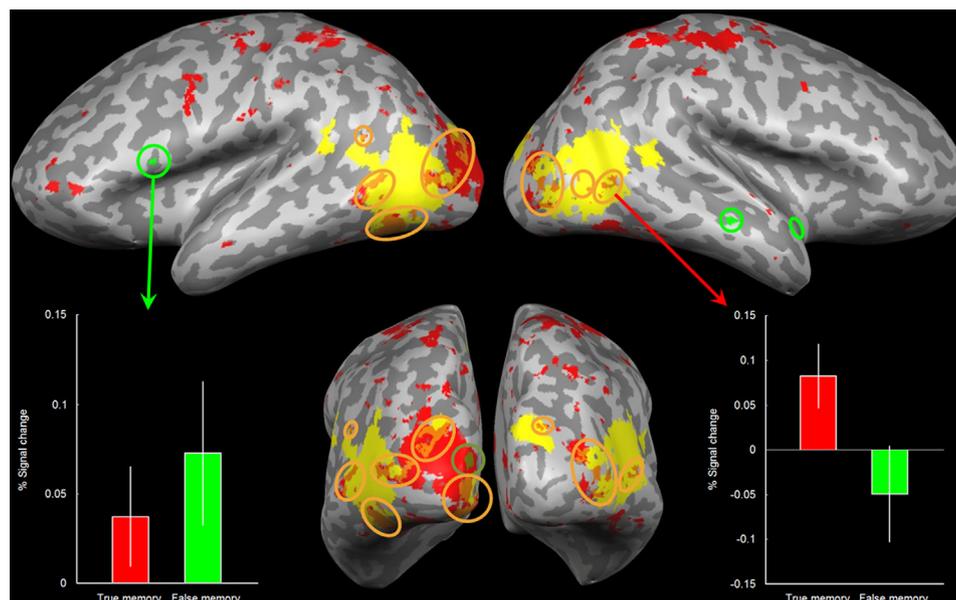
### 3. Results

Behavioral accuracy for classifying moving items and stationary items was at an intermediate level ( $69.1 \pm 3.0\%$  correct; “moving”/moving =  $65.5 \pm 4.4\%$ , “stationary”/moving =  $34.5 \pm 4.4\%$ , “moving”/stationary =  $27.3 \pm 4.1\%$ , “stationary”/stationary =  $72.8 \pm 4.1\%$ ; chance = 50%, mean  $\pm$  1 se). The proportion of subsequent “remember” responses (i.e.,  $N_{\text{remember}}/N_{\text{remember}} + N_{\text{know}}$ ) was 79.8% for true memory (“moving”/moving) and 62.9% for false memory (“moving”/stationary). This indicates that the majority of true memories and false memories were detailed, although the “remember” rate was significantly higher for true memories ( $t(11) = 2.35$ ,  $p < 0.05$ ).

Activity associated with perception/encoding of moving shapes (moving > stationary) occurred in motion processing region MT+ bilaterally within the ascending limb of the inferior temporal sulcus (Fig. 2; in yellow). Activity associated with true memory

for motion (identified by contrasting “moving”/moving items > “stationary”/moving items; i.e., hit > miss; in red) occurred in MT+ bilaterally (Fig. 2; overlap with motion perception/encoding activity in orange). In addition, true memory for motion produced activity in many other cortical regions, including more anterior temporal regions (Fig. 2; in red). There was no significant activity within MT+ associated with false memory for motion (identified by contrasting “moving”/stationary items > “stationary”/stationary items; in green), even at a reduced threshold ( $p < 0.01$ , uncorrected). Like true memory, false memory for motion activated more anterior temporal regions (Fig. 2; in green). Furthermore, false memory but not true memory for motion produced activity in language processing cortex (BA 44/Broca’s area; for a complete list of activations, see Table 1). The magnitude of activity (% signal change) associated with true memory and false memory was extracted from MT+ and BA 44 to better characterize the response profiles within these regions. Within MT+ (Fig. 2, bottom right), the magnitude of true memory activity (“moving”/moving – “stationary”/moving) was significantly positive ( $t(11) = 2.22$ ,  $p < 0.05$ ), but the magnitude of false memory activity (“moving”/stationary – “stationary”/stationary) was not significantly positive ( $t(11) < 1$ ; the “moving”/moving magnitude was also significantly positive,  $t(11) = 3.51$ ,  $p < 0.01$ , and the “moving”/stationary magnitude was not significantly positive,  $t(11) = 1.71$ ,  $p = 0.057$ ). Within BA 44 (Fig. 2, bottom left), the magnitude of true memory activity (“moving”/moving – “stationary”/moving) was not significantly positive ( $t(11) = 1.00$ ,  $p = 0.17$ ), but the magnitude of false memory activity (“moving”/stationary – “stationary”/stationary) was significantly positive ( $t(11) = 2.42$ ,  $p < 0.05$ ; the “moving”/moving magnitude was also not significantly positive,  $t(11) = 1.49$ ,  $p = 0.082$ , and the “moving”/stationary magnitude was significantly positive,  $t(11) = 3.63$ ,  $p < 0.01$ ). It is notable that the magnitude of true memory activity in BA 44 was positive; thus, the null true memory effect in this region may reflect insufficient power due to our limited sample size.

