Social Neuroscience

ISSN: 1747-0919 (Print) 1747-0927 (Online) Journal homepage: https://www.tandfonline.com/loi/psns20

Distinct neural networks support the mere ownership effect under different motivational contexts

Kyungmi Kim & Marcia K. Johnson

SOCIAL NEUROSCIENCE, 2015
Vol. 10, No. 4, 376–390, http://dx.doi.org/10.1080/17470919.2014.999870

Distinct neural networks support the mere ownership effect under different motivational contexts

Kyungmi Kim and Marcia K. Johnson

Department of Psychology, Yale University, New Haven, CT 06520-8205, USA

The "mere ownership effect" refers to individuals' tendency to evaluate objects they own more favorably than comparable objects they do not own. There are numerous behavioral demonstrations of the mere ownership effect, but the neural mechanisms underlying the expression of this self-positivity bias during the evaluation of self-associated objects have not been identified. The present study aimed to identify the neurobiological expression of the mere ownership effect and to assess the potential influence of motivational context. During fMRI scanning, participants made evaluations of objects after ownership had been assigned under the presence or absence of self-esteem threat. In the *absence* of threat, the mere ownership effect was associated with brain regions implicated in processing personal/affective significance and valence (ventromedial prefrontal cortex [vMPFC], ventral anterior cingulate cortex [vACC], and medial orbitofrontal cortex [mOFC]). In contrast, in the *presence* of threat, the mere ownership effect was associated with brain regions implicated in selective/inhibitory cognitive control processes (inferior frontal gyrus [IFG], middle frontal gyrus [MFG], and lateral orbitofrontal cortex [lOFC]). These findings indicate that depending on motivational context, different neural mechanisms (and thus likely different psychological processes) support the behavioral expression of self-positivity bias directed toward objects that are associated with the self.

Keywords: Mere ownership effect; Self-enhancement; Self-esteem threat; Motivation; Self-object associations.

Be it voluntary or not, parting with possessions can be painful. For example, it can be distressing to sell a family home or difficult to throw away old diaries, and involuntary loss of valued possessions through theft or casualty can engender grief and mourning over the loss (Rosenblatt, Walsh, & Jackson, 1976). Even in the absence of a sentimental value attached to possessions over time, simply acquiring ownership of an object enhances its perceived value/desirability (*mere ownership effect* [Beggan, 1992], *endowment effect* [Kahneman, Knetsch, & Thaler, 1991]). And even transient, imagined ownership of objects that are arbitrarily assigned to participants produces increased preference for (Kim & Johnson, 2012, 2014a), and more positive implicit evaluations of (Huang, Wang, & Shi, 2009) "self-owned" objects than the identical or similar objects not owned by the self. The mere ownership effect extends to the appraisal of artificial/inconsequential stimuli such as abstract symbols (Feys, 1991) and intangible, nonmaterial entities such as argument sets and attitude positions that are randomly assigned to individuals (De Dreu & van Knippenberg, 2005).

Acquiring ownership of an object is thought to entail an association between the object and the self (Belk, 1988; Heider, 1958; James, 1890/1983; Wicklund & Gollwitzer, 1982). As a consequence of self-object associations, evaluation of an owned object is influenced by cognitive and affective biases analogous to self-serving biases individuals reveal when evaluating themselves (Beggan, 1992; Heider, 1958). That is, individuals' strong motivation to view themselves in

Correspondence should be addressed to: Kyungmi Kim, Department of Psychology, Yale University, 2 Hillhouse Ave., New Haven, CT, 06520-8205, USA. E-mail: kyungmi.kim@yale.edu
This work was supported by the National Institutes of Health [grant number R37AG009253]; and the Yale University FAS Imaging Fund.

a positive manner (i.e., self-enhancement motivation) extends to evaluations of self-associated objects. Support that the mere ownership effect is an expression of self-enhancement motivation comes from findings showing that factors that accentuate (e.g., self-esteem threat) or reduce (e.g., process accountability, high self-concept clarity) one's self-enhancement tendencies increase or decrease, respectively, the magnitude of the mere ownership effect (Beggan, 1992; De Dreu & Knippenberg, 2005).

Previous neuroimaging studies have provided some insight into the neural substrates supporting the mere ownership effect. Using a transient, imagined ownership manipulation, studies have consistently identified the medial prefrontal cortex (MPFC, especially ventral MPFC [vMPFC]), the region most reliably recruited during self-related processing (Lieberman, 2010). For example, vMPFC showed greater activity when participants were imagining objects as belonging to them ("mine") than belonging to another person ("Alex's") (Kim & Johnson, 2012). Even during a non-self-referential task (i.e., oddball detection), the mere sight of objects that participants successfully imagined owning prior to the task spontaneously activated vMPFC (Kim & Johnson, 2014a). Importantly, vMPFC activity during ownership imagination (Kim & Johnson, 2012) and to the mere sight of owned objects subsequent to ownership (Kim & Johnson, 2014a) was positively related to post-scan measures of the mere ownership effect (i.e., pre- to post-ownership preference increases for objects assigned to the self).

Despite these previous findings demonstrating a role of vMPFC in ownership-induced self-object associations and its association with subsequent manifestations of the mere ownership effect, neural processes underlying the "on-line" expression of the mere ownership effect (i.e., during actual evaluations of the objects subsequent to ownership) have not been identified. Furthermore, it is an open question whether similar neural processes underlie the mere ownership effect arising from a "default" mechanism regulating one's need to feel good about oneself or from a "defense" mechanism that serves to remedy one's threatened self-esteem (Alicke & Sedikides, 2009). Evidence has recently reported that motivational context can affect the neural expression of self-evaluations: Positive self-evaluations are negatively associated with activity in medial orbitoprefrontal cortex (OFC) in the absence of self-esteem threat, and positively associated with activity in OFC in the presence of self-esteem threat (Beer & Hughes, 2010, 2011; Beer, Lombardo, & Bhanji, 2010; Hughes & Beer, 2012a, 2013). These findings suggest that different neural processes may underlie the mere ownership effect depending on whether or not favorable evaluations of self-associated objects arise as a means to restore threatened self-esteem.

The current study had two specific goals. First, we identified brain regions associated with the online expression of the mere ownership effect during the post-ownership evaluations of the objects. Second, we assessed if and how the neural systems supporting a mere ownership effect are affected when individuals have a heightened need to protect their positive self-views (i.e., when self-esteem is at stake). To this end, we measured participants' brain activity using functional magnetic resonance imaging (fMRI) while they made evaluations of objects after ownership had been assigned under the absence or presence of self-esteem threat. Self-esteem threat was generated via delivery of bogus negative performance feedback on an ostensibly unrelated task.

Based on previous findings of positive associations between vMPFC and post-scan measures of the mere ownership effect (Kim & Johnson, 2012, 2014a), we hypothesized that under no self-esteem threat, vMPFC would be engaged when people exhibit a mere ownership effect during evaluations of objects (i.e., greater activity during favorable *vs.* unfavorable evaluations of self-owned objects). Under self-esteem threat, we anticipated two possible informative patterns of results: (a) if the mere ownership effect rests on a single set of underlying neural and psychological processes regardless of motivational context, then increasing the need for self-enhancement through self-esteem threat should not only increase the size of the mere ownership effect but also produce greater engagement of vMPFC associated with this effect compared to that observed under no self-esteem threat (i.e., larger difference in vMPFC activity during favorable *vs.* unfavorable evaluations of self-owned objects). (b) Alternatively, if the mere ownership effect rests on different neural and psychological processes depending on motivational context, then presence of the need to remedy threatened self-esteem should result in recruitment of other brain regions in addition to, or in the absence of the engagement of vMPFC. With regard to the second possibility, if the mere ownership effect arising from an attempt to restore threatened self-esteem is supported by similar neural substrates that underlie positive self-evaluations in response to self-esteem threat (i.e., positive association between OFC activity and flattering self-evaluations, Hughes & Beer, 2013), then OFC activity would contribute to the mere ownership effect under self-esteem threat. In addition, to the extent that one's need to remedy threatened self-esteem shares similar neural and psychological mechanisms with the reappraisal of threatening experiences and regulation of negative emotion (e.g., Ochsner, Bunge, Gross, & Gabrieli, 2002), we expected the mere ownership effect under self-esteem threat would engage brain regions involved in successful emotional regulation/control such as ventrolateral and dorsolateral PFC (Ochsner & Gross, 2005) along with OFC.

