A Functional Magnetic Resonance Imaging Study of Neural Dissociations between Brand and Person Judgments

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Functional magnetic resonance imaging (fMRI) was used to investigate whether semantic judgments about products and persons are processed similarly. Our results suggest they are not: comparisons of neural correlates of product versus human descriptor judgments indicated greater activation in the medial prefrontal cortex regions for persons; for products, activation was greater in the left inferior prefrontal cortex, an area known to be involved in object processing. These findings serve to challenge the view that processing of products and brands is akin to that of humans, and set a precedent for the use of fMRI techniques in consumer neuroscience studies.

Consumer researchers and marketing practitioners have long asserted that products can possess human-like traits (Aaker 1997; Azoulay and Kapferer 2003; Plummer 1985). A tendency to view or describe products in a manner similar to persons may reflect a general inclination to anthropomorphize everyday objects (e.g., cars, computers). There are a number of interrelated reasons for terms descriptive of human traits to be extrapolated to products and brands. Among the most compelling of these is evolutionary: over the millennia, a richly detailed conceptual system has emerged to allow humans to relate their characters and actions to one another; identifiable branding of goods is a comparatively abrupt development. Another possibility is lexical: each language relies on unified, limited corpus of adjectives; terms valid only for products would emerge slowly, if at all, and then only for traits which lack appropriate pre-existing descriptors. A final possibility is purely pragmatic: when describing a product, it is simpler to apply broadly-understood terms for human traits than to cobble together some neologism exclusively appropriate for objects.

This parsimonious overlap in usage may entail unintended consequences. For example, though we might describe both a friend and his car as “reliable”, our meanings would surely not be identical. That is, although we may use similar *vocabularies* to describe judgments of persons and products, we cannot conclude that the same *concepts* are involved in the use of those terms. Nonetheless, when specifically asked to, individuals are able to indicate the degree to which various labels are descriptive of a target object or brand. Because assessments of products’ qualities and attributes have thus far been universally carried out by researchers in this manner, it is of fundamental importance to determine whether qualities ascribed to brands–and more generally, everyday objects–are processed as they are in their typical, human-related usages.

Comparing judgments of brand and human personalities provides a useful research

context for investigating this issue. The brand personality concept has in recent years gained more widespread legitimacy among academic researchers and practitioners alike. The development of the brand personality scale by Aaker (1997) has spurred renewed research interest in the area, as have a number of studies suggesting that consumers' relationships with brands bear broad resemblance to social relationships (e.g., Aggarwal 2004; Fournier 1998). The suggestion that brands can be thought of as having full-fledged human personalities has been controversial (Azoulay and Kapferer 2003). And although we do touch on the nature of this debate, it is not our goal to resolve it, since objects and persons can have similar 'personality structures' but could well be processed using different neural systems.

A spate of recent work in cognitive neuroscience proposes different neural correlates for person versus object processing (Frith and Frith 2001; Gallagher and Frith 2003; Mitchell, Heatherton, and Macrae 2002). Based on this research, we propose that product-based judgments, such as brand personality judgments, are processed differently from human-based ones, specifically, in different brain regions (throughout, "judgment" refers to both observed behavioral and neural-based measures, except where the distinction need be made explicit). The fact that no study to date has directly addressed the issue of whether people think about brands' attributes/descriptors differently from human ones is not surprising, given the unsuitability of commonly used research methods (e.g., experiments, participant observations, surveys) for tackling such a question. For largely linguistic reasons, we are likely to find far greater confluence in response measures using these traditional methods than those which can detect underlying neural activity. For example, a participant may describe both a brand and a person as "powerful", yet distinct cognitive processes may be involved in generating the underlying judgment, which is represented in different neural activations. That is, neural dissociation may

belie functional and cognitive dissociation.

To the extent that judgments about objects and people come about via distinct neural activations, varied and perhaps disparate approaches to inferential processes about them are indicated. Recent advances in neuroimaging technology, particularly so functional magnetic resonance imaging (fMRI), enable researchers to detect processing differences by identifying neural correlates associated with specific classes of stimuli—for example, activation of semantic knowledge about inanimate objects (e.g., places or tools) versus persons. The goals of the present paper are therefore twofold. Our main goal is to use fMRI methods to investigate the implicit (and oftentimes explicit) assumption that the qualities of products and brands are processed like those of people. This article-of-faith underlies a vast commercial and academic research enterprise, relying on verbal stimuli and responses to assess fundamental issues of product positioning, branding and various dimensions of consumer perception. A secondary goal is to introduce consumer neuroscience to academic researchers in marketing who may wish to investigate consumer behavior and decision making at the neural level, using fMRI techniques. These techniques have become increasingly accessible to investigators and offer a powerful platform for answering research questions, across a wide range of academic disciplines, to complement more traditional methods of inquiry (see, for example, Smidts (2002) in marketing; Camerer, Loewenstein and Prelec (2005) in economics). The appendix contains a brief primer on common fMRI techniques, as well as technical details specific to the present study.

BACKGROUND LITERATURE

Recent neuroimaging and neuropsychological data suggest that mental processing

underlying person and object perception may be subserved by distinct brain regions (Frith and Frith 2001; Gallagher and Frith 2003; Mitchell et al. 2002). Evidence suggests that lateral prefrontal regions, particularly the left inferior prefrontal cortex (LIPC), activate differentially for semantic judgments about objects than about people (Mitchell et al. 2002). Based on these results, we reasoned that judgments of products and brands (i.e., objects) are likely to recruit the LIPC more than those of self or others (e.g., persons). In terms of semantic judgments about people, it is the medial prefrontal cortex (MPFC) that appears to modulate these judgments (Mitchell et al. 2002), and to play a particularly prominent role in judgments about the self, compared to other people (Gusnard et al. 2001; Kelley et al. 2002).