We next evaluated whether the magnitude of activity in motion processing cortex associated with true memory was significantly greater than that associated with false memory.



**Fig. 2.** Activity associated with true memory for motion and false memory for motion. Gyri and sulci are shown in light and dark gray, respectively (lateral views are shown at the top and a posterior view is shown at the bottom). Activity associated with motion perception/encoding is shown in yellow. Activity associated with true memory for motion is shown in red (overlap with motion perception/encoding is shown in orange within orange ovals). Activity associated with false memory for motion is shown in green (within green ovals; overlap with motion perception/encoding is shown in olive within olive oval). True memory and false memory activation magnitudes (% signal change) were extracted from BA44 (bottom left) and MT+ (bottom right; mean  $\pm$  1 se). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

**Table 1**  
True memory and false memory activations.

Region	BA	x	y	z
<i>True memory</i>				
Anterior frontal cortex	10	16	55	–3
Anterior frontal cortex	10	35	55	12
Anterior frontal cortex	10	–40	42	2
Medial frontal cortex	12	–4	45	–9
Anterior frontal cortex	10	–32	43	10
Middle frontal gyrus	46	–39	40	26
Anterior frontal cortex	10	–38	46	–3
Middle frontal gyrus	9/46	–30	30	20
Orbital frontal cortex	11	26	32	–5
Anterior cingulate	24	5	31	7
Orbital frontal cortex	11	–26	28	–13
Inferior frontal sulcus	9	41	24	26
Inferior frontal sulcus	9	–37	18	22
Superior frontal gyrus	6	–13	16	57
Anterior cingulate	24	–11	16	30
Medial frontal cortex	6	–4	13	48
Medial frontal cortex	6	–9	6	48
Precentral gyrus	6	52	–2	33
Middle frontal gyrus	6	–33	1	41
Precentral sulcus	6	–52	2	32
Superior frontal gyrus	6	–3	–3	58
Precentral gyrus	6	36	–1	33
Central sulcus	3/4	27	–14	49
Precentral sulcus	4	42	–4	46
Precentral sulcus	6	–19	–13	52
Superior temporal gyrus	22	56	–4	–6
Supramarginal gyrus	40	–58	–17	25
Intraparietal sulcus	40	–49	–20	37
Intraparietal sulcus	40	–38	–26	44
Superior parietal lobule	7	30	–44	52
Supramarginal gyrus	40	44	–29	35
Superior parietal lobule	7	–34	–36	48
Middle temporal gyrus	21	–55	–9	–15
Right amygdala	–	30	–13	–9
Left amygdala	–	–31	–13	–8
Superior temporal gyrus	22/42	–61	–29	18
Superior temporal gyrus	22	–59	–32	12
Posterior cingulate	31	6	–53	28
Fusiform gyrus	19/37	36	–61	–12
Striate and extrastriate cortex	17/18/19/37	–17	–94	6
Fusiform gyrus	19/37	–28	–69	–13
Extrastriate cortex	19	43	–61	4
Superior parietal lobule	7	–20	–61	52
Posterior intraparietal sulcus	19/39	20	–63	39
Precuneus	7	–5	–74	41
Extrastriate cortex	18/19	28	–84	7
<i>False memory</i>				
Inferior frontal gyrus	44	–40	10	12
Superior temporal sulcus	21	51	–20	–9
Extrastriate cortex	18	–22	–89	18
Extrastriate cortex	18	–13	–92	12

BA refers to Brodmann area and Talairach coordinate ( $x, y, z$ ) refers to the center of activation.

Activity associated with true memory versus false memory for motion (identified by contrasting “moving”/moving items > “moving”/stationary items) occurred in motion processing cortex (Fig. 3; overlap with motion perception/encoding activity in orange). Activity associated with false memory versus true memory for motion (the reverse contrast) did not activate motion processing cortex (Fig. 3; in green), even at a reduced threshold ( $p < 0.01$ , uncorrected). False memory versus true memory activated BA 22 (Wernicke’s area; for a complete list of activations, see Table 2), a region previously associated with false memory versus true memory (Garoff-Eaton et al., 2006).