METHODS

Participants and stimuli

Participants were 40 Yale undergraduate students recruited and paid in compliance with the human subject regulations of Yale University (25 females, mean age = 19.57 [*SD* = 1.45], age range: 18–22). All were self-reportedly healthy, right-handed, with normal or corrected-to-normal vision, and within the normal range of self-esteem (>15 on Rosenberg Self-Esteem Scale that ranges from 0–30; Rosenberg, 1965). The participants were randomly assigned to the 'No-Threat' ($N = 20$) or 'Threat' ($N = 20$) conditions (see Experimental Procedure below). Data from 4 additional participants were excluded from analyses because they expressed suspicion about the veracity of the threat manipulation on a post-experimental questionnaire about the study hypotheses and during the final debriefing procedure.

The stimuli were 120 photographs (250 x 250 pixels) of items available for purchase in a large offline/online market (e.g., clothing, stationary). The stimuli were divided into 2 sets of 60 objects that were matched for mean preference level, estimated cost, masculinity/femininity level, and ease of identification based on data from a separate pilot study. The assignment of stimulus sets to the Mine and Other conditions (see Experimental Procedure) was counterbalanced across participants.

Experimental procedure

The experiment used a factorial design with the owner (Mine or Other) as a within-subjects factor and the presence of self-esteem threat (No-Threat or Threat) as a between-subjects factor.

The participants were told that the purpose of the study was to examine how people's ownership of, and preferences for, objects influence neural mechanisms involved in object representations. Participants were also told that they would be participating in a separate pilot study when they got inside the scanner in which we were testing a procedure for a future fMRI study.

Participants first completed the Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965), a 10-item measure of explicit global trait self-esteem. Then, participants completed a letter evaluation task, a measure of implicit self-esteem (Nuttin, 1985), in which the degree to which individuals show a preference for their own initials is interpreted as an index of implicit self-esteem. Participants were presented with a sheet of a paper containing a list of all upper-case alphabet letters arranged in a random order. They were told that this measure was concerned with people's aesthetic judgments of simple stimuli, that is, letters of the alphabet. It was further explained that participants might not be accustomed to evaluating letters, but that previous research had shown that the study of these kinds of judgments can lead to a better understanding of how individual differences in preference arise. Participants were asked to evaluate each letter on a 9-point scale (1 = not at all beautiful, 9 = extremely beautiful) relying on their first, immediate reactions toward the letters.

Immediately following the letter evaluation task, participants performed a series of computerized tasks consisting of the following 6 phases: pre-ownership preference rating, imagined ownership task, "pilot" tasks (i.e., threat manipulation phase), post-ownership preference rating during scanning, source memory test, and imagined ownership rating (see Figure 1).

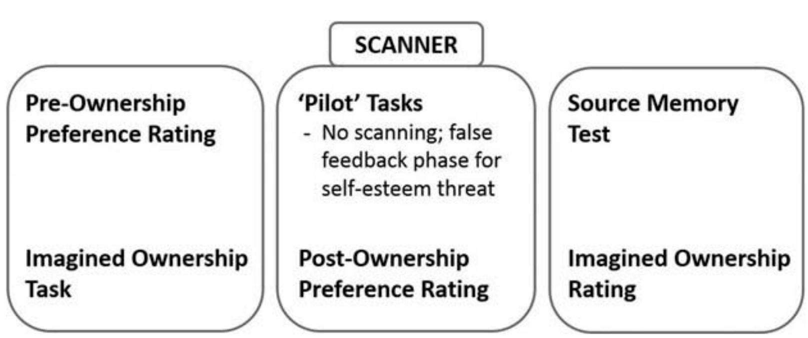

Figure 1. A schematic illustration of the experimental procedure.

Pre-ownership preference rating

On each trial, a picture of an object was presented in the center of a computer screen. Participants' task was to indicate how much they liked each object on a 1 (lowest preference) to 5 (highest preference) scale. Each picture was presented for 4 sec, separated by 400-msec fixation period. Participants were asked to make their responses while the picture was on the screen. A total of 120 objects were rated.

Imagined ownership task

On each 6-sec trial, participants were presented with a picture of an object and two baskets labeled "Mine" and "Alex", respectively. Participants' task was to place each item into the appropriate basket according to the color of a dot appearing on or near the object picture 1 sec after the onset of the object picture. The dot color matched the label color of one of the baskets. As soon as participants pressed the button, the object began moving down into the basket to which they assigned it. Importantly, participants were asked to imagine that they are going to own the items assigned to the "Mine" basket but not those assigned to the "Alex" basket. The objects consisted of the 120 objects from the pre-ownership preference rating task (i.e., 60 Mine and 60 Other ["Alex"] trials). Trials were separated by 1-sec fixation period.

"Pilot" tasks

Participants were told that we were testing a procedure for a future fMRI study aimed at evaluating the relationship between intelligence and attention and that this initial pilot testing would enable us to pick the optimal experimental parameters, such as the timing of the displays. For the participants in the Threat condition only, we additionally provided the following instruction verbally:

> *"When people know in advance that they are just participating in a pilot study, their motivation levels tend to be lower than when they participate in an actual study. And this is one of the major problems that we, researchers, face when gathering pilot data.*
>
> *In an attempt to raise your motivation level to an adequate degree, we are going to provide you some information about the tasks themselves. A set of tasks that you will be soon performing has been shown to be a valid and reliable measure of general intelligence and is increasingly used by schools and businesses to predict future success. Research has demonstrated that people who perform well on this task tend to have higher GPAs and are more successful in the job market, which in turn results in higher earnings.*
>
> *Also, we're going to provide you feedback on your performance inside the scanner based on the accuracy of your responses as well as the response timing. This feedback will tell you how you compare to all the other Yale students who previously participated in this pilot testing. That is, we will let you know about your percentile score out of 100 where 50th percentile represents the average performance of all the students."*

Participants were familiarized with the tasks with practice trials in a separate behavioral testing room before they went into the scanner. The tasks consisted of modified versions of a working memory capacity test ("color change detection task"), a visual search task ("search for the letter task"), and an iconic memory test ("perceptual memory test").

In the "color change detection task," participants were briefly presented with a display containing a number of colored squares, followed by a probe that was exactly the same as the initial display or had the color of one of the squares changed. Participants' task was to indicate whether there was a color change or not by pressing one of two buttons. In the "search for the letter task," participants had to locate a specific target letter in a display containing many other letters and symbols and press a button as soon as they found the letter. In the "perceptual memory test," participants saw a display containing a number of alphabet letters, followed immediately by a probe letter. Participants' task was to indicate whether the probe letter had been presented in the initial display or not by pressing one of two buttons.

Upon completion of the last "pilot" task, the participants in the Threat condition were given bogus feedback on their performance via a screen display. The feedback screen first displayed a normative bell-shape graph. Then, a red arrow appeared at the left end of the graph (i.e., 0 percentile) and slowly moved toward the right end of the graph (i.e., 100th percentile) until it stopped at the 29th percentile. Immediately following this movement, the text "*Below Average*" appeared on the top of the screen along with a short paragraph "*Based on the accuracy/response time of your performance, you ranked 29th percentile of all the other Yale students who previously participated.*" The participants in the No-Threat condition were just thanked.

Post-ownership preference rating (during fMRI scan)

On each trial, a picture of an object was presented for 4 sec, preceded by a 400-msec fixation dot. Participants were asked to indicate how much they liked each object based on their current feelings toward the object using the same 1–5 scale as in the pre-ownership preference rating. The trials were separated by jittered intertrial intervals (11.6–13.6 sec). There were 30 trials (15 Mine and 15 Other) in each of the 4 functional runs, and the trials within each run were randomly ordered.