It is important to note that object and person judgments are also associated with qualitatively different neural responses, reflected by different regional distributions in observed patterns of brain activations. Whereas a neural response typically reflects increases in regional brain activation relative to baseline (e.g., during resting state), a response in the MPFC frequently refers to *decreases* in activation (i.e., deactivation) relative to baseline (for a detailed explanation, see Gusnard and Raichle 2001). This owes to the MPFC being characterized by relatively high rates of metabolic activity during rest (Gusnard et al. 2001). Raichle and colleagues have recently argued that such high levels of metabolic activity reflect mental processes that spontaneously occur during resting states (Gusnard and Raichle 2001; Gusnard et al. 2001; Raichle et al. 2001). These spontaneous mental activities have been linked to social-cognitive processes, and self-referential processes in particular (Adolphs 2001; Gusnard et al. 2001). In other words, brain regions subserving social-cognitive processes display higher levels of mental activity at rest, such that they routinely produce less change (deactivation) than other types of processing. Thus when people engage in object processing, neural activity in MPFC

attenuates relative to baseline. Accordingly, modulations in MPFC reported in the study by Mitchell et al. (2002) reflect differences between decreases in activation associated with person versus object judgment; i.e., they found non-significant changes from baseline in response to person targets and significant deactivations in response to object targets.

The extant findings collectively suggest that brands are likely to differentially activate regions responsible for processing object knowledge as opposed to person knowledge. This in turn argues for dissociations in neural activations for brand and person personality judgments, with brands being processed more like objects. We thus posit the existence of functional differences in how the human brain instantiates person versus brand evaluations and assessments. Specifically, we predict that person judgments will engage the MPFC more than brand judgments, and that brand judgments will recruit the LIPC more than person judgments. More formally, we propose the following hypotheses:

H1: There is greater activation of the medial prefrontal cortex during person judgments than brand judgments.

H2: There is greater activation of the left inferior prefrontal cortex during brand judgments than person judgments.

Additionally, we explore the possibility that the special status afforded to judgments about oneself (relative to others) extends to processing of brands that are relevant to oneself ("self-relevant"), compared to brands that are not. It is well established that self-referential processing results in superior memory performance (e.g., Klein and Loftus 1988), and that subsequent memory for self-referential judgments is better than for judgments about another person, especially if that person is not personally well known to the target, i.e., a famous public figure or remote acquaintance (Bower and Gilligan 1979; Symons and Johnson 1997). Consistent

research findings have been obtained in consumer behavior (e.g., Burnkrant and Unnava 1995; Meyers-Levy and Peracchio 1996).

Other consumer researchers have examined how brands can be related to consumers' self-identity, self-concept and self-expression (e.g., Belk 1988; Escalas and Bettman 2003). These findings suggest that at the behavioral level, we are likely to find enhanced memory for judgments about brands with relatively high self-relevance. At the neural level, even though brands would be expected to activate brain regions associated with object processing, it is also possible that a self-relevant brand will engage regions associated with person processing to the degree there is any overlap in neural processes drawing on knowledge about the self, other people, and self-relevant brands. Findings by Kelley et al. (2002) that the MPFC is differentially engaged during self-referential processing suggest that there may be greater MPFC involvement (i.e., less deactivation) for judgments of the self than other persons. Accordingly, we would expect the same neural activation pattern to hold for judgments of the self versus other persons. What is less clear is whether the uniqueness of neural activations in MPFC associated with self judgments extends to brands that are more self-relevant. In the present study, we examine this possibility by testing whether there is differential MPFC activation for judgments of self-relevant compared to non-self-relevant brands. More formally, we propose the following hypothesis:

H3: The difference in activation of the medial prefrontal cortex between the judgments of the self-relevant and non-self-relevant brands is smaller than between the judgments of the self and other persons.

METHOD

The three hypotheses were tested through an event-related fMRI study. A pretest was first conducted to develop stimuli materials, followed by a behavioral session and an fMRI session.

Pretest

Seventy female and 82 male volunteers (M = 20.1 years old) participated in a pretest to identify appropriate brands and non-self (other) persons for which trait judgments would be elicited in the fMRI session. We observed no systematic differences in main measures (neural or otherwise) between the male and female participants, and so do not refer to gender in the sequel. Each respondent completed two questionnaire booklets, in counterbalanced order: one pertaining to a large set of brands (familiarity, liking, and the degree to which each brand 'reflects the self'), the other eliciting familiarity and liking ratings for a large set of well-known people (e.g., Bill Clinton, Barbara Walters). One hundred such brands were selected for use in the behavioral session (detailed below), based on all participants having some familiarity (at least 4 on a 9-point scale) and moderate levels of liking for the brand (4-6 on a 9-point scale). Fifteen well-known ("Nonself") persons were identified, with equivalent mean ratings for familiarity (M = 5.28) and liking (M = 5.58) across participants; these were divided into five lists of three Nonself persons, each list randomly assigned to trials within a separate functional run during the fMRI session.

Behavioral Session

The behavioral session, the first of the two separate parts of the main study, was intended to identify a set of 15 self-relevant ("Self") brands and 15 not self-relevant ("Nonself") brands to

be used for each participant's brand judgments in the subsequent fMRI session. Because participants differed on which brands were (and were not) self-relevant, we sought to identify a maximum number of brands that were equivalently self-relevant (or not) across all tested individuals, and allowed the remaining brands to be unique to each individual.

Twenty-five volunteers were recruited from the same university population as the pretest and screened for participation in the fMRI session. The participants were between the ages of 18 and 23 (M = 20.0), and had mean education levels of 14.4 years. All were screened for safety-related contraindications to fMRI scanning (e.g., metal or implanted devices in the body, claustrophobia, pregnancy) and for conditions known to affect brain organization, function, or blood flow (such as handedness, native language, pharmaceutical / drug use, and particular psychiatric, neuropsychological and medical disorders). Self-reported health rating was assessed on a 5-point scale (1 = 'much worse than average', etc.), with an average score of 3.6. All participants were right-handed, native English speakers and gave informed written consent in accordance with University Medical School IRB guidelines.

