Semantic and episodic components of brand knowledge: evidence from functional neuroimaging

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Abstract
Brand knowledge has historically been conceptualized in terms of associative models of memory derived from cognitive psychology. This, however, ignores the growing scientific consensus that human memory is not a monolithic faculty, but rather a collection of relatively independent systems underpinning by dissociable neural circuits and characterized by different patterns of learning, unlearning, and biases. Here we applied machine learning tools to functional neuroimaging data to explore the hypothesis that brand knowledge can be decomposed into a collection of distinct forms of memories. In particular, we sought to contrast memory systems that underlie brand knowledge related to traits that consumers project onto brands on the one hand, versus memory for experiences that result from interactions with brands on the other hand. Our results suggest that distinct types of memory traces are activated in parallel during brand evaluation, and that they relate to notions of semantic and episodic memory systems that are among the most well studied divisions in human memory. Together, these findings call for a move away from models of brand knowledge and brand equity based on unitary models of consumer memory, and towards a neuro-scientifically grounded conceptualization of multiple memory systems.

Keywords: consumer neuroscience, consumer memory, branding, human memory, fMRI, machine learning
1 Introduction

What goes through a consumer’s mind when she thinks about a brand like Disney? She may think of the first time she went to a Disney theme park as a child, the Disney movies she has watched, the family-oriented nature of its products, but perhaps also how commercial and expensive these products have become. Although the specific details differ, many of us can recognize similar types of memories and associations that we hold ourselves.

For marketers, this collection of memories and associations is commonly referred to as brand knowledge, which plays a key role in developing brand strategy and measuring brand equity (Keller 1993; Aaker 2012; Rust, Zeithaml, et al. 2004). Consequently, there is great interest on part of consumer researchers to conceptualize and measure the knowledge that has been created about the brand in consumers’ minds from the firm's investment in previous marketing programs (Aaker 2009; Keller 1993).

Beginning with seminal works of Aaker (2009) and Keller (1993) in the 1980s, conceptualizations of brand knowledge and their constituent parts have been based on “spreading activation” models of associative memory from cognitive psychology (Collins & Loftus 1975). Under this view, consumer memory is stored in a set of nodes and connected by links that vary in strength. Information retrieval is then conducted via a spreading activation process where activation of one node can spread to other linked nodes in memory. When the activation of another node exceeds some threshold level, the information contained in that node is recalled (Collins & Loftus 1975; Keller 1993).

Since their development, these models of brand knowledge and consumer memory have been highly successful, and provide fundamental insights into how marketers think about phenomenon such as brand extension (e.g., Hutchinson et al. 1994), ad retention, and channel strategy (Keller & Aaker 1992). However, despite this success, current conceptualizations of brand knowledge and consumer memory have remained largely unchanged since their original development (Rust, Lemon, et al. 2004). In particular, they have ignored the growing scientific consensus that human memory is not a monolithic faculty, but rather a collection of relatively independent systems underpinning by dissociable neural circuits and characterized by different patterns of learning, unlearning, and biases (Milner et al. 1998; Squire & Wixted 2011).

Perhaps the most well known division in human memory concerns that between semantic memory on the one hand, consisting of a “mental thesaurus” that provides “the memory necessary for the use of language”, and episodic memory on the other, consisting of experiences that are “temporally dated episodes or events, and the temporal-spatial relations” (Tulving 1972; Wheeler et al. 1997). In the motivating example, when our consumer recalls the price of Disney products or the specific dates of her visits, she is drawing on semantic memory. In contrast, when she remembers the specific events of her first visit or the emotions going through her on the rides, she is drawing on episodic memory. Importantly, both semantic and episodic memory can be invoked during a single recall event. For example, when our consumer recalls the family-friendly nature of Disney products, she can invoke both abstract symbolic semantic associations with Disney, or relive the specific family-friendly features of the products.