Source memory test

Each trial consisted of a 400-msec fixation dot, followed by a 4-sec presentation of an object picture. For each object, participants were asked to indicate to whom (i.e., self or Alex) it was assigned during the imagined ownership task. All the Mine and Other items were presented in a random order. Previous studies have shown the impact of self-esteem threat at encoding (e.g., sub-optimal, shallow encoding of self-threatening information, Sedikides & Green, 2004) and at retrieval (e.g., selective retrieval of self-enhancing memories following self-esteem threat, Crocker, 1993) of item memory. However, no previous studies investigated the impact of self-esteem threat on source memory (for examples of differential effects of emotion on item and source memory, see, e.g., Johnson, Nolde, & De Leonardis, 1996; Mather et al., 2006). In the present study, we did not find a difference in source memory between the No-Threat and Threat groups (see Behavioral Results section below). Given that the participants in the Threat group had an opportunity to remedy threatened self before the memory test by exhibiting exaggerated positive evaluations of self-owned objects during the post-ownership preference rating task, our finding of no difference in source memory between the No-Threat and Threat groups is in line with recent evidence that an opportunity to restore threatened self (i.e., affirmation of the threatened aspects of the self) eliminates motivated forgetting of threat-related item information (Dalton & Huang, 2014). However, this interpretation requires more direct evidence (e.g., an effect of self-esteem threat on source memory in the absence of post-ownership preference ratings as an opportunity to remedy threatened self) and, hence, the source memory data are reported below but not discussed in detail.

Imagined ownership rating

In this phase, only the 60 Mine items were presented one at a time. Participants rated how well (easily, vividly, or successfully) they could imagine each object as belonging to themselves during the imagined ownership task on a 1 (not very well) to 4 (very well) scale. The trials were self-paced. This phase was included to measure relative strength of the association between the self and each of the to-be-owned objects.

At the end of the experimental session, participants completed the State Self-Esteem Scale (SSES; Heatherton & Polivy, 1991), a measure sensitive to manipulations designed to temporarily alter self-esteem, and the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), a measure of mood, as self-esteem threat manipulation checks. Participants were instructed to complete these measures based on what they thought or felt after they completed the pilot tasks but before they began the main post-ownership preference rating task.

As is typical after false feedback procedures (e.g., Hughes & Beer, 2013), a debriefing using a post-experimental questionnaire was conducted at the end of study to probe participants' suspicion about the veracity of the threat manipulation. There was an open-ended question about participants' general impressions of the purpose of the experiment ("Can you guess the purpose/hypothesis of this study? If yes, please tell us what you think as specifically as possible."). If a participant's answer included any mention of the feedback procedure, the experimenter further probed for any suspicion about the threat manipulation with follow-up questions (e.g., "What kind of feedback did you receive?", "Did you have any reactions to the feedback you received?"). Three of the four excluded participants claimed that they had a "hunch" that the purpose of the pilot tasks was to experimentally manipulate their mood and thus did not believe the feedback they received. The remaining excluded participant mentioned that the experiment was about how people evaluate objects differently from before and after receiving positive *vs.* negative feedback. When asked about her reactions to the feedback, she further explained that she was suspicious about the veracity of the negative feedback as she thought she performed very well in the pilot tasks. Finally, participants were fully debriefed as to the purpose of the study, in particular, about the bogus nature of the pilot tasks and feedback procedure.

Image acquisition and preprocessing

Data were acquired using a 3T Siemens TimTrio scanner with a 12-channel head coil. A total of 258 functional image volumes for each run of the post-ownership preference rating task were acquired using an echo planar pulse sequence (TR = 2000 msec, TE = 25 msec, flip angle $\alpha = 90°$, FOV = 240 mm, matrix = 64^2, slice thickness = 3.5 mm, 34 slices).

Two sets of structural images were acquired for registration: coplanar images, using T1 Flash sequence (TR = 300 msec, TE = 2.47 msec, α = 60°, FOV = 240 mm, matrix = 256^2, slice thickness = 3.5 mm, 34 slices); and high-resolution images, using 3D MP-RAGE sequence (TR = 2530 msec, TE = 3.34 msec, α = 7°; FOV = 256 mm, matrix = 256^2, slice thickness = 1 mm, 160 slices).

Image preprocessing was performed using the FMRIB software library (FSL, http://www.fmrib.ox.ac.uk/fsl). The first 4 volumes (8 sec) of each functional dataset were discarded to allow for MR equilibration. Preprocessing included skull-stripping, slice-timing correction, motion correction, spatial smoothing (Gaussian, FWHM 5 mm), and high-pass temporal filtering (cut off = 50 sec). Registration was conducted through a 3-step procedure: functional images were registered to coplanar images, which were then registered to high-resolution images, and normalized to the Montreal Neurological Institute's MNI152 template.

fMRI data analysis

Whole-brain voxel-wise regression analyses were performed using FSL's FEAT tool. First-level general linear model analyses were performed using a separate explanatory variable (EV) for each trial type: trials were conditionalized as a function of owner (Mine or Other based on the experimental assignment to these conditions) and post-ownership preference change (higher, lower, or no-change), resulting in 6 EVs consisting Mine Higher, Mine Lower, Mine No-Change, Other Higher, Other Lower, and Other No-Change.[1] Each trial type was modeled for the entire 4-sec trial duration with a boxcar function convolved with a single-gamma hemodynamic response function. Subject-level analyses combining multiple runs were conducted using a fixed effects model. Contrasts comparing parameter estimates obtained from the regression analyses were defined at the subject level to identify brain regions showing trial-type specific effects. The contrast of particular interest was the 2-way interaction between the owner (Mine or Other) and post-ownership preference change (higher or lower).

Group-level analyses were performed on the parameter estimates obtained for each contrast calculated at the subject level using a mixed effects model, with the random effects component of variance estimated using FSL's FLAME 1 + 2 procedure. First, in order to probe brain regions showing sensitivity to ownership-induced preference changes in each group, the 2 (owner: Mine or Other) × 2 (post-ownership preference change: higher or lower) interaction effects defined at the subject level were analyzed at a group-level for No-Threat and Threat groups separately, treating participants as a random factor. Then, as a confirmatory analysis for the results obtained from the 2 (owner) × 2 (post-ownership preference change) interaction analyses performed separately for No-Threat and Threat groups, we conducted a whole-brain 2 (group: No-Threat or Threat) × 2 (owner: Mine or Other) × 2 (post-ownership preference change: higher or lower) interaction effects analysis, treating group as a fixed factor and participants as a random factor. For significance testing, voxels were first thresholded at an entry level of $Z > 2.1$, and the significance of the resulting cluster was then evaluated at a corrected $p < .05$ using a Gaussian random field theory approach, unless otherwise mentioned.

To interpret interaction effects and to further illustrate different patterns of activation across the No-Threat and Threat groups in each of the activated regions identified with the group-level interaction analyses, percent signal changes were extracted from each activated region using FSL's Featquery. Each of the activated clusters obtained from the whole-brain interaction analyses were first confined along approximate anatomical boundaries of the respective brain regions by conjunction with the Harvard-Oxford Structural Cortical Atlas (fMRIB, Oxford, UK) so that only the active voxels that resided within the anatomical boundary of a given region contributed to estimates of percent signal changes.

Of the regions showing significant activation, we focus our interpretation/discussion on regions that previously have been found to be associated with self-related processing including self-object associations, self-referential processing bias, positive self-evaluations/self-perception, and threat regulation/emotional control (e.g., Beer & Hughes, 2010; D'Argembeau et al., 2012; Hughes & Beer, 2013; Kim & Johnson, 2012; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006; Ochsner & Gross, 2005; Sharot, Riccardi, Raio, & Phelps, 2007): MPFC, OFC, anterior cingulate cortex (ACC), posterior cingulate cortex (PCC), ventro- and dorso-lateral PFC, and insula.

[1]The trials with no pre- to post-ownership preference change (i.e., No-Change trial types) were included in the model as a trial type of no interest so that they would not contaminate the estimation of the BOLD signal for trial types of interest (i.e., trials associated with pre- to post-ownership preference increases or decreases).

RESULTS

Pre-experimental measures of self-esteem

RSES (Rosenberg, 1965)

A one-way analysis of variance (ANOVA) with group (No-Threat or Threat) as a factor showed that groups did not significantly differ (M = 23.65 [SD = 4.48] and M = 24.25 [SD = 3.85] for the No-Threat and Threat groups, respectively) in their explicit self-esteem levels prior to the self-esteem threat manipulation, $p > .65$.