After completing a demographic and a health questionnaire, participants provided familiarity and liking ratings for the 15 Nonself persons (from the pretest), and 12 additional people as filler items; ratings for the set of 15 Nonself persons were in line with pretest results ($M_{\text{familiarity}}$ = 5.09 and M_{liking} = 5.54).

Participants then answered a set of seven questions for each of the 100 brands selected from the pretest. The first two questions were whether a participant had heard of the brand, or ever used it before. The next four (the brand "suits me", reflects "who I am" or "wish to be", involves a "personal connection"), adapted from the Self-Brand Connection Scale (Escalas and Bettman 2003), were intended to gauge the brands' relevance to each participant's self. The final

question assessed overall attitude towards the brand. Finally, participants were each paid $15 and told they may be contacted to participate in an fMRI session in the near future.

Responses to these seven questions were analyzed to identify an individual-specific set of 15 Self and 15 Nonself brands for each participant; only those brands with affirmative answers to either of the first two questions (heard of the brand; used the brand) were retained. Brands with high ratings (at least 5 on a 7-point scale) on the four self-brand connection questions were categorized as Self brands and those with low ratings (at most 2) as Nonself brands. A participant was selected to proceed to the fMRI task only if at least 15 Self brands and 15 Nonself brands, with equivalent mean liking scores across the two brand types, could be identified. The 15 Self brands and 15 Nonself brands were then each divided into five lists for each participant in the fMRI session.

In addition to five versions of the 'Nonself persons' list mentioned above, five versions of the list for the 'Self person' condition were created; each consisted of an approximately equal mix of the word "self" and the participant's full (first and last) name. This was done to introduce variability in stimuli presentation in the 'Self person' condition, to avoid participants' becoming differentially accustomed to the visual cue in this treatment condition compared to those in others. Finally, five versions of the list were constructed for the Case condition as well, each comprising an approximately equal mix of the upper case and lower case designations.

Thus, five versions of five list types were created. Each of the five list types was then assigned to a separate treatment condition in the subsequent fMRI session: Person-Self, Person-Nonself, Brand-Self, Brand-Nonself, and Case. Each version of the five list types was used to construct the trials within a separate functional run during the fMRI session. Treatment conditions in the fMRI study are further described in the Procedure and Task Design section.

fMRI Session

Participants. Twenty (10 males and 10 females) of the 25 volunteers completing the behavioral session participated in the fMRI session. One was excluded for technical reasons related to functional data misalignment. Although the resulting sample is smaller than is typical in behavioral studies, it is representative of fMRI studies (Desmond and Glover 2002; Murphy and Garavan 2004) including similar paradigms (Kelley et al. 2002; Mitchell et al. 2002).

Procedure and Task Design. Participants were imaged during five functional runs while making judgments about whether a trait adjective described a target cue. During each functional run, a participant was presented with five different types of target cue items concurrently presented with an adjective. The five types of judgments corresponding to the critical treatment conditions were: a) Person-Self [i.e., does the adjective describe you?]; b) Person-Nonself [i.e., does the adjective describe the person (e.g., Peter Jennings)?]; c) Brand-Self [i.e., does the adjective describe a brand that is self-relevant (e.g., Sprite)?]; d) Brand-Nonself [i.e., does the adjective describe a brand that is *not* self-relevant (e.g., Harley-Davidson)?]; and e) Case [i.e., is the adjective presented in upper case or lower case?]. The case judgment reflected a relatively shallow form of processing with little encoding of meaning; activations from these scans, along with fixation crosses (i.e., rest conditions), thus served as control conditions for fMRI measurements of the critical conditions (cf. Gusnard and Raichle 2001).

A total of 450 unique adjectives were selected from the list of traits used in Craik et al. (1999), and the brand personality attributes from Aaker (1997). Ten lists of 45 adjectives were created from a total set of 450 trait adjectives. Lists were counterbalanced for word length,

number of syllables, and valence (an equal number of positive, negative and neutral traits). Approximately half of the words on each adjective list were presented in upper case (e.g., PLEASANT) while the remaining words on the list were presented in lower case (e.g., cheerful). Five of the lists were used in the fMRI session; each list was randomly assigned to a functional run and the adjectives within each list were randomly matched up with a target cue. The remaining lists of adjectives were retained for the subsequent recognition task.

During each of the five functional runs, each target cue type was presented nine times, along with another 30 fixation trials. Four unique pseudorandom orderings of intermixed trial types were created using genetic algorithms (Wager and Nichols 2003), to optimize power while counterbalancing the sequence of trials. Each adjective judgment trial was presented on the screen for 4000 msec, with a fixation cross replacing the adjective judgments for the final 500 msec. Fixation trials consisted of a central fixation point presented on the screen for 4000 msec. Interstimulus intervals were "jittered" from 0 sec (an adjective trial immediately follows the previous trial) to 36 sec (nine consecutive baseline trials) to compute unique estimates of hemodynamic response for trial types of interest (Ollinger, Shulman, and Corbetta 2001). (See the appendix for more information on the imaging procedures and apparatus used in the study.)

Participants responded by pressing the key under their index finger for 'yes', or middle finger for 'no', to each trial consisting of the target cue (Person-Self, Person-Nonself, Brand-Self, Brand-Nonself, or Case) presented above a central fixation cross and a unique trait adjective (see figure 1). Participants indicated whether or not the adjective described the given brand or person (except for Case judgments, where they responded to a cue of "upper" or "lower"), and were asked to make each judgment as quickly, yet accurately, as possible.