1.1 Brand Knowledge as Multiple Forms of Memory

That multiple forms of consumer memory may underlie brand knowledge is important for three reasons. First, substantial neuroscientific evidence suggest that these systems are associated with different patterns of
learning and unlearning. Episodic memory, for example, is fast forming and context dependent. In contrast, semantic memory, in keeping with its abstract symbolic nature, is largely context-independent but slow in acquisition (Milner et al. 1998). Second, semantic and episodic memory systems are subject to different forms of biases and distortions (Schacter & Slotnick 2004). Episodic memory is a late-developing and early-deteriorating memory system, more vulnerable than other memory systems to neuronal dysfunction, and thought to be unique to humans (Tulving 2002; Schacter & Slotnick 2004). For example, there has been much focus on the creation of “false memories” (Schacter & Slotnick 2004; Schacter 1999). There is now substantial evidence that each retrieval of an episode, in particular those that are highly memory charged, alters the memory in some significant way (Nader et al. 2000). In contrast, semantic memory appears widely distributed and robust to brain damage (Patterson et al. 2007).

Perhaps most importantly, the distinction between semantic and episodic memory bears a number of important similarities to what marketers refer to as “brand image” and “brand experience”, respectively. Similar to semantic memory, “brand image” typically contains the set of associations that customers hold regarding brands. Among others, it includes both product-related brand attributes and non-product related brand attributes such as brand attitude (Aaker 1997; Faircloth et al. 2001). Similar to episodic memory, experiential components of the brand include those that occur during interaction with goods, over the course of shopping or receiving service, and during the consumption of the goods (Brakus et al. 2009; Schmitt 2009). However, despite the widespread distinction between the brand image and experience amongst practitioners, they have largely been discussed in the context of strategic typologies, rather than conceptual frameworks rooted in consumer psychology. Connecting these notions through our knowledge of the basic neurobiology of human memory can therefore at the minimum enable consumer researchers to provide more detailed guidance to managers regarding the timing and frequency of measurements.

For example, because consolidation of semantic knowledge is slow, measures of semantic content about brands should be taken when sufficient time has passed from the marketing action. Conversely, because episodic memory is easily distortion, researchers should measure the memory quickly and repeatedly to understand the trajectory of any distortion. In turn, results of these measurements have implications for how managers interpret the success or failure of marketing actions. For example, attributing long-term changes to brand equity to short-term changes relying on episodic memory may overstate the success of campaigns. Conversely, disappointing initial outcomes to an advertising campaign may simply be due to insufficient time between ads and performance.

1.2 Addressing Challenges in Studying Consumer Memory

Although prominent in basic memory research, the idea of multiple memory systems has not yet been widely incorporated into conceptualization of consumer memory in marketing (Alba et al. 1991; Lynch & Srull 1982), owing to two important challenges. First, much like early memory research, measures such as scripts and post-hoc recall in consumer memory studies provide insufficient granularity into the processes that generate memory, and are frequently difficult to analyze given inter-subject variability (Lynch & Srull 1982; Wheeler et al. 1997; Tulving 2002). In the specific case of consumer research, this is even more challenging because of the fact that real-world stimuli such as consumer goods and brands will likely evoke,
simultaneously, both semantic and episodic memories. As a result, researchers studying consumer memory do not have the luxury of isolating and observing brain responses to semantic and episodic content.

Second and more generally, because memory processes relate to internal mental representations that are not directly observable, researchers must consider both the memory representation and the processes that translate memory to behavior (Lynch & Srull 1982; Alba et al. 1991). In particular, substantial research exist suggesting that recall is often not equivalent to retrieval of information in memory but may be the construction of a plausible response (Johar, Maheswaran, and Peracchio 2006). As a result, it is possible that consumer responses may be constructed to suit the explicit questions of the researcher, and that these explicit measures have little to do with consumers’ actual memories and associations.

For these reasons and others, modern memory research has been increasingly included neuroscientific techniques to address both questions (Schacter & Slotnick 2004; Squire & Wixted 2011; Milner et al. 1998). First, by directly probing the mental representations of interest, neuroscientific measures are capable of capturing memory traces that are unaffected by the recall protocol. That is, neuroscientific tools enable researchers to in principle be able to “read out” memory traces based on brain activity alone. In the first such application to consumer research, Chen et al. (in press) used a combination of machine learning tools and functional neuroimaging data to show that it was indeed possible to recover mental content related to brand personality in a passive viewing task. That is, memory traces related to brand personality was present inside the mind of the consumer, even without any explicit questions that may guide and possibly bias consumer response.