Letter evaluation task (Nuttin, 1985)

Initials-preference scores were calculated by subtracting the normative rating of each participant's first and last initials (averaged across participants whose names did not contain that letter) from each participant's rating of his/her own initials. A one-way ANOVA with group (No-Threat or Threat) as a factor showed that groups did not significantly differ (M = 0.88 [SD = 1.19] and M = 1.14 [SD = 2.04] for the No-Threat and Threat groups, respectively) in their implicit self-esteem levels prior to the self-esteem threat manipulation, $p > .63$. In both groups, the average scores were significantly greater than zero, suggesting that participants' implicit self-esteem was generally positive, ts > 2.49, ps < .05, cohen's ds > 1.14.

Manipulation check of the self-esteem threat manipulation

SSES (Heatherton & Polivy, 1991)

A one-way ANOVA with group (No-Threat or Threat) as a factor showed that the Threat group (M = 69.80 [SD = 12.77]) exhibited significantly lower overall state self-esteem than the No-Threat group (M = 82.35 [SD = 10.54]), $F_{(1, 38)} = 11.49$, $p < .005$, $\eta_p^2 = .23$. Examination of the sub-factors of the state self-esteem revealed that the Threat group showed significantly lower *performance* (M = 24.45 [SD = 5.06]), $F_{(1, 38)} = 9.96$, $p < .005$, $\eta_p^2 = .21$, and *social* (M = 24.50 [SD = 6.12]) state self-esteem, $F_{(1, 38)} = 10.45$, $p < .005$, $\eta_p^2 = .22$, than the No-Threat group (M = 28.80 [SD = 3.52] and M = 29.90 [SD = 4.29] for performance and social self-esteem, respectively). The *appearance* self-esteem did not significantly differ between groups (M = 23.65 [SD = 3.88] and M = 21.85 [SD = 2.93] for the No-Threat and Threat groups, respectively), $p > .10$.

PANAS (Watson et al., 1988)

A one-way ANOVA with group (No-Threat or Threat) as a factor showed that the Threat group experienced significantly more negative affect after the pilot tasks (M = 15.95 [SD = 5.30]) than the No-Threat group (M = 12.35 [SD = 2.01]), $F_{(1, 38)} = 8.08$, $p < .01$, $\eta_p^2 = .18$. There was no significant difference between the groups for the amount of positive affect experienced (M = 26.05 [SD = 4.96] and M = 23.50 [SD = 5.83] for the No-Threat and Threat groups, respectively), $p > .14$.

Behavioral results

Source memory

Source memory accuracy was calculated by dividing the number of correct source assignments to each owner by the total number of items for that owner type. A mixed-design ANOVA with owner (Mine or Other) as a within-subjects factor and group (No-Threat or Threat) as a between-subjects factor showed only a significant main effect of owner, $F_{(1, 38)} = 8.18$, $p < .01$, $\eta_p^2 = .18$, with a non-significant main effect of group, $p > .29$, and a non-significant 2-way interaction between group and owner, $p > .18$. Participants were more successful at remembering an object's source for items from the Mine condition (M = 76.39% [SD = 12.76]) compared with items from the Other condition (M = 71.44% [SD = 14.75]).

Preference ratings

A 2 (group: No-Threat or Threat) × 2 (owner: Mine or Other) × 2 (time of rating: pre-ownership or post-ownership) mixed-design ANOVA revealed a significant main effect of owner, $F_{(1, 38)} = 10.45$, $p < .005$, $\eta_p^2 = .22$, and 2-way interaction between owner and time of rating, $F_{(1, 38)} = 36.74$, $p < .001$, $\eta_p^2 = .49$. Importantly, these effects were qualified by a significant 3-way interaction among group, owner, and time of rating, $F_{(1, 38)} = 14.40$, $p < .005$, $\eta_p^2 = .28$. As shown in Figure 2, simple effects analyses indicated that in the No-Threat group, Mine objects were given higher preference post-ownership (M = 3.09 [SD = 0.34]) than pre-ownership (M = 3.02 [SD = 0.33]), $F_{(1, 19)} = 5.82$, $p < .05$, $\eta_p^2 = .23$,

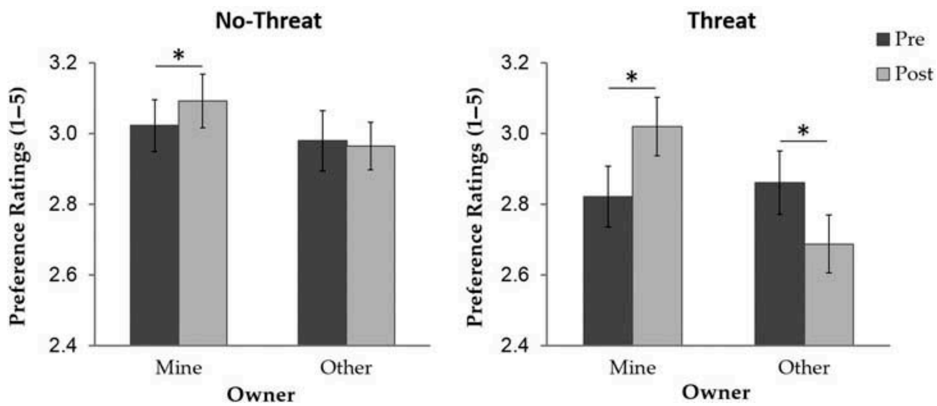

Figure 2. Pre- and post-ownership preference ratings as a function of owner (Mine or Other) in the No-Threat and Threat groups. Error bars indicate standard error of the mean (SEM). Asterisks (*) indicate significant differences at $p < .05$.

whereas there was no significant difference in preference ratings between pre- ($M = 2.98$ [$SD = 0.38$]) and post-ownership ($M = 2.96$ [$SD = 0.30$]) for the Other objects, $p > .65$. In comparison, in the Threat group, whereas Mine objects were given higher preference post-ownership ($M = 3.02$ [$SD = 0.37$]) than pre-ownership ($M = 2.82$ [$SD = 0.38$]), $F_{(1,\ 19)} = 17.99$, $p < .001$, $\eta_p^2 = .49$, Other objects were given lower preference post-ownership ($M = 2.68$ [$SD = 0.36$]) than pre-ownership ($M = 2.86$ [$SD = 0.40$]), $F_{(1,\ 19)} = 15.82$, $p < .005$, $\eta_p^2 = .46$. Subsequent one-way ANOVAs with group (No-Threat or Threat) as a factor performed on the post-ownership preference changes (post-ownership preference ratings minus pre-ownership preference ratings) revealed a greater pre- to post-ownership preference increase for Mine items in the Threat group ($M = 0.20$ [$SD = 0.21$]) than in the No-Threat group ($M = 0.07$ [$SD = 0.13$]), $F_{(1,\ 38)} = 5.39$, $p < .05$, $\eta_p^2 = .12$, and a greater pre- to post-ownership preference decrease for Other items in the Threat group ($M = -0.17$ [$SD = 0.20$]) than in the No-Threat group ($M = -0.02$ [$SD = 0.15$]), $F_{(1,\ 38)} = 8.37$, $p < .01$, $\eta_p^2 = .18$. Confirming that pre-ownership ratings did not significantly differ between owner across the groups, a 2 (group) × 2 (owner) mixed-design ANOVA performed on pre-ownership ratings showed neither a main effect of owner, $p > .96$, nor a 2-way interaction, $p > .24$.

Of the 60 Mine and 60 Other objects, the average number (and range) of objects that were associated with increased (i.e., Higher) *vs.* decreased (i.e., Lower) pre- to post-ownership preference ratings in each group were as follows: In the No-Threat group, there were 29.95 (23–36) Mine Higher, 21.95 (19–26) Mine Lower, 22.15 (20–28) Other Higher, and 24.95 (21–27) Other Lower objects. In the Threat group, there were 31.1 (28–36) Mine Higher, 21.25 (20–24) Mine Lower, 20.9 (19–27) Other Higher, and 27.85 (22–34) Other Lower objects.