Insert figure 1 about here

The central fixation remained on-screen for the duration of each trial. Trial text and fixation crosses appeared in 40-point Arial bold, black on a white background. Prior to the first functional run, participants received a set of practice trials. Four 2-minute rest breaks were interspersed between functional runs. After the final (fifth) functional run, participants rested quietly during structural image acquisition for approximately six minutes. In total, the fMRI session lasted about one hour. Upon exiting the scanner, participants were asked to perform an unexpected recognition memory test after a delay of approximately 10 minutes..

Participants viewed the 225 'old' trait adjectives previously presented during the fMRI session, along with 225 'new' trait adjectives. Each of the 450 adjectives was presented in random order, remaining on the screen until one of two keys was pressed to indicate whether the adjective was 'old' (i.e., recognized as one presented during scanning) or 'new'. Participants were told that, although the words would be presented in the same case as in the previous task, case did not matter for the recognition task. Speed and accuracy were stressed again, although trials were self-paced and rest breaks were allowed after every 90 words. After the recognition task, participants were compensated $50. They were then thanked, debriefed, and dismissed.

Functional Image Analysis

The model for each participant's data consisted of six predictors, as discussed previously: Person-Self, Person-Other, Brand-Self, Brand-Nonself, Case, and Baseline. Because MPFC is known to respond to people more than objects, we predicted in hypothesis 1 that Person trials

would engage the region more than Brand trials. To test this main effect of Person versus Brand, we calculated contrast images as the difference of the betas for Person conditions (Person-Self and Person-Nonself) minus Brand conditions (Brand-Self and Brand-Nonself). Because the LIPC has been found to engage more for objects than people, we predicted in hypothesis 2 that Brands would activate the region more than Person trials. To examine the main effect of Brand versus Person, we calculated contrast images as the difference of the betas for the Brand conditions (Brand-Self and Brand-Nonself) minus Person conditions (Person-Self and Person-Nonself). Finally, we tested hypothesis 3, whether the enhanced engagement of MPFC to self-relevant information was selective for person information only, by calculating the contrast to test the interaction of Self/Nonself x Person/Brand.

Because these predictions were limited to specific anatomical regions, we adopted a region-of-interest (ROI) approach. Such an approach tests the contrasts only in those specified regions rather than across the entire brain and, by reducing the degree of correction needed for multiple comparisons, allows greater sensitivity in detecting effects. Regions were defined using MARINA software (Bertram Walter, Bender Institute of Neuroimaging), which has predefined anatomical regions that can be used as masks. The medial prefrontal cortex mask consisted of the MARINA “left and right superior frontal gyrus, medial” regions and the left inferior prefrontal cortex mask consisted of the “left inferior frontal gyrus, opercular and triangular” regions. The contrasts of interest for each participant were tested in the appropriate masked region, and then taken to the second level and entered into a one-sample *t*-test in a random effects group analysis.

RESULTS

Recognition Data

We first assessed recognition performance to ascertain whether adjectives encoded in the Brand-Self condition showed an enhanced memory effect, similar to that of adjectives in the Person-Self condition (Craik et al. 1999; Kelley et al. 2002). One participant was excluded from behavioral analyses due to self-reported failure to follow directions during the recognition test. In a repeated measures ANOVA with Target Cue Type (Brand/Person) and Self-relevance (Self/Nonself) as the variables, we replicated prior findings in the literature of memory enhancement for self-relevant (M = .58) relative to non self-relevant information (M = .49; $F(1, 17) = 32.45$, $p < .001$). Furthermore, we found a significant main effect of Target Cue Type with superior memory when adjectives were encoded for Persons (M = .59) as opposed to Brands (M = .48, $F(1, 17) = 47.00$; $p < .001$). The interaction of Target Cue Type x Self-relevance was also significant ($F(1, 17) = 32.21$, $p < .001$), suggesting that the self-relevant enhancement applies to person judgments more than brand judgments.

Although self-relevance did not benefit brand information to the same extent as person information, brands appeared to have invoked deeper processing compared to the shallow case judgments. All simple main effects tests of each of the brand and person judgment conditions, relative to the case judgment condition, yielded significantly greater memory performance (all ps < .001).

fMRI Data

We predicted that judgments about persons and brands would activate unique cortical regions. Specifically, MPFC has been implicated for person knowledge and LIPC for object knowledge. To the degree semantic judgments about brands are more similar to judgments about

objects than about people, we expected to find a dissociation in the pattern of results, such that brands should engage LIPC more than person judgments while persons will engage MPFC more than brand judgments.

As a test of hypothesis 1, the contrast of Persons (Self and Nonself) minus Brands (Self and Nonself) was conducted in the medial prefrontal (ROI). As predicted, person judgments engaged the ROI more than brand judgments. After setting a voxel-level threshold of $p < .005$ (uncorrected for multiple comparisons) for voxels within the ROI, a large cluster of 473 voxels emerged as significant at a corrected cluster level $p < .001$. The peak activated voxel was located at MNI coordinate of (0, 48, 24) and the cluster of activation is shown in figure 2a. As predicted, the increased activation for person over brand judgments in the MPFC region suggests that distinct processes underlie judgments about people and about brands. This finding calls to question similarities in brand processing and perception inferred solely on the basis of verbal stimuli and/or responses.

Insert figure 2 about here

Next, in order to assess hypothesis 2, a contrast of Brands (Self and Nonself) minus Persons (Self and Nonself) trials was tested in the left inferior prefrontal ROI. Within the restricted region, the results were thresholded using an uncorrected $p < .005$. This resulted in a cluster of 71 voxels, at a corrected cluster level $p < .001$, around the peak MNI coordinate of (-51, 27, 18). The activation, displayed in figure 2b, further bolsters the claim that judgments for brands are not processed like those for humans; specifically, brand judgments involve neural areas extending to object-related processes (Mitchell et al. 2002) more than person processes.