Second, capturing the content of specific memory traces further allows researchers to understand the neural circuits that are known to operate on semantic and episodic memory. Whereas semantic memory is highly distributed across the cerebral cortex, episodic memory is more spatially localized in the hippocampus and medial prefrontal cortex (Moscovitch et al. 2006; Milner et al. 1998; Wheeler et al. 1997). By relating different consumer memory components to these neuroanatomical substrates, therefore, it is possible to ask the extent to which different classes of consumer memory are engaged. In Chen et al. (in press), for example, brand personality contents were found to be highly distributed across a number of cortical regions, consistent with its similarity to traditional notions of semantic memory. However, despite the importance of experiential memory for brand managers, no study to date has addressed its relationship to episodic memory and implications for current conceptualizations of consumer memory.

Therefore, in the current study we build upon previous results in Chen et al. (in press) and characterize how memory traces related to brand experience are represented in the mind of consumers. In particular, we will use the recent brand experience scale developed by Brakus et al. (2009) to capture consumer memory related to episodic memory. Unlike psychological constructs such as brand personality (Aaker 1997), which consists of traits that consumers project onto the brands, the brand experience scales is aimed to capture consumer responses to brands related to the set of sensations, feelings, and behavioral responses evoked by brand-related stimuli (Schmitt 2009; Brakus et al. 2009)—for example, “I use the iPod when I am jogging, and I exercise more because of the iPod”. Although it undoubtedly only captures a small subset of actual consumers’ experiences with brands, it nevertheless provides a useful first step to capture the rich episodic details that brands can elicit.
More specifically, in keeping with the idea that brand knowledge can be decomposed into distinct forms of memories, we hypothesize that memory traces related to brand experience will exist independently of those related to brand personality. That is, brand personality and brand experience will be contained in distinct neural systems, corresponding to semantic and episodic forms of memory (Figure 1). Furthermore, consistent with what is known about these memory systems, we hypothesize that whereas brand personality, is widely distributed in the brain, brand experience will be contained in neural circuits involved in episodic memory processing, in particular the hippocampal formation.

2 Methods

fMRI Study Participants. Using data from Chen et al. (in press), the study consisted of fMRI responses from 17 participants (6 females, mean age 34.2, S.D. 6.5) from the San Francisco Bay Area were recruited from Craigslist to participate in the functional magnetic resonance imaging (fMRI) study. Each participant was paid $70 in cash upon completion of the experiment.

fMRI Scanning Procedure. Participants in the fMRI study underwent scanning in a passive viewing task involving logos of 44 well-known brands (Figure 1A). The set of brands were selected from the list of 100 Best Global Brands (Interbrand, available at: www.interbrand.com) to ensure diversity in brand associations and represented industries. Each of the 44 stimulus items was presented four times in a pseudo-random sequence on the gray background (Figure 1B), and each presentation lasted for 4-8s. Participants were instructed prior to the scanning session that they were free to think about any characteristics of the brand, and no attempt was made to obtain consistency in participant responses across participants nor across repetition times.

fMRI Data Acquisition. Functional images were acquired on a Siemens 3T TIM/Trio scanner at Henry H. Wheeler Jr. Brain Imaging Center at University of California, Berkeley. An EPI sequence was used to acquire the functional data: repetition time (TR) = 2,000ms; echo time (TE) = 30ms; voxel resolution = 3mm × 3mm × 3mm; FOV read = 192mm; FOV phase = 100%; interleaved series order. The scan sequences were axial slices approximately flipped 30 degrees to the AC-PC axis. High-resolution structural T1-weighted scans (1mm × 1mm × 1mm) were acquired by using an MPRage sequence.

Behavioral Study Participants. We recruited undergraduate students for a behavioral study in exchange for course credits. These participants either completed an online questionnaire of the brand personality scale or the brand experience scale with the same set of the 44 brands used in the fMRI study. 94 students completed the personality survey, and each of them judged the descriptiveness of the 42 traits toward randomly selected 22 brands (Aaker 1997), with a five-point scale from not at all descriptive (rating=1) to extremely descriptive (rating=5) (Figure 1A). The other 165 students completed the experience survey, and each of them judged the descriptiveness of the 12 brand experience items toward randomly selected 11 brands. The 12-item brand experience scale (Brakus et al. 2009) involved judgment of the descriptiveness of 12 items to each brand (Figure 1B), with a seven-point scale from not at all descriptive (rating=1) to extremely descriptive (rating=7).