Imagined ownership rating

A one-way ANOVA with group (No-Threat or Threat) as a factor showed that groups did not significantly differ ($M = 2.76$ [$SD = 0.28$] and $M = 2.73$ [$SD = 0.29$] for the No-Threat and Threat groups, respectively) in their ratings of how successfully they could imagine owning the Mine items, $p > .66$. In both groups, the average ratings were significantly higher than the midpoint "2.5" on a 4-point likert scale, ts > 3.49, ps < .01, cohen's ds > 1.60.

fMRI results

Brain regions showing interaction between owner and post-ownership preference change in the No-Threat group

The whole-brain 2 (owner: Mine or Other) × 2 (post-ownership preference change: higher or lower) interaction analysis performed in the No-Threat group identified significant activation in vMPFC, ventral ACC (vACC), medial OFC (mOFC), PCC, and right insula, along with other regions (see Table 1 and Figure 3A [insula not shown]). As shown in Figure 3B, simple effects analyses revealed that in the No-Threat group whereas there was greater activity for Mine Higher than for Mine Lower objects in these regions, $Fs_{(1,\ 19)} > 7.38$, ps < .05, η_p^2 s > .28, activity levels did not differ between Other Higher and Other Lower objects, ps > .34. In the Threat

TABLE 1
Peak coordinates showing an interaction between owner and post-ownership preference change in the No-Threat Group

		MNI coordinates (mm)			
Brain region (Right/Left)	*BA*	*x*	*y*	*z*	*Z-score*
Ventromedial prefrontal cortex (R)	10	2	56	−12	2.77
Ventral anterior cingulate cortex (L)	24	−8	32	−8	3.24
Medial orbitofrontal cortex (R)	11	4	30	−14	2.84
Posterior cingulate cortex (R)	30/23	4	−46	22	3.41
Insula (R)	13	36	−20	8	3.40
Caudate (L)		−12	0	12	3.23
Thalamus (R)		18	−16	8	3.57
Thalamus (L)		−14	−18	10	3.67

Note: BA = Brodmann's area.

group, activity levels in these regions did not differ between Mine Higher and Mine Lower objects, ps > .09, or between Other Higher and Other Lower objects, ps > .28 (Figure 3C).

Brain regions showing interaction between owner and post-ownership preference change in the Threat group

The whole-brain 2 (owner: Mine or Other) × 2 (post-ownership preference change: higher or lower) interaction analysis performed in the Threat group identified significant activation in right inferior frontal gyrus (IFG), right middle frontal gyrus (MFG), right lateral OFC (lOFC), and right insula, along with other regions (see Table 2 and Figure 4A). As shown in Figure 4C, simple effects analyses revealed that in the Threat group whereas there was greater activity for Mine Higher than for Mine Lower objects in these regions, $Fs_{(1,\ 19)} > 5.65$, ps < .05, η_p^2 s > .23, activity levels did not differ between Other Higher and Other Lower objects, ps > .31. In the No-Threat group, activity levels in these regions did not differ between Mine Higher and Mine Lower objects, ps > .08, or between Other Higher and Other Lower objects, ps > .21 (Figure 4B).

Brain regions showing interaction among group, owner, and post-ownership preference change

The analyses in the previous two sections identified brain regions in each of the No-Threat and Threat groups that showed differential activity associated with the mere ownership effect. As noted above and shown in Figures 3 and 4, these regions were largely non-overlapping. To confirm this pattern and potentially identify other regions that differentiated between No-Threat and Threat groups with respect to the mere ownership effect, we also conducted a whole-brain 2 (group: No-Threat or Threat) × 2 (owner: Mine or Other) × 2 (post-ownership preference change: higher or lower) interaction analysis. This analysis identified significant 3-way interactions in right IFG, right MFG, right lOFC, and right insula, along with other regions (see Table 3). As can be seen from comparing the list of brain regions in the Tables 2 and 3, these regions overlapped with those showing a 2 (owner) × 2 (post-ownership preference change) interaction in the Threat group, suggesting differential activity in these regions in the Threat group drove the 3-way interaction. As expected, simple effects analyses performed on IFG, MFG, lOFC, and Insula revealed that in the Threat group, these regions showed greater activity for Mine Higher than for Mine Lower objects, $Fs_{(1,\ 19)} > 8.07$, ps < .05, η_p^2 s > .30, with no significant difference between Other Higher and Other Lower objects, ps > .58. As for the No-Threat group, activity in these regions did not significantly differ between Mine Higher and Mine Lower, ps > .09, or between Other Higher and Other Lower, ps > .08.

No region listed above showed a 3-way interaction that was driven by differential activity in the No-Threat group. In an exploratory manner, we used a lenient threshold (uncorrected $p < .01$, number of contiguous voxels ≥20) to identify brain regions in which the No-Threat group showed differential activity patterns in response to ownership-induced preference changes compared to the Threat group. At this more lenient threshold, brain regions showing a 3-way interaction driven by activity patterns in the No-Threat group included vMPFC, vACC, along with left middle temporal gyrus, as shown in Table 3. Consistent with the results obtained from the 2 (owner) × 2 (post-ownership

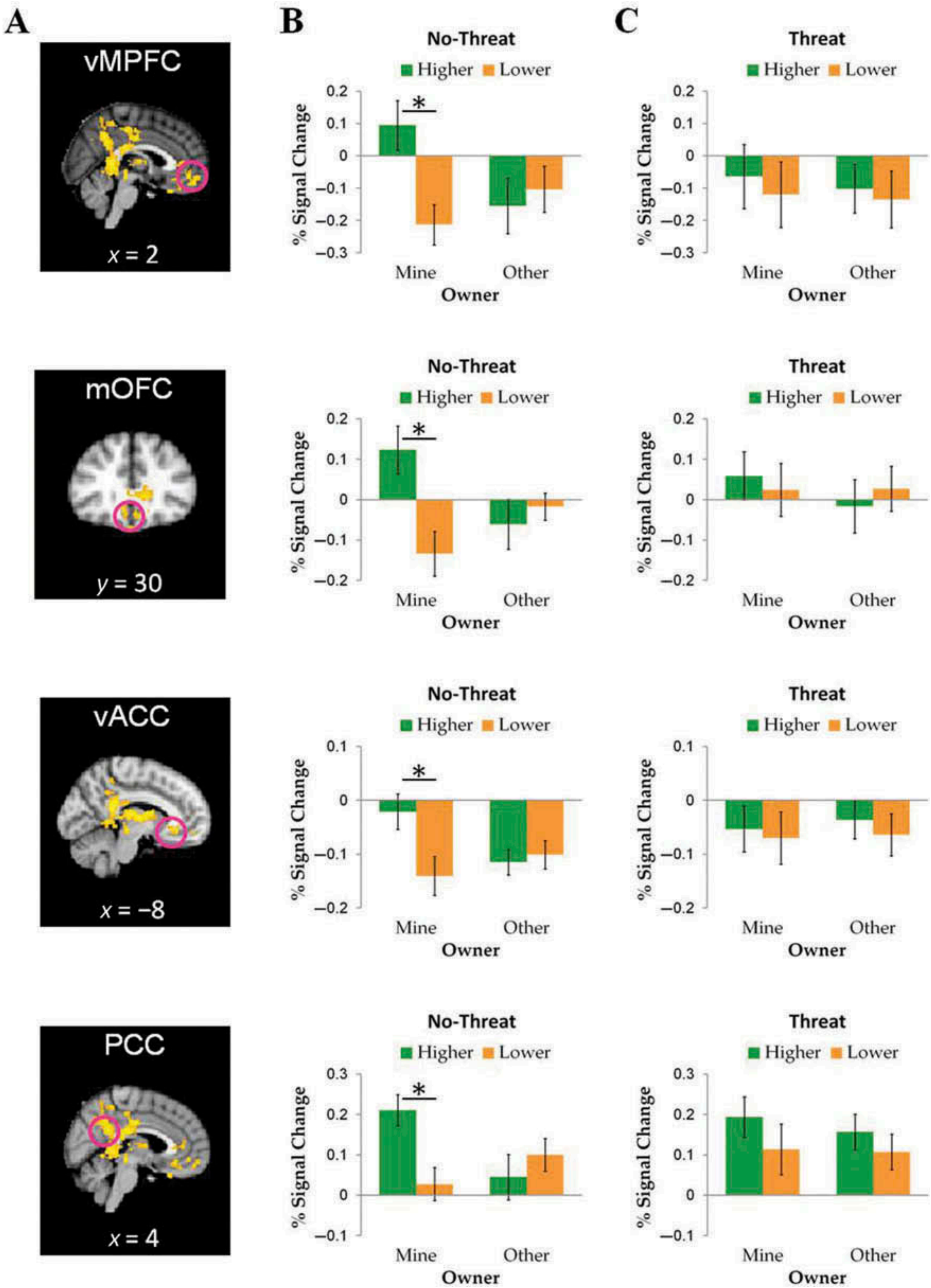

Figure 3. (A) Brain areas showing a 2-way interaction between owner (Mine or Other) and post-ownership preference change (Higher or Lower) in the No-Threat group. (B) Percent signal change as a function of owner and post-ownership preference change in the No-Threat group. (C) Percent signal change as a function of owner and post-ownership preference change in the Threat group (Error bars = SEM, asterisks = significant differences at $p < .05$).