Finally, in order to test hypothesis 3, we assessed whether the enhanced MPFC

involvement for self-relevant judgments was unique to persons. This hypothesis was tested in the medial prefrontal region of interest, which has been demonstrated to respond more to judgments regarding the self than to judgments about other people (Kelley et al., 2002). The contrast of Person/Brand x Self/Nonself revealed a cluster of 12 voxels with a peak MNI coordinate of (0, 36, 51), significant at the uncorrected voxel level $p < .005$. Two smaller clusters, consisting of 4 voxels and 1 voxel, were also significant at the uncorrected voxel level $p < .005$. Activations are displayed in figure 2c. However, none of these clusters surpassed the cluster-level corrected significance threshold of $p < .001$. Nonparametric tests used as checks yielded substantively identical results. We also conducted a repeated measures ANOVA on the beta coefficients with Target Cue Type (Brand/Person) and Self-relevance (Self/Nonself) as the independent variables and found a non-significant interaction effect ($F(1, 18) = 2.56$, $p > .10$). Moreover, comparisons of the betas, for each judgment trial condition relative to the fixation baseline, yielded substantially different MPFC activation patterns for judgments of self-relevant brands (Brand-Self) versus the self (Person-Self) (see figure 3). Whereas MPFC activation was near baseline in the Person-Self condition ($F < 1$), the activation in the Brand-Self condition was significantly different from baseline ($F(1, 18) = 30.37$, $p < .001$). Taken together, the results do not provide compelling support for hypothesis 3.

Insert figure 3 about here

DISCUSSION AND CONCLUSION

Until recently, experimenters assessing processing similarities were forced to rely entirely on self-reports and observed behavioral measures. The advent of fMRI and other

neuroimaging techniques holds the promise of greatly enhancing our ability to distinguish processes which may appear identical, or broadly similar, based on measures of what people say and do, as opposed to the neural activity associated with those actions. Among the ideas advanced in both commercial and academic marketing, heightened in recent years through 'brand personality' research, is that the traits of persons and brands are processed in essentially similar ways. Here, we directly explored the neural activities giving rise to these behaviors, by examining product and human trait judgments via fMRI techniques.

Overall results of the present fMRI investigation support the contention that consumers do *not* process descriptive judgments of products in the same manner as those applied to humans. In particular, we obtained a neural dissociation of cortical regions subserving descriptive judgments about products and people. As predicted, we found different regions of the brain to be modulated by Person versus Brand judgments. Specifically, comparisons of neural responses for judgments about Persons (Self and Nonself) and Brands (Self and Nonself) indicated significantly greater MPFC activation for persons. These results were consistent with prior studies that found MPFC to be more engaged for persons versus objects. As predicted, the increased activation in this region of person over brand judgments suggests that distinct processes underlie judgments about people, and that these processes are not involved to the same extent for judgments bout brands.

Also as hypothesized, comparisons of Brands (Self and Nonself) and Persons (Self and Nonself) revealed significantly greater activation of the LIFC for brand judgments. Thus, the neural responses associated with brand judgments in the present study appear to accord with the sort of object processing found in previous neuroimaging studies. This pattern lends credence to the assertion that brand personality may not be processed like human personality, and that it

involves unique processes that do not extend to person trait processing. Although this region has been identified for object-related processes, a direct comparison of objects with brands in future studies is needed to ascertain the degree to which the two classes of stimuli may draw on neuroanatomically distinct regions.

Moreover, we found that the uniqueness of judgments about the self (Person-Self) relative to others (Person-Nonself) in the MPFC does not appear to extend to judgments about brands that are self-relevant (Brand-Self) versus not self-relevant (Brand-Nonself). Instead, we obtained neural evidence suggesting that the self-referencing effect may not operate for brands the way it does for persons.

In addition, recognition performance results were in line with findings in the prior literature. Adjectival descriptors that were judged semantically (in Person-Self, Person-Nonself, Brand-Self, and Brand-Nonself conditions) were better recognized in a subsequent memory task than adjectives judged in terms of Case. Further, judgments of the self (Person-Self) were better recognized than those in other conditions; that is, the present results indicated a self-reference effect in memory, consistent with previous findings (e.g., Craik et al. 1999; Symons and Johnson 1997). However, with respect to product judgments, recognition of adjectives about brands did not improve with greater self-relevance. What may account for this departure from the self-referencing effects documented in the marketing literature is that all prior studies involved recall of message information on tasks that required processing of relatively complex persuasive messages. Hence we speculate that tasks requiring more extensive elaboration—for example, processing of advertising messages or complex information about brands—may yield differences in effects of self-referencing on memory for brand judgments. Furthermore, we cannot rule out the possibility that the experimental task in the present study may not have been sensitive enough

to detect significant memory differences between the two brand types, even though care was taken to ensure that the brands in the Brand-Self and Brand-Nonself conditions differed maximally in terms of self-relevance to each individual participant.

A fair criticism of the sort of differences documented in this paper is that each could well be, to invoke a line beloved of philosophy professors, “a distinction without a difference”. For example, can one brain region process a particular sort of stimulus (e.g., human traits), while a second, physically separate region processes a very different one (brands), yet with little discernable difference in substantive outcome measures? It is impossible to rule this out entirely. Nonetheless, specialization of the cortex has long been recognized at the gross level of the cortical lobes as well as the cellular level, and recent findings of functional specialization in focal regions such as the fusiform face area (Kanwisher, McDermott and Chun 1997) further push the envelope on cortical specialization. As such, the likelihood that brand judgments lie in one area and human judgments in an entirely separate one, but that they are otherwise fundamentally alike, can only be viewed as remote. Rather, it would appear that the behavioral measures employed in prior studies have not, as of yet, been able to ferret out these distinctions, which seem to be separate processes, subserved by different brain regions. The present study, however, does not directly address such issues, and we anticipate future research will help clarify them.

In sum, neuroimaging offers an exciting new window onto underlying mental processes and activities. Until recently, researchers have had to rely on what we are told or observe, not what is, to quote the old saw, going on inside someone’s head. The advent of fMRI helps transcend this final barrier and, as such, holds great potential for theorists, experimenters and practitioners alike.