Behavioral Data Analysis. To characterize personality/experience features associated with our brands using participant ratings, we used a factor analytic approach to summarize variation in trait ratings and reduce collinearity issues. For personality (experience) survey, mean ratings of personality traits (experience items)
were factor-analyzed using principal components analysis and varimax rotation. Factors were selected if the associated eigenvalue were greater than one and explained a significant portion of variance. Each brand was re-expressed in terms of its personality/experience vector.

**fMRI Data Preprocessing.** Image data were preprocessed in the following order using SPM8 (Statistical Parametric Mapping, Wellcome Trust Centre for Neuroimaging): correction for slice time artifacts, realignment, coregistration to the subject’s T1 image, normalization to Montreal Neurological Institute coordinates. Finally, consistent with previous MVPA studies, data were left unsmoothed to preserve local voxel information (Haynes & Rees 2006; Clithero et al. 2009).

To identify the representative fMRI image of a brand, we used the procedure outlined in Mumford et al. (2012) using a general linear model in SPM8 to estimate a single fMRI image for each of the 176 brand presentations using method LS-S in Mumford et al. (2012). Using brain images for each brand at each repetition time, we standardized the activation levels for each voxel by z-scoring over the 176 files. Then, for each brand, we averaged the four brain images of the four repetition times to obtain the averaged fMRI image associated with thinking about the brand. Finally, we applied the individual grey matter mask to include voxels within the grey matter.

**fMRI Data Analysis:** To localize the brain regions that contain information of thinking about brands’ personality features or experience features, a whole-brain MVPA searchlight analysis was performed to test the classifier’s ability to discriminate the two previously unseen brands using different sets of independent variables (personality or experience) (Kriegeskorte et al. 2006). For each voxel v_i, we defined a sphere of 10 mm radius centered on v_i. The fMRI data from this cluster were then used for training and testing the model, iterating over all possible pairwise combination of the 44 brands. This procedure was repeated for every voxel in the brain, and results were mapped back to yield a whole brain accuracy map for each subject.

For each voxel v_i, we defined a sphere of 10 mm radius centered on v_i. The following procedure was repeated for every voxel in the brain. For each iteration, two brands were held out of the training set, and the model was trained using the remaining 42 brands. Specifically, training involved regressing activation level of each voxel on the set of personality or experience features of the training brands obtained from the factor analysis. The derived maximum likelihood estimates were used as c^T_j terms, which were then combined with the personality or experience factor scores of each hold-out brand to form its a predicted fMRI pattern. This leave-two-out train-test procedure was iterated 946 times, leaving out each of the possible brand pairs. Following training, the computational model was evaluated by comparing these predicted fMRI pattern to the observed fMRI pattern of the two hold-out brands, evaluated over the image voxels within each of the searchlight. Finally, the average performance within the searchlight was mapped back to yield a whole brain accuracy map for each subject. The procedure was similar to which in Chen (2015). The only difference is that the model is trained and tested with voxels within the sphere centered on each voxel in the brain, instead of selecting the most stable voxels.

3 Results

3.1 Consumer Memory for Associations and Experiences

First, we sought to characterize the set of personality feature f_{n,j} associated with our brands using participant ratings of brands on the set of traits outlined in the Aaker framework (Figure 2A). Specifically, we used a factor analytic approach to summarize variation in trait ratings and reduce collinearity issues. Consistent
with previous results, we found that a substantial proportion (86%) of the variance was captured by 5 factors.

Second, we used the brand experience scale to capture the set of experiential traits that participants associate with the brand (Brakus et al. 2009). Consistent with previous results, we found that a substantial proportion (72%) of the variance was captured by 3 factors. Further inspection of the factor loadings showed that our results largely replicated those of previous studies. This included the “sensory/affective”, “intellectual”, and “behavioral” factors (Figure 2B).

3.2 Dissociable Neural Representation for Associations and Experiences
For each voxel centered on the 10mm sphere searchlight, the resulting map shows how well the multivariate signal in the local spherical neighborhood differentiates the previous unseen brands, comparing using brand personality to model the psychological features of brands to using brand experience to model the psychological features of brands. Paired T tests were performed at each voxel location of the individual accuracy maps for personality and the individual accuracy maps for experience from whole-brain decoding using an MVPA searchlight approach. Colors indicate T-values from a voxel-wise paired t test comparing decoding accuracy of the two models. Warm colors show the brain regions where the personality model performs better than the experience model. Cold colors show the brain regions where the experience model performs better than the personality model.