The preceding behavioral analysis showed that the “remember” rate was significantly higher for true memory than false memory. As such, it could be argued that our differential fMRI findings in

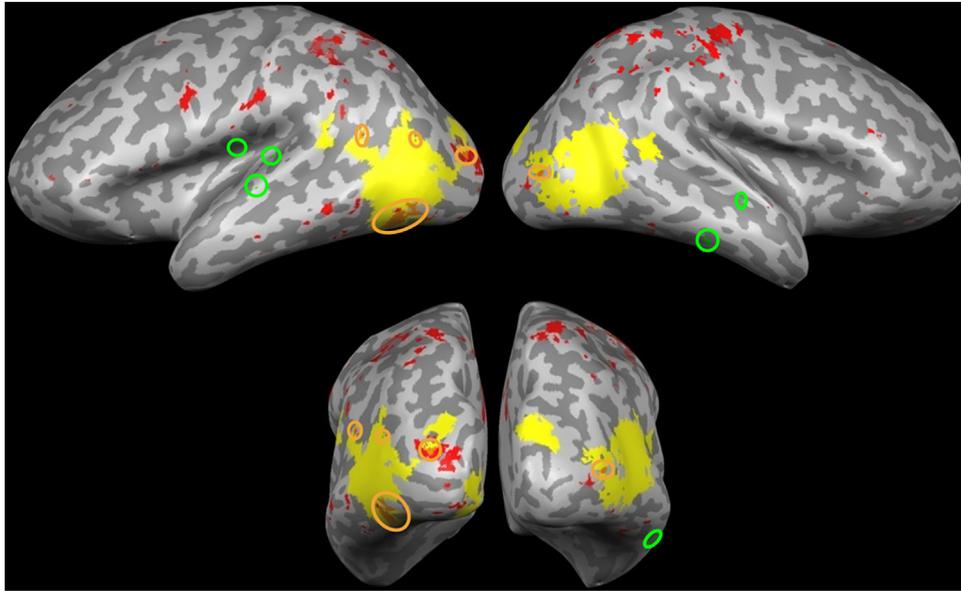
MT+ reflected more detailed processing during true memory. In an effort to equate the level of detail during true memory and false memory, we conducted a post-hoc individual participant behavioral analysis. We found that the differential “remember” response rates for true memory and false memory were driven by four participants (i.e., the differential response rates had a bimodal distribution; four participants had values > 0.29 and the remaining participants had values < 0.12). After the four participants with the highest differential “remember” response rates were eliminated from the behavioral analysis, the “remember” response rates for true memory (77.2%) and false memory (74.5%) did not significantly differ ( $t(7) < 1$ ; location accuracy did not significantly differ for these participants either,  $t(7) = 1.78$ ,  $p = 0.12$ ). It is notable that this false memory “remember” response rate is similar to that reported during the Deese–Roediger–McDermott paradigm (Roediger & McDermott, 1995). The fMRI analysis was conducted using the participants with matched true memory and false memory “remember” rates, and we observed the identical pattern of results described above.

#### 4. Discussion

In the present study, true memory for motion produced greater activity in motion processing region MT+ than false memory for motion, while both true memory and false memory for motion produced activity in more anterior temporal regions. The identical pattern of activity was observed when subjective detail was equated. These results support previous fMRI findings (Slotnick & Schacter, 2004; Stark et al., 2010) that true memory produces greater activity in earlier sensory processing regions than false memory, and that true memory and false memory produce similar patterns of activity in later sensory processing regions.

These findings support the hypothesis that there is a dissociation between behavioral results that indicate true memory and false memory can have a similar degree of sensory detail (Lampinen et al., 1998; Payne et al., 1997; Porter et al., 1999; Roediger & McDermott, 1995; but see, Henkel, Franklin, & Johnson, 2000), and fMRI results that indicate true memory is associated with a higher degree of sensory detail than false memory (Slotnick & Schacter, 2004; Stark et al., 2010). The current paradigm was designed to produce false memory for feature-specific (motion) information, rather than modality-specific information as employed in previous fMRI studies (Slotnick & Schacter, 2004; Stark et al., 2010), such that false memory for motion might have produced activity in MT+, yet no such activity was observed. Considering the consistent pattern of true memory and false memory activity across the present and previous fMRI studies, the neural basis of true memory and false memory for visual information does not appear to be task dependent. The discrepancy between the behavioral findings, which suggest false memory can be highly detailed, and fMRI findings, which suggest false memory is not highly detailed, needs to be reconciled. It appears that the detailed subjective experience associated with behavioral false memory does not reflect feature-specific sensory processing, which would have been manifested in the present study by activation of MT+, but rather reflects high confidence based on activity in later processing regions. As memory confidence has been associated with activity within the left ventrolateral prefrontal cortex (the left inferior frontal gyrus in Chua, Rand-Giovannetti, Schacter, Albert, & Sperling, 2004; BA 44 in Kao, Davis, & Gabrieli, 2005), false memory for motion in the current paradigm may have been mediated, in part, by activity in the left inferior frontal gyrus (BA 44; Table 1).