Appendix

Primer on fMRI and Specific Procedures Used

Functional magnetic resonance imaging (fMRI) is a technique for estimating neural activity non-invasively and with relatively good spatial and temporal resolution. Functional MRI has become one of the most popular and powerful tools for studying the brain basis of human behavioral function. This primer is necessarily brief; the reader is referred to standard references (Buxton 2002; Huettel, Song, and McCarthy 2004) for a more detailed discussion.

Data Acquisition. Both conventional MRI and fMRI operate by sending out safe radiofrequency (RF) pulses and listening for echoes from water molecule protons. Functional MRI is tuned to distinguish oxygenated blood, found in active parts of the brain, and so can be used to estimate neural activity. It does not measure neural activity directly, but rather a Blood Oxygen Level Dependent (BOLD) signal (the so-called hemodynamic response function) strongly correlated with it.

During a typical fMRI experiment, a human participant is asked to lie still on his or her back in an MRI machine for 60 to 90 minutes. The first (or sometimes the last) 6 to 15 minutes of an experimental session usually consists of 4 or 5 anatomical/structural scans of the brain, with the participant lying still and not performing any tasks. These structural scans serve two purposes: as guides in specifying where the functional data should be collected, and to provide a high resolution image of the brain anatomy over which the functional data can be overlaid. Functional data are then collected in a series of “runs” (usually 5-10) lasting from 3-10 minutes each. During each run, participants respond to visual, auditory or tactile stimuli designed by the experimenter, by pressing buttons on a pad, while the scanner records the BOLD signal throughout the brain in approximately 2-second intervals. These images are then analyzed to

identify brain areas that are significantly more active during some conditions/tasks than others.

The most common and powerful method for assessing effects is via a *blocked design*, trials grouped together (in time) to represent a level of an independent variable. Experimental conditions are separated into distinct blocks, each presented for an extended period; transitions between blocks represent changes in the level of an independent variable. Greater experimental flexibility, though reduced statistical power, is offered by *event-related* designs, which allow for detection of neural activity associated with short, discrete events whose timing and order need to be randomized (Liu et al. 2001) Estimation power for event-related designs can be greatly boosted through "jitter", the temporal randomization of intervals between successive event presentations (Ollinger et al. 2001).

Depending on the length of the experiment, 500 to 1500 functional brain images may be generated, each subdivided into small cubes called *voxels* (the three-dimensional analog of pixels). Voxel size is typically 3-5 mm, with 25,000 to 50,000 voxels typically required to cover the entire brain. Data from a single voxel over the course of an experiment constitute a time series of BOLD signals from the 500 to 1500 time points. Because fMRI data consist of numerous, voxel-level time series whose signals and errors are both temporally and spatially correlated, a good deal of *preprocessing* must be performed. Preprocessing corrects for several types of non-task-related variability, for example: that generated by participants (e.g., pitch, roll and yaw head motions over time; fixed by *realignment*), by the scanner (e.g., 2-second time lag between initial and final scan 'slices'; accounted for by shifting the time series via interpolation with earlier and later time points), by variability in brain size and shape (corrected by mapping onto a 'standard' brain, involving *normalization* and *co-registration*), by technical limitations (voxelization of the image and scanner noise, addressed by *convolving* with a Gaussian kernel),

among others. Full descriptions can be found in standard texts (e.g., Huettel et al. 2004).

Model Fitting. Given preprocessed data, the standard approach is to fit a general linear model (GLM) using covariates corresponding to the different conditions in the experiment. Coefficient beta values each correspond to a *t*-value associated with each voxel for a given covariate contrast. Standard tests for simple differences and other contrasts arise naturally from the GLM setting. Once statistics of interest have been computed for every voxel, these can be displayed together in a *statistical parametric map* (or SPM), simply a brain image in which the value at each voxel is its corresponding statistic. These SPMs can then be *thresholded* and overlaid on structural images in order to graphically display which areas of the brain exhibit activity surpassing a given degree of statistical significance, often using color to denote degree of significance. Analyses must account for the substantial *temporal autocorrelation* in fMRI data: data from timepoint X is *not* statistically independent of data from timepoint X+1. Analysis packages automatically optimally adjust degrees-of-freedom (downward) accordingly.

When such analyses are done over the entire brain, a very substantial multiple comparisons problem arises: given tens of thousands of voxel time series, some exhibit large statistical values by chance alone. The usual resolution to this ubiquitous statistical problem is to identify *clusters of contiguous voxels* above some threshold, and to calculate the probability of doing so by chance (most analysis packages provide this functionality). This approach requires knowing how smooth the data are, so many labs smooth their data during preprocessing as a means of imposing a known amount of spatial smoothness. A distinct approach to addressing the multiple comparisons problem is to restrict analysis to a small *region-of-interest* (or ROI) and to exclude voxels outside the ROI from the analysis altogether.

Apparatus. Imaging was conducted using a full-body 3.0 T GE LX scanner (General

Electric, Milwaukee, WI) outfitted with a standard headcoil. The experiment was presented using E-Prime software (Psychology Software Tools Inc.), and participants viewed the display through goggles (Resonance Technology VisuaStim XGA). The scanner interfaced with the experimental presentation through the IFIS 9.0 system (MRI Devices Corp.).