TABLE 2
Peak coordinates showing an interaction between owner and post-ownership preference change in the Threat Group

		MNI coordinates (mm)			
Brain region (Right/Left)	*BA*	*x*	*y*	*z*	*Z-score*
Inferior frontal gyrus (R)	44	48	12	18	4.02
Middle frontal gyrus (R)	6	42	2	52	3.75
Lateral orbitofrontal cortex (R)	47	42	24	−6	3.83
Frontal pole/Inferior frontal gyrus (R)	46	46	36	6	3.50
Insula (R)	13	38	4	−2	3.36
Superior frontal gyrus (R)	6	18	4	68	3.15
Precuneus (L)	7	−2	−44	52	3.66
Precentral gyrus (R/L)	6	0	−14	60	3.69
Postcentral gyrus (L)	24	−4	−44	64	3.46
Superior temporal gyrus (R)	22	58	−8	−8	3.45
Supramarginal gyrus (R)	13	50	−42	14	3.42
Temporal occipital fusiform cortex (R)	37	44	−48	−26	3.38
Superior lateral occipital cortex (L)	7	−18	−68	38	3.24
Occipital pole (L)	18	−26	−98	14	3.39

Note: BA = Brodmann's area.

preference change) interaction analysis in the No-Threat group shown in Table 1 and Figure 3, in the No-Threat group, activity in vMPFC and vACC was greater for Mine Higher than for Mine Lower objects, $Fs_{(1,\ 19)} > 6.58$, $ps < .05$, $\eta_p{}^2\ s > .25$, with no significant difference between Other Higher and Other Lower objects, $ps > .60$. As for the Threat group, neither vMPFC nor vACC showed differential activity levels in response to Mine Higher *vs.* Mine Lower, $ps > .53$, or in response to Other Higher *vs.* Other Lower objects, $ps > .10$.

DISCUSSION

Numerous empirical studies demonstrated that simply acquiring ownership of an object produces greater liking for owned objects compared to similar or identical objects that are not owned by the self (Beggan, 1992; De Dreu & van Knippenberg, 2005; Feys, 1991; Huang et al., 2009). The mere ownership effect has been suggested to arise due to individuals' tendency to self-enhance that extends to overvaluing objects that are associated with the self (Beggan, 1992; De Dreu & van Knippenberg, 2005). In the current study, we identified the neurobiological expression of the mere ownership effect and assessed the potential influence of motivational context (here, the presence of a threat to one's self-esteem) on the neural expression.

Under no self-esteem threat, we found greater activity in vMPFC, vACC, mOFC, PCC, and insula when people evaluated their own objects as more *vs.* less favorable compared to their evaluations prior to ownership acquisition. Importantly, vMPFC and vACC were selectively engaged during positive evaluations of owned objects in the No-Threat *vs.* Threat group. Previous work has documented a recruitment of vMPFC in self-related processing in general (Lieberman, 2010), for example, when reflecting on one's personality attributes (e.g., Moran et al., 2006) and thinking about one's aspirations and obligations (Johnson et al., 2006). Recent work has suggested a role of vMPFC/mOFC in representing or evaluating personal significance of self-related information (Abraham, 2013; D'Argembeau, 2013; Kim & Johnson, 2014b) and in generating affective meaning of incoming stimuli for flexible, goal-directed decision making (Roy, Shohamy, & Wager, 2012); for example, activity in vMPFC/mOFC when participants judge how well trait adjectives described them was positively related to post-scan ratings of how important it was to participants to possess or not to possess certain personality attributes (i.e., emotive investment in self-views, D'Argembeau et al., 2012). In addition, the vACC has been shown to differentiate positive valence from negative valence for both self-relevant (e.g., Moran et al., 2006; Somerville, Heatherton, & Kelley, 2006) and non-self-relevant information (e.g., Beer & Hughes, 2010; Hughes & Beer, 2012b), showing greater activity for positive than negative information in both cases. Taken together, the current findings suggest that when self-esteem is not at stake, brain regions that process personal/affective significance

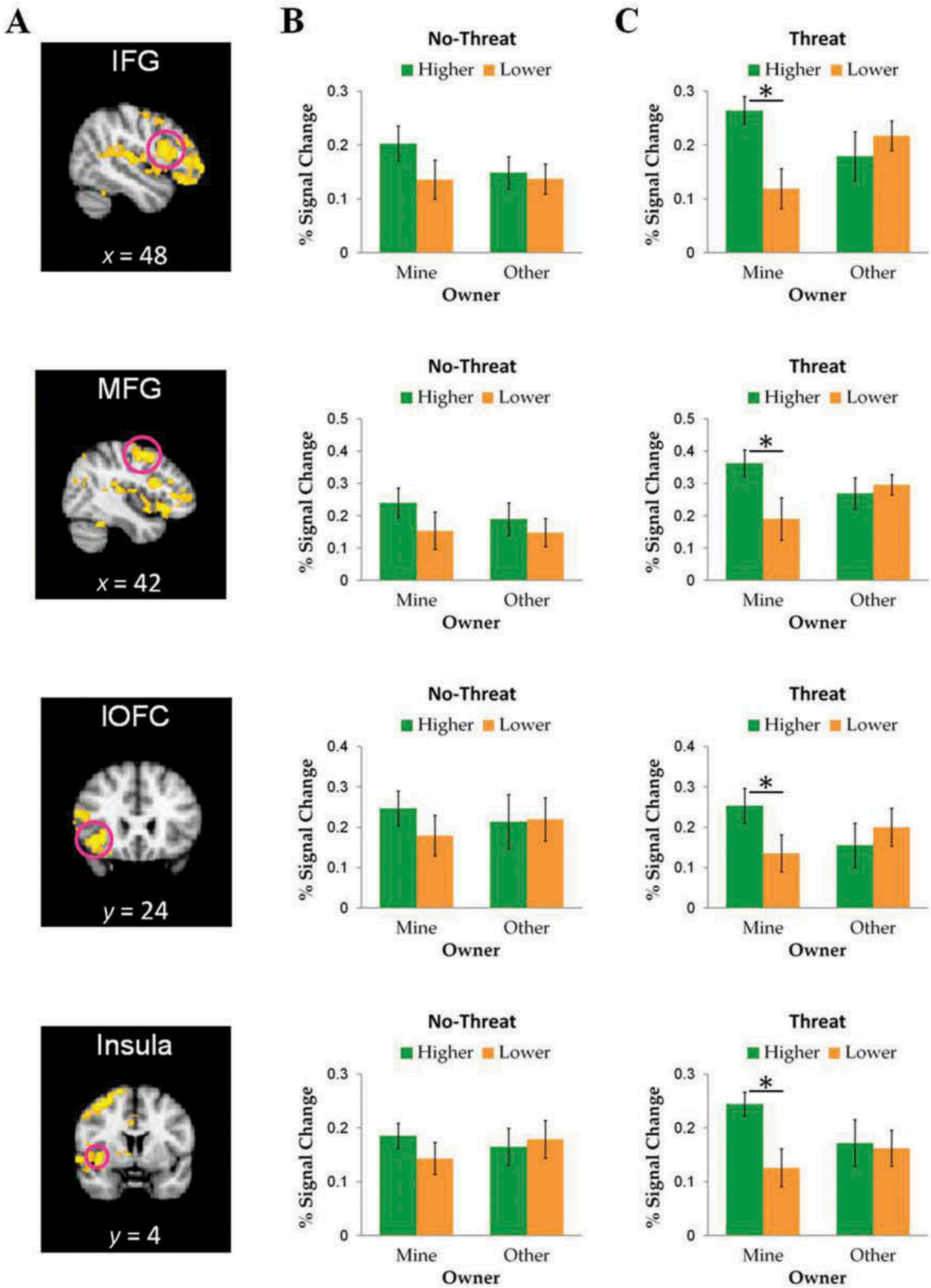

Figure 4. (A) Brain areas showing a 2-way interaction between owner (Mine or Other) and post-ownership preference change (Higher or Lower) in the Threat group. (B) Percent signal change as a function of owner and post-ownership preference change in the No-Threat group. (C) Percent signal change as a function of owner and post-ownership preference change in the Threat group (Error bars = SEM, asterisks = significant differences at $p < .05$).