We threshold the whole-brain t-statistics map in Fig. 4 to obtain the set of brain regions where using the personality model significantly performs better than using the experience model (results were considered statistically significant at p < 0.01). We find that compared to brand experience, information about personality contains in dorsolateral prefrontal cortex (DLPFC), dorsomedial prefrontal cortex (DMPFC), temporoparietal junction (TPJ), and anterior insula. These brain regions are usually associated with semantic memory.

We threshold the whole-brain t-statistics map in Figure 6 to get the brain regions where using the experience model significantly performs better than using the personality model (results were considered statistically significant at p < 0.01). We find that compared to brand personality, information about experience contains in posterior insula, hippocampus, and anterior cingulate cortex (ACC). These brain regions are usually associated with episodic memory.

4 Discussion
Compared to marketing actions that yield more direct and immediate effects, the ability of marketers to measure returns on brand investment have lagged in key metrics such as revenue and profitability (Rust,
Lemon, et al. 2004; Kamakura & Russell 1993; Knox & Walker 2001). Thus, although brands are often seen as one of the most valuable assets for firms, brand managers nevertheless face significant challenges to justify the impact of their spending. These challenges have only increased in recent years as branding has grown to more and more focus on abstract and intangible considerations, and managers are increasingly seeking to understand aspects of brands unrelated to the actual physical product or service specifications (Keller 2012; Aaker 2009).

Our findings highlight two areas where insights from cognitive neuroscience can begin to improve and guide managerial decision-making. First, by providing a more rigorous and nuanced notion of human memory, neuroscientific data have the potential to allow consumer researchers to ground conceptualizations of brand knowledge on a firmer scientific footing. Moreover, thinking about multiple memory systems can potentially improve our understanding of how changes in brand knowledge affect revenue and profitability. Whereas traditional marketing theories take it for granted that more favorable associations stored in consumer memory will result in increase customer acquisition and retention (Keller 1993), advances in decision and consumer neuroscience have provided a more nuanced understanding of conditions under which memory influences decisions.

For example, the fact that episodic memory is fast forming but easily distorted and semantic memory is slow forming but resilient has potential implications for development of marketing strategy. In particular, this distinction suggests that the optimal balance between “showing” and “telling” in advertisements will differ depending on the novelty of the product category, the strength of existing associations to one’s own offerings and those of competitors. More practically, our research has direct implications for development and evaluation of scales that seek to capture notions of brand knowledge and brand equity. That multiple forms of consumer memory underlie brand knowledge highlight the importance of understanding the timing and frequency of measurements, above and beyond considerations about content.

For example, because consolidation of semantic knowledge is slow, it may be critical for researchers to measure factual understanding of brands when sufficient time has passed from the marketing action. Conversely, because episodic memory is easily distortion, researchers may want to measure the memory quickly and repeatedly to understand the trajectory of any distortion. Finally, the fact that memory is often inaccessible to conscious recall opens the door to neuroscientific and implicit measures to supplement self-report measures, including fMRI, EEG, and implicit association test. This will be particularly important in cases where consumers are either unable, such as in the case of habits, or unwilling, such as personally sensitive information, to reveal to the researcher.
References


Figures and Tables

Figure 1: Multiple memory systems model of human long-term memory. Adapted from Milner et al. (1998).

Figure 2: Behavioral Responses of Brand Personality and Brand Experience.

A

Personality Traits

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 |
|---|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
|   | down-to-earth | family-oriented | small-town | honest | sincere | real | wholesome | original | cheerful | sentimental | friendly | daring | trendy | exciting | spirited | family-oriented | small-town | honest | sincere | real | wholesome | original | cheerful | sentimental | friendly | daring | trendy | exciting | spirited | family-oriented | small-town | honest | sincere | real | wholesome | original | cheerful | sentimental | friendly | daring | trendy | exciting |

Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5
<table>
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<tr>
<th></th>
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<td>-1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

B

Experience Questions

1. This brand makes a strong impression on my visual sense or other senses.
2. I find this brand interesting in a sensory way.
3. This brand does not appeal to my senses.
4. This brand induces feelings and sentiments.
5. I do not have strong emotions for this brand.
6. This brand is an emotional brand.
7. I engage in physical actions and behaviors when I use this brand.
8. This brand results in bodily experiences.
9. This brand is not action oriented.
10. I engage in a lot of thinking when I encounter this brand.
11. This brand does not make me think.
12. This brand stimulates my curiosity and problem solving.