Imaging Procedure. Participants performed the fMRI tasks lying supine, heads held in place by custom-fit foam pads to reduce motion artifacts. Throughout, they could communicate by intercom or hand-held emergency alarm; none reported fatigue, claustrophobia, or any other discomfort. Before the functional runs, a structural T1 overlay was acquired in the same space as the T2* images. Functional acquisitions were single-shot gradient-echo spirals with a 2000 ms TR, a 40 ms TE, and a 20 cm field-of-view (FOV). Thirty-two 4mm axial slices (an effective matrix of $64^{2,}$ 3.125mm x 3.125mm) oriented parallel to the anterior commissure-posterior commissure (AC-PC) line covered the entirety of the cortex. Following the functional runs, a high resolution image of the brain was acquired via 3D spoiled gradient recalled echo (SPGR) with 120 sections at 1.5 mm thickness and a 24 cm field-of-view (FOV). Each provided a high-resolution participant-specific anatomical reference for superimposition of functional maps. Functional images were slice-time corrected to adjust for differences in the acquisition timing across slices, using an 8 point Hanning windowed sinc interpolation. Images were realigned by rigid body transformation to correct for intra-subject motion using AIR 3.08. Using SPM99 (Wellcome Department of Cognitive Neurology, London, UK) the high-resolution anatomical images were co-registered to same space as functional images, then both were normalized to standard MNI space (Montreal Neurological Institute) and resampled to 3-mm cubic voxels. The normalized functional images were smoothed with a 6 mm Gaussian kernel.

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FIGURE 1

EXAMPLES OF JUDGMENT TRIAL STIMULI

NOTE.—A judgment trial consisted of a trait adjective paired with a target cue (Person-Self, Person-Nonself, Brand-Self, Brand-Nonself, or Case). Trials were randomly intermixed, and one trial was presented every 4 sec. For each of the five judgment trial types, the "cue" (presented above the fixation cross) indicated what type of judgment to make for the trait adjective (presented below the fixation).

FIGURE 2

NEURAL ACTIVATIONS OF BRAND AND PERSON JUDGMENTS

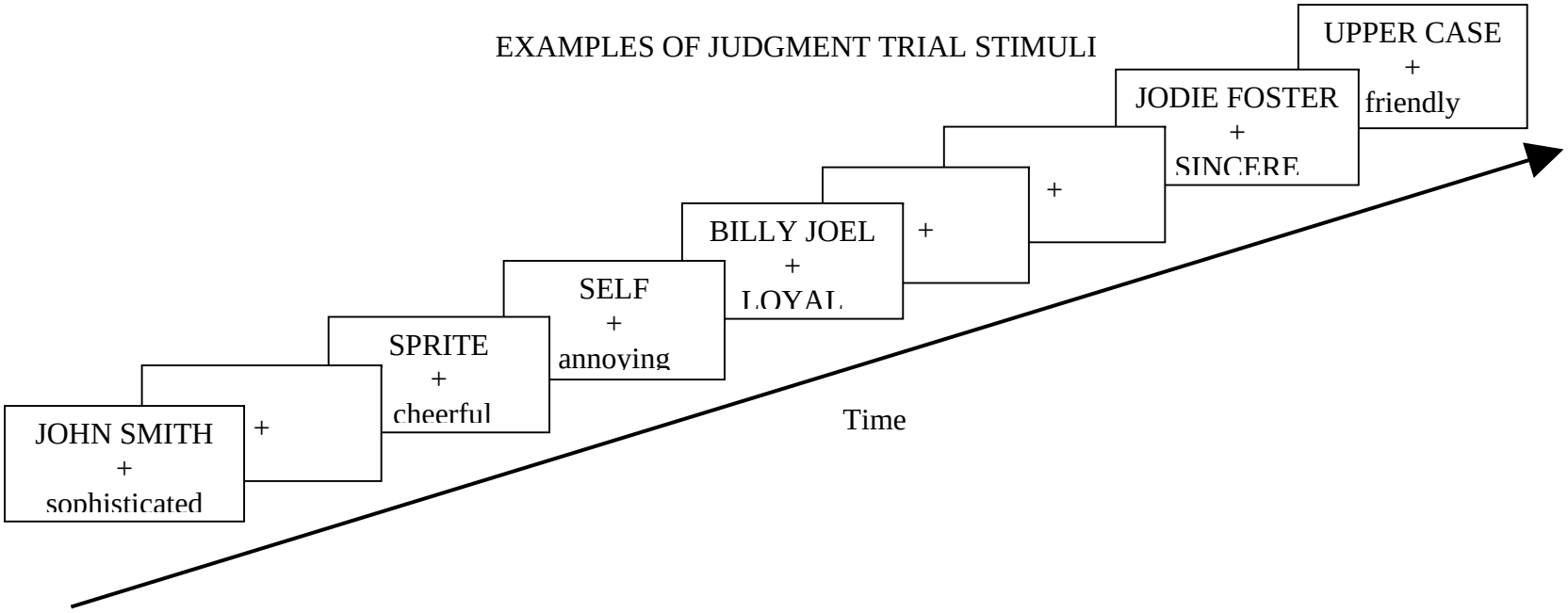
NOTE.—In each row, the same group activation is displayed from three different perspectives (from left to right: sagittal, coronal, and axial) on an individual participant's normalized SPGR structural image. The displayed anatomy does not represent the anatomical variation of all 19 participants. The region of interest in which the contrast was tested is marked in white and the significant voxels ($p < .005$ uncorrected at the individual voxel level) within that region are marked with color, according to *t*-scores.

FIGURE 3

BASELINE MINUS JUDGMENT TRIAL CONDITION ACTIVATIONS

NOTE.—Each bar represents the difference of the betas for baseline minus judgment trial conditions in the medial prefrontal cortex. Lower (i.e., more negative) beta differences (e.g., for Person-Self) correspond to greater MPFC activation in the judgment condition than the baseline. * $p < .001$.

