Locating Brand Equity: Neural correlates of virtual shopping choices

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Abstract

Marketers are fundamentally interested in how consumers make buying decisions. A recent method of non-invasive brain imaging, magneto encephalography (MEG), was used to observe subjects making decisions on a virtual (video) supermarket visit. At each of 90 stops, the subject was invited to choose one of three brands. Package height discrimination between a sub-set of the same stimuli provided a control experiment. Subjects also completed a questionnaire to indicate their familiarity with each of the brands shown in the video. The objectives were to identify brain regions which become differentially engaged when choosing brands, as against discriminating packaging height, and the extent to which familiarity with the brand would affect both the choice and the associated brain processes. As expected, activations in brand choice differed from those for height discrimination and were faster when one brand was more familiar. Brand choice appeared to involve silent vocalization. The right parietal cortex was only activated where the subject indicated strong relative brand familiarity. This therefore appears to be a key location for brand equity both because it is only activated for the most salient brands and because it seems to be linked with intentionality. This is probably the first time brand equity has been located. The paper concludes with the benefits for marketers and marketing research.
Marketers are fundamentally interested in how consumers make buying decisions and now we can virtually look into their minds when they are doing so. This paper reports research using a recent non-invasive brain imaging methodology, magneto encephalography (MEG). This research is believed to be the first examination of brand choice using MEG.

Marketers also want to know how brand equity affects those buying decisions. Brand equity is variously defined (see Keller 1998) but here it refers to the asset that good marketing creates in brains of consumers and other stakeholders. We know it exists but so far we have only been able to measure it indirectly by inputs (e.g. advertising spend), intermediate associates (e.g. reported perceived quality) and behavior (e.g. loyalty). This research explores how brain activations for familiar brands, i.e. those with higher brand equity, differ from less familiar brands.

Subjects were taken on a virtual tour of a supermarket, via a video which paused occasionally to be replaced by a still photograph offering a choice of three competitive items. Subjects were invited to choose, or decline to choose, one brand from a choice of three. We used 90 such triplets. Brain scans were recorded from immediately before to just following each selection period. The shopping tour was as realistic as possible and used popular packaged goods brands (no private label). Height discrimination provided
a control experiment. Using 60 of the same triplet photographs, each subject was asked to indicate which package was the shortest. Magnetic brain signals were recorded in both conditions for later analysis.

Following the MEG session, each subject completed a questionnaire in which they indicated their familiarity with each of the 270 items. Despite individual differences, analysis of the data reveals a robust temporal sequence of spatially distinct cortical regions, beginning in the primary visual cortex and culminating in the right parietal, engaged during the first second following presentation of the images, and before the final choice is indicated by key-press.

The objectives were to identify brain regions which become differentially engaged when choosing to purchase a particular brand, as against simply determining the height of the packaging, and the extent to which familiarity with the brand would affect both the choice and the associated brain processes. The importance of this research is firstly that it opens the door to studying decision-making directly. Today’s technology is expensive, rare and slow, especially for analysis, but that is changing fast. These techniques may become as quick, cheap and painless as X-rays at the dentist but only if exploratory studies, such as this, show what can be done.

Secondly, this research shifts the balance of attention from the new stimuli, which are most often the subject of research, to what consumers already have in their heads. Of course decision-making involves both and some (e.g. Ehrenberg 1974, 1994) have long argued that advertising [persuasion] is less important than ingrained behavior. This research tests that view, in the context of frequently purchased packaged goods.
The importance for marketing research lies in piloting real-time brain imaging of decision-making. As with any technique in its infancy, limitations and reservations are plentiful but, at the risk of overstatement, the development can be compared with the early cinema. At this stage what we are seeing is far from clear but we do know it is a different way of perceiving the world. Psychology is becoming increasingly anchored in neuroscience and we will become less dependent on interpreting behavior.