TABLE 3
Peak coordinates showing an interaction among group, owner, and post-ownership preference change

		MNI coordinates (mm)			
Brain region (Right/Left)	*BA*	*x*	*y*	*z*	*Z-score*
A. 3-way interaction driven by the Threat group (cluster-corrected, p < .05)					
Inferior frontal gyrus (R)	9/44	50	12	20	3.22
Middle frontal gyrus (R)	6	44	6	50	3.29
Lateral orbitofrontal cortex (R)	13/47	32	26	−6	2.91
Insula (R)	13	30	22	−2	3.03
Frontal pole (R)	10/46	46	48	6	3.36
Superior frontal gyrus (R)	6	30	0	64	2.93
Precentral gyrus (R)	6	50	6	42	2.95
Inferior lateral occipital cortex (L)	19	−44	−86	8	2.90
Occipital fusiform gyrus (L)	19	−30	−78	−20	3.05
Temporal occipital fusiform cortex (L)	20/37	−36	−48	−26	2.87
Inferior temporal gyrus (L)	37	−48	−64	−22	2.85
Occipital pole (L)	18	−40	−92	4	3.49
B. 3-way interaction driven by the No-Threat group (uncorrected, p < .01)					
Ventromedial prefrontal cortex (L)	10/32	−6	42	−16	2.63
Ventral anterior cingulate cortex (L)	24	−8	26	−12	2.79
Middle temporal gyrus (L)	21	−60	−20	−14	3.09

Note: BA = Brodmann's area.

and valence of incoming information work in concert to support positive evaluations of one's own objects.

Under self-esteem threat, however, we found recruitment of brain regions that are quite different from those found under no such threat. When participants' self-esteem was threatened via negative performance feedback, favorable evaluations of owned objects were associated with activity in IFG, MFG, lOFC, and insula, the regions frequently found to be recruited during successful regulation of threatening experiences and negative emotion (Ochsner & Gross, 2005; Ochsner et al., 2002). Importantly, these regions were selectively engaged during positive evaluations of owned objects in the Threat *vs*. No-Threat group. Ventrolateral PFC, especially IFG in the right hemisphere, has been implicated in inhibitory control functions such as self-control (Aron, 2007; Tabibnia et al., 2011), and dorsolateral PFC, including MFG, has been associated with selective attention and working memory functions (Banich et al., 2000; Curtis & D'Esposito, 2003). The current findings thus suggest that the mere ownership effect arising from a heightened need to maintain/protect self-esteem may engage higher-order inhibitory/selective cognitive mechanisms (e.g., suppression of processing negative attributes of one's own objects supported by IFG, selective processing of positive attributes and/or maintaining the self-protection motivation/goal in mind supported by MFG).

By demonstrating engagement of different networks of brain regions underlying the expression of the mere ownership effect in the absence *vs*. presence of self-esteem threat, the current findings provide initial support that different neural and psychological mechanisms may underlie behavioral manifestations of positively-biased evaluations of *self-associated entities* depending on motivational context in which the evaluation takes place. These findings therefore augment previous findings indicating that motivational context affects the neural mechanisms recruited during positive self-evaluations (Hughes & Beer, 2012a, 2013). What might be the kinds of psychological processes that are associated with different neural networks under the absence *vs*. presence of self-esteem threat? That the processing of personal/affective significance and self-relevancy can occur in an automatic/spontaneous manner (D'Argembeau et al., 2012; Moran, Heatherton, & Kelley, 2009; Rameson, Satpute, & Lieberman, 2010) suggests that psychological processes supporting the mere ownership effect under no self-esteem threat may reflect automatic or implicit forms of self-enhancement (e.g., implicit egotism, Pelham, Carvallo, & Jones, 2005) supported by automatic/spontaneous assessment of personal significance of self-owned objects as a "default" or "routine" mechanism in the service of one's need to "feel good" (Alicke & Sedikides, 2009). Identifying a network of brain regions supporting implicit self-positivity biases toward self-associated entities (e.g., the name letter effect, Nuttin, 1985; implicit positive evaluations of one's possessions; Huang et al., 2009) and comparing it to the one found under the No-Threat condition in the current study should shed light on this possibility. The psychological processes supporting the mere ownership effect under self-esteem threat, in contrast, may reflect relatively more deliberate, strategic forms of self-enhancement. Future studies that investigate similarities and dissimilarities between brain regions underlying the mere ownership effect when individuals are not consciously aware of the presence of threat to the self (e.g., sub-threshold presentation of an association between self-related and threat-related words in an ostensibly unrelated task) and the brain regions found under No-Threat *vs*. Threat conditions in the current study should help better characterize the nature of psychological processes supporting self-enhancement as used as a "defense" mechanism (Alicke & Sedikides, 2009).

Whether object perception is better construed as social or nonsocial is determined by the feelings and thoughts of a perceiver about a target object, rather than the nature of the object itself (Brewer, 1988). Thus, to the extent that self-associated objects are imbued with the "unique interest" that each individual places on the self (James, 1890/1983), individuals' perceptions and evaluations of those objects can be a "social" process just as perceiving and evaluating the self is (Beggan, 1992). Further efforts to delineate conditions under which similar or different neural and psychological mechanisms contribute to favorable construal of self and self-associated entities and the boundary conditions under which motivationally induced biases occur should contribute to our understanding of how the self construes the world and, by extension, to our understanding of social processing more generally.

Original manuscript received 5 August 2014
Revised manuscript accepted 11 December 2014
First published online 9 January 2015

REFERENCES

Abraham, A. (2013). The world according to me: Personal relevance and the medial prefrontal cortex. *Frontiers in Human Neuroscience*, *7*, 1–4. doi:10.3389/fnhum.2013.00341

Alicke, M. D., & Sedikides, C. (2009). Self-enhancement and self-protection: What they are and what they do. *European Review of Social Psychology*, *20*, 1–48. doi:10.1080/10463280802613866

Aron, A. R. (2007). The neural basis of inhibition in cognitive control. *The Neuroscientist*, *13*, 214–228. doi:10.1177/1073858407299288

Banich, M. T., Milham, M. P., Atchley, R. A., Cohen, N. J., Webb, A., Wszalek, T., & Brown, C. (2000). Prefrontal regions play a predominant role in imposing an attentional 'set': Evidence from fMRI. *Cognitive Brain Research*, *10*, 1–9. doi:10.1016/S0926-6410(00)00015-X

Beer, J. S., & Hughes, B. L. (2010). Neural systems of social comparison and the "above-average" effect. *Neuroimage*, *49*, 2671–2679. doi:10.1016/j.neuroimage.2009.10.075

Beer, J. S., & Hughes, B. L. (2011). Self-enhancement: A social neuroscience perspective. In M. Alicke & C. Sedikides (Eds.), *The handbook of self-enhancement and self-protection* (pp. 49–68). New York, NY: Guilford Press.

Beer, J. S., Lombardo, M. V., & Bhanji, J. P. (2010). Roles of medial prefrontal cortex and orbitofrontal cortex in self-evaluation. *Journal of Cognitive Neuroscience*, *22*, 2108–2119. doi:10.1162/jocn.2009.21359

Beggan, J. K. (1992). On the social nature of nonsocial perception: The mere ownership effect. *Journal of Personality and Social Psychology*, *62*, 229–237. doi:10.1037/0022-3514.62.2.229

Belk, R. W. (1988). Possessions and the extended self. *Journal of Consumer Research*, *15*, 139. doi:10.1086/209154

Brewer, M. B. (1988). A dual process model of impression formation. In T. K. Srull & R. S. Wyer Jr. (Eds.), *Advances in social cognition* (Vol. 1, pp. 1–36). Hillsdale, NJ: Erlbaum.