FIGURE 1

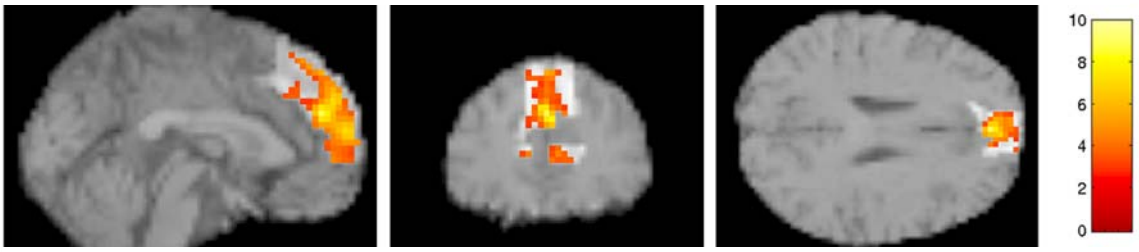


NOTE.—A judgment trial consisted of a trait adjective paired with a target cue (Person-Self, Person-Nonself, Brand-Self, Brand-Nonself, or Case). Trials were randomly intermixed, and one trial was presented every 4 sec. For each of the five judgment trial types, the "cue" (presented above the fixation cross) indicated what type of judgment to make for the trait adjective (presented below the fixation).

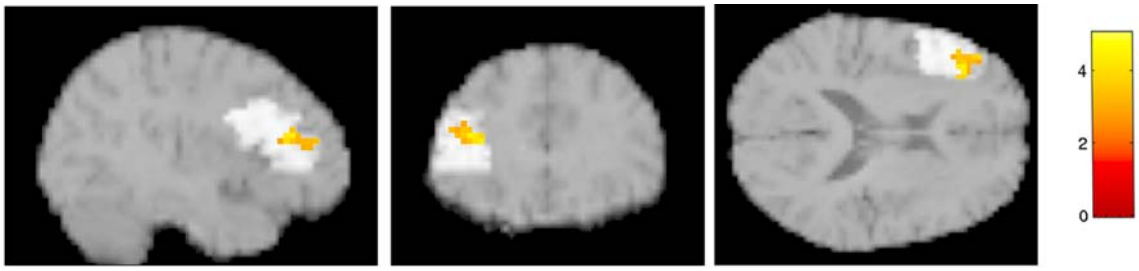
FIGURE 2

NEURAL ACTIVATIONS OF BRAND AND PERSON JUDGMENTS

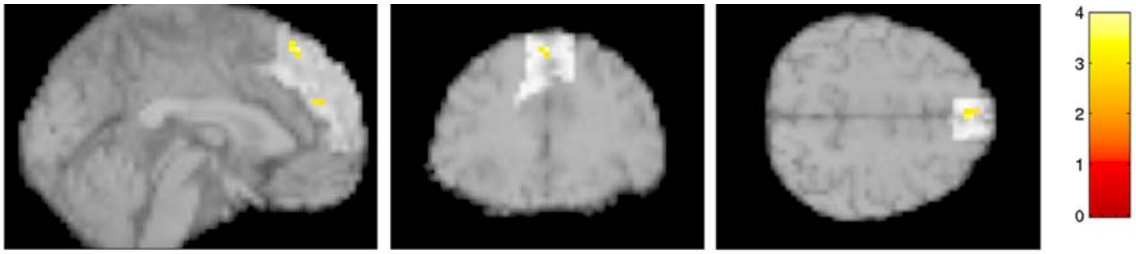
A: The contrast of Person vs. Brand comparison in medial prefrontal cortex



B: The contrast of Brand vs. Person comparison in left inferior prefrontal cortex



C: The contrast for the interaction of Person/Brand x Self/Nonself in medial prefrontal cortex



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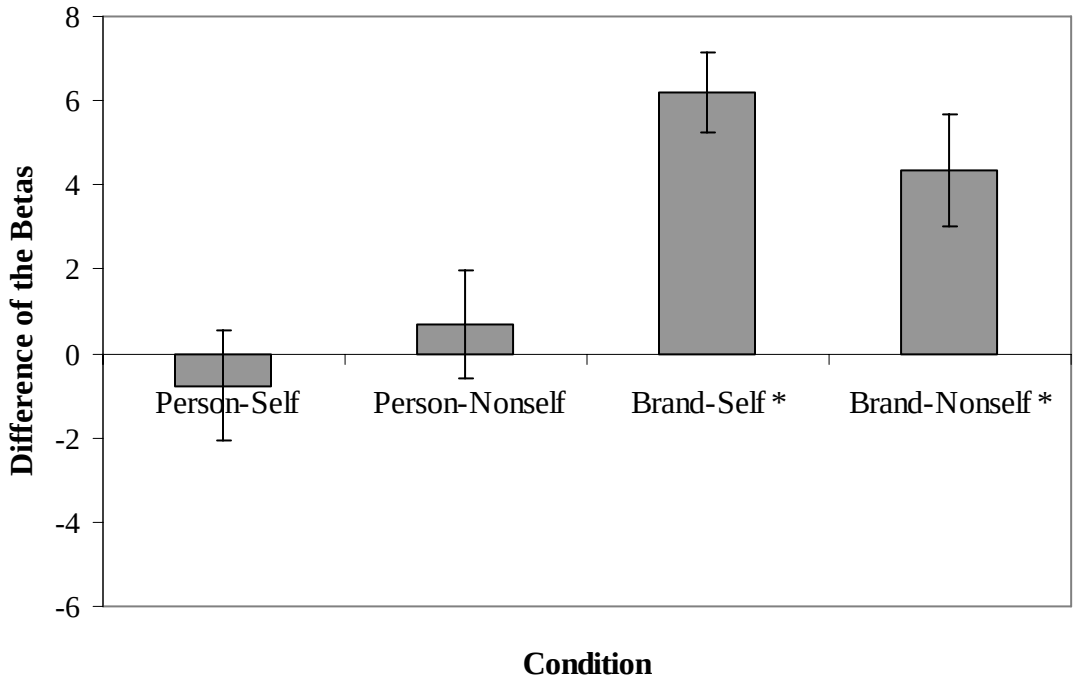
BASELINE MINUS JUDGMENT TRIAL CONDITION ACTIVATIONS



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* $p < .001$.

Headings List