This experimental design is a step towards examining brain mechanisms engaged in something approximating real decision-making. Indeed, as an increasing number of people actually shop on the Internet, real life and this study situation come ever closer. The brain has to reconcile new information arriving at the point of decision with what is already in the head, i.e. brand equity in the case of brands. There is of course no suggestion that the brain has created any special area for brand equity: that would make no sense. But on the other hand brand memories (brand equity) have to be stored somewhere and we here seek to understand the pathways between point of sale input, the location of what we now call brand equity and the decision.

The paper is structured as follows. After reviewing previous consumer decision-making and neurological research, we develop hypotheses. We then describe the design of the experiments and outline the MEG technology, recordings and analysis, followed by results, discussion and suggestions for future research which show how this research may be developed to benefit marketers and marketing research.
**Previous research**

Ever since Ebbinghaus in the 19th century, laboratory research in the cognitive processes engaged in memory has attempted to abstract the items to be learned or remembered from the normal richly contexted experiential web within which such memories are made and acted upon in day-to-day life. The reasons for this are straightforward: individual autobiographic experience combines episodic, semantic and procedural elements of personal memory (Rose 1993), and are by their nature idiosyncratic. It is therefore difficult to devise an experimental procedure to investigate the neural correlates of such real-life memories which can be applied equivalently across many subjects. However, there are commonalities in the experience of urban dwellers in industrialized societies which can potentially be exploited.

Most people have some experience of supermarket shopping, and choosing specific items from arrays of competing brands. Choices are likely be influenced by a variety of individual factors such as national cultures (Briley, Morris and Simonson 2000) and memories and habits which accumulate from early childhood (John 1999). Decisions are not based just on information newly presented but rely on habits, memories and experience/preference of the brands. However, although individual needs and preferences vary, the processes associated with making choice may be expected to show some common features. Furthermore the supermarket purchasing experience, mimicked in this research, is routine with little requirement for new information. Thus consumer heterogeneity so far as information needs and control (Bettman 1979) are concerned, are minimized. Conversely, the role of brand equity should be relatively enhanced.
In this context, there are dangers in linking brain areas too strongly with particular
cognitive, emotional, memorial and behavioral processes, but certain associations are
now well established. For example, visual imaging, verbalization, rational thinking and
emotional processing would be expected to show clearly (Kandel, Schwartz and Jessel
imaging to show the activation of the right hippocampus in London taxi drivers
planning their routes.

Pieters and Warlop (1999) studied eye-movements of subjects who visually inspected
different brands. Fixation on the chosen (preferred) brand was almost 53 ms longer
than the fixation durations for the non-chosen brands, indicating greater attention.
Lewis and Bridger (2000) studied heart rates and blood pressures during a shopping trip
in London's Oxford Street; one of the busiest streets of the capital. Both increased
dramatically during these trips, indicating an elevated level of stress.

Rothschild et al. (1988) and Rothschild and Hyun (1990) monitored the brain's electric
signals (EEG) while subjects watched television commercials. One of their findings
was that the left hemisphere was more responsive to verbal elements (e.g., the brand
name), and that the right hemisphere was more responsive to non-verbal elements (e.g.,
a corporate logo). This builds precisely on the long-believed hemispheric distinction
between rationality (left) and space/affect (right) pioneered in marketing research by
Hanna, Wagle and Kizilbash (1999) found that print ad effectiveness depended on the informational (presumed left) and visual (presumed right) appeals used and the relative hemispheric dominance of the individual. In other words, predominately right brained respondents were more positive about visual ads and the more left dominated by the informational ads. The separation of the two groups of respondents was on the basis on the Banks (1991) (psychological) scale scores and thus there is some risk circularity. Mantel and Kardes (1999) achieved similar results: individuals with high need for cognition requiring attribute information for decisions whereas those with low need for cognition, but high need for affect, tending to make attitude-based decisions.

All the consumer decision-making research that we found relies on psychological interpretations of the, mostly experimental, data rather than using brain measurements directly. The distinction between right and left brain is used colloquially rather than precisely. For example, Maddock and Fulton (1996) refer to “right brain” strategies in structuring motives, context and affective aspects of advertising as distinct from rationality.