Crocker, J. (1993). Memory for information about others: Effects of self-esteem and performance feedback. *Journal of Research in Personality*, *27*, 35–48. doi:10.1006/jrpe.1993.1004

Curtis, C. E., & D'Esposito, M. (2003). Persistent activity in the prefrontal cortex during working memory. *Trends in Cognitive Sciences*, *7*, 415–423. doi:10.1016/S1364-6613(03)00197-9

D'Argembeau, A. (2013). On the role of the ventromedial prefrontal cortex in self-processing: The valuation hypothesis. *Frontiers in Human Neuroscience*, *7*, 1–13. doi:10.3389/fnhum.2013.00372

D'Argembeau, A., Jedidi, H., Balteau, E., Bahri, M., Phillips, C., & Salmon, E. (2012). Valuing one's self: Medial prefrontal involvement in epistemic and emotive investments in self-views. *Cerebral Cortex*, *22*, 659–667. doi:10.1093/cercor/bhr144

Dalton, A. N., & Huang, L. (2014). Motivated forgetting in response to social identity threat. *Journal of Consumer Research*, *40*, 1017–1038. doi:10.1086/674198

De Dreu, C. K. W., & van Knippenberg, D. (2005). The possessive self as a barrier to conflict resolution: Effects of mere ownership, process accountability, and self-concept clarity on competitive cognitions and behavior. *Journal of Personality and Social Psychology*, *89*, 345–357. doi:10.1037/0022-3514.89.3.345

Feys, J. (1991). Briefly induced belongingness to self and preference. *European Journal of Social Psychology*, *21*, 547–552. doi:10.1002/ejsp.2420210608

Heatherton, T. F., & Polivy, J. (1991). Development and validation of a scale for measuring state self-esteem. *Journal of Personality and Social Psychology*, *60*, 895–910. doi:10.1037/0022-3514.60.6.895

Heider, F. (1958). *The psychology of interpersonal relations*. New York, NY: Wiley.
Huang, Y., Wang, L., & Shi, J. (2009). When do objects become more attractive? The individual and interactive effects of choice and ownership on object evaluation. *Personality and Social Psychology Bulletin*, *35*, 713–722. doi:10.1177/0146167209333046
Hughes, B. L., & Beer, J. S. (2012a). Medial orbitofrontal cortex is associated with shifting decision thresholds in self-serving cognition. *Neuroimage*, *61*, 889–898. doi:10.1016/j.neuroimage.2012.03.011
Hughes, B. L., & Beer, J. S. (2012b). Orbitofrontal cortex and anterior cingulate cortex are modulated by motivated social cognition. *Cerebral Cortex*, *22*, 1372–1381. doi:10.1093/cercor/bhr213
Hughes, B. L., & Beer, J. S. (2013). Protecting the self: The effect of social-evaluative threat on neural representations of self. *Journal of Cognitive Neuroscience*, *25*, 613–622. doi:10.1162/jocn_a_00343
James, W. (1890/1983). *The principles of psychology*. Cambridge, MA: Harvard University Press.
Johnson, M. K., Nolde, S. F., & De Leonardis, D. M. (1996). Emotional focus and source monitoring. *Journal of Memory and Language*, *35*, 135–156. doi:10.1006/jmla.1996.0008
Johnson, M. K., Raye, C. L., Mitchell, K. J., Touryan, S. R., Greene, E. J., & Nolen-Hoeksema, S. (2006). Dissociating medial frontal and posterior cingulate activity during self-reflection. *Social Cognitive and Affective Neuroscience*, *1*, 56–64. doi:10.1093/scan/nsl004
Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1991). Anomalies: The endowment effect, loss aversion, and status quo bias. *The Journal of Economic Perspectives*, *5*, 193–206. doi:10.1257/jep.5.1.193
Kim, K., & Johnson, M. K. (2012). Extended self: Medial prefrontal activity during transient association of self and objects. *Social Cognitive and Affective Neuroscience*, *7*, 199–207. doi:10.1093/scan/nsq096
Kim, K., & Johnson, M. K. (2014a). Extended self: Spontaneous activation of medial prefrontal cortex by objects that are 'mine'. *Social Cognitive and Affective Neuroscience*, *9*, 1006–1012. doi:10.1093/scan/nst082
Kim, K., & Johnson, M. K. (2014b). Activity in ventromedial prefrontal cortex during self-related processing: Positive subjective value or personal significance? *Social Cognitive and Affective Neuroscience*. Advance Online Publication. doi:10.1093/scan/nsu078
Lieberman, M. D. (2010). Social cognitive neuroscience. In S. T. Fiske, D. T. Gilbert, & G. Lindzey (Eds.), *Handbook of social psychology* (5th ed., pp. 143–193). New York, NY: McGraw-Hill.
Mather, M., Mitchell, K. J., Raye, C. L., Novak, D. L., Greene, E. J., & Johnson, M. K. (2006). Emotional arousal can impair feature binding in working memory. *Journal of Cognitive Neuroscience*, *18*, 614–625. doi:10.1162/jocn.2006.18.4.614
Moran, J. M., Heatherton, T. F., & Kelley, W. M. (2009). Modulation of cortical midline structures by implicit and explicit self-relevance evaluation. *Social Neuroscience*, *4*, 197–211. doi:10.1080/17470910802250519
Moran, J. M., Macrae, C. N., Heatherton, T. F., Wyland, C. L., & Kelley, W. M. (2006). Neuroanatomical evidence for distinct cognitive and affective components of self. *Journal of Cognitive Neuroscience*, *18*, 1586–1594. doi:10.1162/jocn.2006.18.9.1586
Nuttin, J. M. (1985). Narcissism beyond Gestalt and awareness: The name letter effect. *European Journal of Social Psychology*, *15*, 353–361. doi:10.1002/ejsp.2420150309
Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. E. (2002). Rethinking feelings: An fMRI study of the cognitive regulation of emotion. *Journal of Cognitive Neuroscience*, *14*, 1215–1229. doi:10.1162/089892902760807212
Ochsner, K. N., & Gross, J. J. (2005). The cognitive control of emotion. *Trends in Cognitive Sciences*, *9*, 242–249. doi:10.1016/j.tics.2005.03.010
Pelham, B. W., Carvallo, M., & Jones, J. T. (2005). Implicit Egotism. *Current Directions in Psychological Science*, *14*, 106–110. doi:10.1111/j.0963-7214.2005.00344.x
Rameson, L. T., Satpute, A. B., & Lieberman, M. D. (2010). The neural correlates of implicit and explicit self-relevant processing. *Neuroimage*, *50*, 701–708. doi:10.1016/j.neuroimage.2009.12.098
Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.
Rosenblatt, P. C., Walsh, R. P., & Jackson, D. A. (1976). *Grief and mourning in cross-cultural perspective*. New Haven, CT: Human Relations Area Files Press.
Roy, M., Shohamy, D., & Wager, T. D. (2012). Ventromedial prefrontal-subcortical systems and the generation of affective meaning. *Trends in Cognitive Sciences*, *16*, 147–156. doi:10.1016/j.tics.2012.01.005
Sedikides, C., & Green, J. D. (2004). What I don't recall can't hurt me: Information negativity versus information inconsistency as determinants of memorial self-defense. *Social Cognition*, *22*, 4–29. doi:10.1521/soco.22.1.4.30987
Sharot, T., Riccardi, A. M., Raio, C. M., & Phelps, E. A. (2007). Neural mechanisms mediating optimism bias. *Nature*, *450*, 102–105. doi:10.1038/nature06280
Somerville, L. H., Heatherton, T. F., & Kelley, W. M. (2006). Anterior cingulate cortex responds differentially to expectancy violation and social rejection. *Nature Neuroscience*, *9*, 1007–1008. doi:10.1038/nn1728
Tabibnia, G., Monterosso, J. R., Baicy, K., Aron, A. R., Poldrack, R. A., Chakrapani, S., & London, E. D. (2011). Different forms of self-control share a neurocognitive substrate. *Journal of Neuroscience*, *31*, 4805–4810. doi:10.1523/JNEUROSCI.2859-10.2011
Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, *54*, 1063–1070. doi:10.1037/0022-3514.54.6.1063
Wicklund, R. A., & Gollwitzer, P. M. (1982). *Symbolic self-completion*. Hillsdale, NJ: Lawrence Erlbaum.