Note: We used subjects’ ratings of the descriptiveness of personality traits and experience items to characterize the psychological features of brands. (A) (Top) Personality traits used in the survey. (Bottom) The factor analysis and the criteria yielded five factors, labeled as excitement, sincerity, competence, ruggedness, and sophistication. Further inspection of the factor loadings showed that our results largely replicated those of previous studies (B) (Top) Experience items used in the survey. (Bottom) The factor analysis and the criteria yielded three factors, labeled as sensory/affective, intellectual, and behavioral.
Figure 3: T Statistics Map for Comparison between Personality and Experience.

Figure 4: Brain regions where activity contained significant amount of information related to brand personality, controlling for brand experience (uncorrected $p < 0.001$, cluster size $k > 10$).
Figure 5: Brain regions where activity contained significant amount of information related to brand experience, controlling for brand personality (uncorrected $p < 0.001$, cluster size $k > 10$).

<table>
<thead>
<tr>
<th>Region/Feature</th>
<th>Prob.</th>
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<tr>
<td>insula</td>
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<tr>
<td>emotional faces</td>
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<tr>
<td>hippocampus</td>
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<tr>
<td>anterior cingulate</td>
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</tr>
<tr>
<td>emotional faces</td>
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<tr>
<td>emotional information</td>
<td>0.81</td>
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Table 1: Features of semantic and episodic memory systems.

<table>
<thead>
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<th>Memory System</th>
<th>Memory Type</th>
<th>Learning Rate</th>
<th>Neural Substrates</th>
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<td>Semantic</td>
<td>Knowledge and facts</td>
<td>Slow</td>
<td>Neocortex, highly distributed</td>
</tr>
<tr>
<td>Episodic</td>
<td>Events and experiences</td>
<td>Fast</td>
<td>Hippocampus, localized</td>
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Table 2: Voxel locations of brain regions shown in Figure 4 where the model performance using personality factors was significantly better than using experience factors.

<table>
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<tr>
<th>Cluster Size</th>
<th>T</th>
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<th>Y</th>
<th>Z</th>
<th>L/R</th>
<th>Region</th>
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<td>Precuneus</td>
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<td>73</td>
<td>4.3</td>
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<td>40</td>
<td>L</td>
<td>Inferior Parietal Lobule</td>
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<td>34</td>
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<td>Precuneus</td>
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1. Cluster size (voxels).
2. T values from a voxelwise paired t test comparing decoding accuracy of using personality to experience.
3. Voxel location (X, Y, Z) in MNI coordinate (mm).
4. Laterality of activation (L = left hemisphere, R = right hemisphere).
Table 3: Voxel locations of brain regions shown in Figure 5 where the model performance using experience factors was significantly better than using personality factors.

<table>
<thead>
<tr>
<th>Cluster Size</th>
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<th>Voxel Location (X, Y, Z)</th>
<th>Laterality</th>
<th>Region</th>
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<td>R</td>
<td>Caudate</td>
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<td>26</td>
<td>3.87</td>
<td>-42, -10, -5</td>
<td>L</td>
<td>Insula</td>
</tr>
<tr>
<td>7</td>
<td>3.48</td>
<td>-57, -25, -17</td>
<td>L</td>
<td>Inferior Temporal Gyrus</td>
</tr>
<tr>
<td>17</td>
<td>3.34</td>
<td>-30, -55, 10</td>
<td>L</td>
<td>Parahippocampal Gyrus</td>
</tr>
<tr>
<td>8</td>
<td>3.16</td>
<td>9, 32, 22</td>
<td>R</td>
<td>Anterior Cingulate</td>
</tr>
</tbody>
</table>

1. Cluster size (voxels).
2. T values from a voxelwise paired t test comparing decoding accuracy of using experience to personality.
3. Voxel location (X, Y, Z) in MNI coordinate (mm).
4. Laterality of activation (L = left hemisphere, R = right hemisphere).