Bagozzi, Gopinath and Nyer (1999) reviewed the literature concerning the role of emotions in marketing. They suggested that recent research has given considerable attention to the way emotional reactions to ads influence consumer decision-making but this attention has focused more on the first part of this (the ads), e.g. Agres, Edell and Dubitsky (1990), Ambler and Burne (1999), than on decision-making, pace Shiv and Fedorikhin (1999). The first Bagozzi et al. proposal for future research was to examine
how consumer appraisals are conducted and in particular the roles of the amygdala, hippocampus, and other neural systems (see Figure 1). This is what we have done.

Holbrook, O’Shaughnessy and Bell (1990, p.137) integrated competing marketing schools of thought into “An Integrative Overview of the Consumption Experience” with three types of component: reasons (thoughts, intention), emotions (wants, appreciation) and memory (habit, reinforcement, experience). Usage reinforced the emotional components which, in turn, acted on the rational and habit components which drove acquisition. At the same time, thoughts and wants, looped with emotions, also moderated reasons.

Damasio (1994) co-located decision-making especially with the primarily associated with the ventro-medial frontal lobes (VMFL – shown as “OB” in Figure 1). Patients with lesions in the VMFL were unable to make decisions more complex than the simply habitual (like crossing the road). His findings are supported by Adolphs et al. (1994) and Phelps and Anderson (1997).

Note to Editor: We know JMR requires B/W figures but these are in color while we explore contrast raising techniques for their conversion
Key:

OB/ SF/ MF – orbital/superior frontal/middle frontal gyrus are part of an extensive area known as the pre-frontal association cortex. It receives input from many cortical and sub-cortical areas, commonly assigned a regulatory role of a person’s depth of feeling, initiative and judgement.

OCC – occipital cortex, encompasses primary visual area, which receives input from the eyes.

EXS – extra-striate cortex, second order processing of visual information, involved in shape, movement, and object recognition.

IOT – inferior occipito-temporal cortex, similar to EXS, distinction is difficult.

P – parietal cortex, complex sensory input (anterior parts), higher order integration, motor planning (posterior parts, these are also termed association cortices).

CB – cerebellum, control of posture, co-ordination of limb and eye movements.

AT/ MT – anterior/medial temporal cortices, memory recall, semantic analysis.

IF – inferior frontal gyrus, encompasses motor speech area of Broca, damage usually results in paralysis of speech.
**Hypotheses development**

Against this background, hypotheses were formulated as follows.

On the basis that brand choice will involve memory and emotional activation not required for a more simple discrimination task such as judging the relative heights of three packages (Gross 1995), we predicted that:

H1: Reaction times for brand choice will be longer than for height discrimination.

Similarly, where one brand is more familiar, the decision is likely to be faster than for unfamiliar brands. Preference and liking are not issues. The difference in levels of familiarity is termed “salience” which is defined more precisely later. We therefore predicted that:

H2: Brand choice will be faster where salience is greater.

Activation of the left anterior and medial temporal cortices is known from a variety of brain imaging studies to be engaged in semantic processing and the memory-based interpretation of visually presented material (McCarthy, Nobre, Bentin and Spencer 1995; Braeutigam, Bailey and Swithenby 2001; Damasio et al. 1996; Nyberg et al. 1996). Thus we predicted that:

H3: For the same visual stimulus, brain activation differences will be observed between brand choice and height discrimination.

Broca’s area is a region of the brain known since the 19th century to be associated with speech and verbalization. Silent vocalization can occur when interpreting visual
presentations similar to brand choice (Tulving et al. 1996). The choice when one brand was much more familiar than the other two would be expected to be faster and to show differences relative to triplets with similar levels of familiarity. Thus:

H4: Brand choices with high salience will show a different pattern of activity from those with low salience.

And in line with the work noted above on vocalization:

H5: When choosing brands there will be increased activity in the language areas compared to when determining relative height.

And finally, in line with Damasio (1994) and Ambler, Ioannides and Rose (2000) we predicted that:

H6: The brand choice decisions will be associated with activations in the frontal lobe (e.g. VMFL or orbital gyrus).
Experimental design

The design had four stages: piloting the entire process to remove confusion, a supermarket virtual tour to choose brands, a repeat of the tour for the height discrimination task and the completion of a questionnaire to assess brand familiarity. The questionnaire needed to follow the brain imaging to avoid prompting.