More broadly, the present results fit within a constructive memory framework. True memory construction can be based on



**Fig. 3.** Activity associated with true memory versus false memory for motion. Activity associated with motion perception/encoding is shown in yellow. Activity associated with true memory greater than false memory for motion is shown in red (overlap with motion perception/encoding is shown in orange, within orange ovals). Activity associated with false memory greater than true memory for motion is shown in green (within green ovals). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

**Table 2**

True memory > false memory and false memory > true memory activations.

Region	BA	x	y	z
<i>True memory &gt; false memory</i>				
Anterior frontal cortex	10	−34	47	3
Middle frontal gyrus	46	−28	37	26
Middle frontal gyrus	46	29	37	24
Orbital frontal cortex	11	23	35	−5
Inferior frontal sulcus	9/46	39	27	21
Medial frontal cortex	32	10	26	34
Superior frontal sulcus	6	17	10	45
Middle frontal gyrus	6	−25	5	45
Precentral sulcus	6	−39	−2	47
Precentral sulcus	6	−51	2	32
Postcentral sulcus	2	47	−20	34
Postcentral gyrus	1	54	−14	36
Postcentral sulcus	2	−53	−19	27
Postcentral sulcus	2	31	−23	47
Postcentral sulcus	2	−36	−28	36
Intraparietal sulcus	7/40	−34	−46	46
Supramarginal gyrus	40	53	−44	35
Intraparietal sulcus	40	35	−51	35
Superior temporal sulcus	21	55	−5	−10
Inferior temporal sulcus	37	−58	−35	−12
Inferior temporal sulcus	21/37	−54	−43	−4
Superior parietal lobule	7	19	−59	54
Fusiform gyrus	19/37	−46	−64	−12
Extrastriate cortex	18	−24	−83	13
Extrastriate cortex	19	39	−83	3
Extrastriate cortex	19	−22	−83	−9
Extrastriate cortex	19	31	−85	2
Extrastriate cortex	19	−28	−88	7
Extrastriate cortex	18	−10	−89	−10
<i>False memory &gt; true memory</i>				
Central sulcus	3	49	−5	18
Lateral sulcus	40	−39	−16	18
Superior temporal sulcus	22	−58	−17	−1
Superior temporal sulcus	21/22	50	−17	−6
Inferior temporal sulcus	37	49	−26	−14
Lateral sulcus	41	−40	−29	12
Extrastriate cortex	18	10	−65	5

BA refers to Brodmann area and Talairach coordinate (x, y, z) refers to the center of activation.

reactivation of sensory details associated with a previously studied item, while false memory construction can be based on retrieval of non-detailed information such as a verbal label that was shared with a previously studied item (for a review, see Schacter, Norman, & Koutstaal, 1998). This framework has been supported by evidence from the visual, auditory/language, olfactory, and motor modalities (e.g., Gottfried, Smith, Rugg, & Dolan, 2004; Garoff-Eaton et al., 2006; Nyberg et al., 2001, Vaidya, Zhao, Desmond, & Gabrieli, 2002; Wheeler & Buckner, 2004; for a review, see Slotnick, 2004). To illustrate, true memory for visual and auditory information (i.e., pictures and sounds) produced activity in visual and auditory processing cortex (Wheeler, Petersen, & Buckner, 2000), and false memory for visual information (i.e., abstract shapes) produced activity in language processing cortex (Garoff-Eaton et al., 2006). More recent studies have provided feature-specific evidence that further supports the constructive memory framework during true memories. For instance, memory for color has been shown to reactivate color processing region V8 (Slotnick, 2009a), memory for spatial location has been shown to reactivate contralateral/retinotopic extrastriate cortex (Slotnick, 2009b), and memory for motion has been shown to reactivate motion processing region MT+ (Slotnick & Thakral, 2011). In the present study, true memory for motion also activated MT+, whereas false memory for motion did not activate this region. However, false memory for motion did rely on more anterior cortical regions involved in processing non-detailed visual information, including language processing regions that represent the verbal label “moving” that was sometimes incorrectly attributed to stationary shapes (see Garoff-Eaton et al., 2006).

The present feature-specific fMRI results support and extend previous modality-specific fMRI findings (Slotnick & Schacter, 2004; Stark et al., 2010) that have indicated true memory but not false memory is associated with activity in earlier sensory regions and both true memory and false memory are associated with activity in later sensory regions. Considered together, these fMRI results provide support for the same pattern of true memory and false memory activity in both domain-specific and feature-specific paradigms. Future work will be needed to assess whether this pattern of activity is observed for different sensory modalities.

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