The subjects, all from the UK, were taken on a visit to a virtual supermarket, a video-tour lasting some 18 minutes. During the tour through the shopping aisles, the video periodically ceased, and subjects were presented with a product shelf containing three competing items, either related products or different brands of closely related products. These were grouped into 18 different categories, ranging from beer and wine to tinned pet food. None of the products were supermarket ‘private label’ and all were presented so that their names and/or logos were clearly visible. There were 15 items in each general product category, and the subject was presented with images of them in groups of three items; i.e. five sets of three brands for each product category (e.g. Figure 2).

Each set of three was shown for 5 seconds, followed by a 3 second blank interval. Subjects were instructed to indicate which of the items they would prefer to purchase.
when given the choice by pressing a keypad with their right hand, using the index, middle or ring finger corresponding with the item’s position on the screen. If they would not wish to purchase any of the items, or could not choose between them, they were instructed to press with their thumbs. There were thus 90 (18x5) one-out-of-three choices to be made.

Subjects were not asked to supply reasons for their choices and we therefore expected them to make decisions in their conventional way (Simonson and Nowlis 2000).

The time intervals were selected on the basis of respondent comfort: having to wait too long caused irritation whereas time pressure was expected to have a positive effect in this context (Dhar and Nowlis 1999). In other words it would increase the likelihood of a choice being made using such features as were apparent. Thus there was no emphasis on speed: subjects were asked to press a key as soon as they had reached a decision.

Subjects would ordinarily encounter pricing issues in supermarkets and we needed to remove conflicts between any prices we quoted and those they were found in their home supermarket. To deal with this and to add realism, they were instructed to ignore price differentials but, at the conclusion of the experiment, they would be given a shopping voucher to the value of £50 which could be used to towards purchase of the brands selected during the MEG run. The implication of the latter instruction was that more premium choices would result in fewer goods to bring home. In practice no subjects reported that these pricing arrangements created artificiality.
This protocol was piloted without brain recordings with a group of volunteers in Milton Keynes. Two months later, four of the participants in that pilot study, together with five other subjects, were flown to the MEG facility at the Low Temperature Laboratory of the Helsinki University of Technology, to take part in the main experiment. The gap between the two stages was long enough to be confident that the main study would not be affected.

MEG is described in the next section. Subjects had normal or corrected-to-normal vision and signed an informed consent form prior to the experiment (Helsinki Declaration). The stimuli were delivered in the form of a video projected onto a screen within a magnetically shielded room. One of the MEG records obtained was unusable for technical reasons, and the final study group therefore consisted of 8 right handed adults, aged 30-63, with relevant shopping experience (4 males, 4 females).

Subjects remained in the MEG machine following the choice experiment, and were shown a subset of 60 of the images used in the initial presentation. They were asked to use the key-press simply to indicate which of the three items (left, middle or right) was the shortest (thumb-press if they could not discriminate). The images were selected to guarantee ease of discrimination and equal probability of the shortest item being in each of the three positions. This set of recordings served as a control in order to distinguish between simple perception of the three choice items and making a memory-based choice between them.
At the end of the recordings, participants rated their familiarity with each individual consumer product shown, based on a questionnaire. The questionnaire had a 5-point scale for each of the 270 items shown. Each brand/product was thus scored independently on a scale ranging from 1 (unfamiliar/not known) to 5 (very familiar/most often used). These scores were converted into measures, S, of salience, to indicate the strength of the informed familiarity for the chosen item relative to the other two in each triplet. The salience measure, in effect the relative brand recognition, was calculated according to the formula:

\[ S = \frac{1}{8} (4 + V_c - \frac{1}{2} (V_1 + V_2)). \]

S ranges from 1 (high) to 0 (low). The maximum value would occur if the item chosen \((V_c)\) scores 5, whereas the two non-chosen items \((V_1 \text{ and } V_2)\) both score 1. The minimum would signify the reverse situation and where all three are equally [un]familiar salience would be 0.5. Thus for each choice, we could distinguish between those images in which one brand was substantially more or less familiar than the other two or where familiarity scores were similar. For subsequent analysis, the data from the choice task were split, at the median, into two groups corresponding to the upper and lower values of S, denoted by high and low salience respectively.

**MEG recordings and analysis**

MEG takes advantage of the fact that the language with which nerve cells communicate in the brain is electrical, and all electric currents generate magnetic fields at right angles
to the direction of the current. Thus the human head is surrounded by a minute, fluctuating magnetic field, so small as to be until recently below the level of detection. However over the past decade, advances in superconductor physics have made possible the construction of instruments to detect these small magnetic fields. The merit of the MEG system is that it can detect changes in magnetic fields at something approximating the speed at which the brain works, i.e. in milliseconds time, which more conventional imaging systems (PET, fMRI) cannot achieve.

A current limitation of MEG imaging techniques is the time required for analysis. While collecting the brain signals is relatively speedy once the instrumentation is available, the amount of data generated from even a single 10 minute recording from one individual is so large that it can require several months to decode. Therefore the numbers of subjects that can practically be studied in such experiments is small, and care must be taken in drawing robust conclusions.

Neuromagnetic responses following image presentation were recorded using a VectorView™ system (Hämäläinen 1997), which has a helmet-shaped array of 102 pairs of first order gradiometer sensors. The helmet is illustrated in Figure 3. The local root-mean-square (rms) signal summed over the two readings is a measure of the strength of currents below each sensor site. The data were sampled at 600Hz (0.01 to 200Hz anti-alias filter). Electro-oculogram, electrocardiogram and head position were monitored to control, so far as possible, for artifacts due to body movements, eye-blins, and brain functions unconnected with the experiment.
As described below, the average time from presentation of photograph to key-press was some 2.6 seconds in the choice task, but as subjects were free to take their own time in key-pressing, it varied between subjects and choices. There are, in principle, two ways to standardize and analyze the data. Time can be measured forward from the time of stimulus presentation, or back from the time of key-press. In preliminary analyses we looked at both possibilities, but have opted for the forward measure as being conceptually simpler and without any limitations revealed by comparison with the backward analysis.

After one second the data becomes confounded by the preparations for the motor activity involved in the key-press. Accordingly, the data presented here is limited to the first second following stimulus onset. For each subject, the signal epochs were averaged in 10ms segments within the interval –200 to 1000 ms for both tasks. We then made comparisons between choice and height control tasks, and, within the choice task, between high and low salience images. We examined the data for each subject separately averaged across all choices made by that subject and then combined all subjects and choices.
A time-dependent measure $P(t)$ was used to identify latencies where there are significant differences between neuronal activation associated with the different sets of responses:

$$P(t) = \text{prob}\left(\chi^2\right) = \text{prob}\left(-2\sum_{i=1}^{N} \ln W_i(t)\right).$$

$N$ denotes the number of channels (204), and $\text{prob}$ is the significance level of the quantity in brackets (Batschelet 1981). $w_i$ is the level of significance of a paired Wilcoxon (Conover 1980) test of the pairs of evoked responses from all subjects in the $i$th channel. (Brauetigam, Bailey and Swithenby 2001a). Comparisons were carried out both for choice versus control and for high versus low salience responses (split at the median).

MEG data is recorded in signal space. The MEG helmet surrounds the head, and the data output is represented on a flattened projection of the brain as shown in Figure 3. After showing the helmet, Figure 3 shows the sequence of brain activations. The frontal areas are at the top of each pictogram. The lighter the color, the more brain activation is taking place.
In order to identify the brain regions which are the sources of the responses, these two dimensional images are projected back into three dimensional brain space. As each individual’s head is slightly different, it is normal practice to obtain magnetic resonance images (MRI) of individual brain anatomy for at least a proportion of the subjects in order to be able to show the results pictorially. In the present case, anatomical MRI scans were obtained for four subjects which were deemed adequate for these purposes. Using individual (reconstructed) cortical surfaces, we identified those source components that describe the observed differences between signals consistently across the four subjects.
Results

Brand familiarity and choice

For each of the 90 images in the video, subjects could choose one of the three items of the image set, or decline to choose. Overall there were 74 percent positive choices, a mean which masked large individual differences – positive choices ranged from 46-97 percent between subjects. Despite our instructions, some subjects reported that they had felt under some constraint to make a choice even when they were indifferent.

Familiarity as indicated by the questionnaire was a good predictor of choice. On the five point scale prior to conversion to salience, the average score of the chosen items was 2.8 and of the non-chosen 1.8 (t(8):9.59, p<0.001).

One advantage of using the pilot subjects again for the main experiment was that we were able to check the consistency of choice by the same subject, i.e. whether s/he was not making real choices but was pressing random digits. With 270 items two months apart, there was no possibility of memorizing choices. Overall, consistency was 69 percent which, while far from 100 percent was well in excess of random (33 percent even if “no choice” is discounted). The shortfall is explained by relative indifference when familiarity was marginal. For high salience choices, consistency rose to 94.9 percent.

The low salience group had scores ranging from 1.5 to 4.5. In other words, there were no examples of the chosen brand being much less familiar than both the other two. For 70 percent of the trails in this low salience group, the familiarity scores were
approximately equal. In the remaining 30 percent of cases, the chosen brand was slightly less familiar than one of the other two. In the high salience group, the chosen brand was much more familiar than at least one of the other two.

Reaction times

The first two hypotheses relate to reaction times – that is time from onset of image to key-press. Subjects responded significantly ($t_7 = 6.4; p < 0.001$) faster to high salience stimuli (average key-press at 2410 ms$^2$) than to low salience stimuli (2950 ms). Decision-making in the control task (height discrimination) was much faster, and subjects responded by pressing the appropriate key on average 860 ms after stimulus onset. In this case, the occurrence of ‘cannot discriminate’ presses was negligible (< 0.5 percent). Thus Hypotheses 1 and 2 were supported. The much shorter reaction time for the control task however presents a problem in comparing the MEG records in the choice and height tasks beyond the first 500 ms or so. After this time, the only valid comparison is between high and low salience scores.

$^2$ Millisecond
Neural activity

In both the choice and the height control tasks, the first appreciable evoked responses following presentation of images were observed at about 100 ms after presentation of the images over the primary visual cortices in the occipital lobe – see Figure 1. Subsequently, evoked responses were observed over extra-striate, parietal, and superior-temporal regions. Examples of the data are shown in Figure 3. Despite considerable variability across subjects, non-parametric statistical analysis identified four robust temporally distinct stages of neural activity during which the responses were significantly modulated by the task conditions across all subjects within the one-second stimulus presentation. These stages, as listed below and shown in Figure 4, were identified in signal-space by the condition $P(t) < 0.01$.

Stage 1 – V (visual): Responses over primary visual cortices at around 90 ms after stimulus onset, consistent with a localized source region in primary visual cortex (Figure 4, V). Although both tasks produced visual cortical responses within this latency range, signal amplitudes were higher when choosing an item, independently of its salience, as opposed to determining its height.
Stage 2 – T (temporal): Responses over left (primarily anterior and medial) temporal cortices at around 325 ms after stimulus onset. Some weaker generators also locate in the left middle frontal and orbital gyri (Figure 4, T). There is some evidence that activity in right extra-striate cortex contributed to this differential response. Signal amplitudes were higher when expressing a preference for and choosing an item, independently of its salience, than when determining its height.

Stage 3 – F (frontal): Responses over left frontal cortices at around 510 ms after stimulus onset (Figure 4, F). Signal amplitudes following low-salience stimuli were higher than those following high-salience stimuli. The differences in activity were predominantly generated in cortical regions homologous to Broca’s speech area. As noted above, comparison with the height discrimination condition is not valid, because of overlap with motor related activity linked to the much faster key responses observed in the control task.

Stage 4 – P (parietal): Responses over right parietal cortices at around 885 ms after stimulus onset (Figure 4, P). Signal amplitudes following high-salience stimuli were higher than those following low-salience stimuli. At this latency non-differential extra-striate, right inferior-temporal, orbital, and cerebellar generators were also involved to varying degrees across subjects.

Thus Hypotheses 1 and 2 were supported. The next section discusses the support for Hypotheses 3 and 5 and lack of support for Hypotheses 4 and 6 although a more interesting observation appeared.
Discussion

These results reveal a striking temporal sequence of consistent neural responses following the presentation of the product images, against a background of individual differences in response varying with subject and choice items. The initial, primary visual cortex response, at around 90 ms following stimulus onset is compatible with the timing found in a variety of studies involving visual responses (Halgen et al. 1994; Yoneda, Sekimoto, Yumoto, and Sugishita 1995; Brauetigam, Bailey and Swithenby 2001b). However, it is noteworthy that this response was stronger when subjects were asked to choose an item than when they merely had to judge relative heights. Although this supports Hypothesis 3, the expectation referred to the later responses, downstream of initial representation in the visual cortex.

This observation indicates that even the earliest brain response to the brand pictures is affected by the purposes intended for perception, i.e. why the object is being studied. One interpretation would be that a complex stimulus has to be more strongly represented in striate cortex if it is intended for subsequent higher cognitive analysis. This interpretation is supported by de Fockert et al. (2001) subsequent to the completion of our analysis. They reported that when visual stimuli are presented in association with a working memory task, activation of the visual cortex is increased,
The later response, at 325 ms in the left anterior and medial temporal cortices, was also stronger in the choice task than in the height task, as anticipated in Hypothesis 3. The finding is thus compatible with the hypothesis that, at this time, the images presented are being recognized and compared with retrieved memories of brands. The activity in right extra-striate cortex may indicate that object recognition is part of this process (Allison et al. 1994). What we cannot tell from this, of course, is the nature of the retrieved memories. For instance, memories of this type are generally classified as declarative, but within this category they are subdivided into semantic versus episodic. A semantic memory of a brand might be a general recognition of the brand name and product concerned; an episodic memory would involve recall of a particular episode of purchasing or using the brand. What is clear is that at this point in the sequence, the valence of this recalled memory seems unimportant, as the activation was independent of the salience measure, and hence at this time Hypothesis 4 is not supported.

The process of brand recognition seems to be continued by the third robust response in the choice task, occurring at around 510 ms and mapping onto Broca’s area thus supporting Hypothesis 5. It was in some cases possible for observers of subjects in the MEG machine to see lip movements as the images were presented. However, perhaps surprisingly, the signal is stronger for the low than for the high salience stimuli. Where either all three items have similar familiarity, there seems to be greater difficulty in making a choice, as is also indicated by the longer time before key-press compared with high salience conditions. Vocalization could be an aid in choosing where no one brand has dominant equity.
Perhaps the most important response is found at 885 ms in right parietal cortex. Here there is enhanced activity in high salience conditions, i.e. when the subject has a strong familiarity with one of the three brands. This is consistent with Hypothesis 4, although in making those hypotheses we had only broad ideas of which brain regions might show the anticipated differences. As indicated by Hypothesis 6, we had expected to find more frontal activity, in accord with a number of general hypotheses and some lesion data concerning the role of the frontal cortex. However, Hypothesis 6 was not confirmed. Instead we were faced with the question of how to interpret this strongly lateralized parietal signal.

The parietal cortex is a large and complex region, parts of which are conventionally associated with the planning of motor activity. However as our subjects were right handed and pressing a keypad with their right fingers, which would be expected to engage left parietal activity, this cannot be the explanation. The parietal also receives converging input from many sources, making it available for second order mapping; it is engaged in relating spatial to other representations (Anderson and Zipser 1990), notably during memory retrieval. Lesions of the right parietal affect a person’s capacity to produce speech with normal prosody and emotion (Heilman, Scholes, and Watson 1975; Ross and Mesulam 1979).

Damasio (2000) has broadened these observations into a specific ‘somatic marker hypothesis’ according to which damage to the right parietal cortex (Damasio 2000; Charlton 2000) results in anosognosia, i.e. intentionality is profoundly damaged. Thus such lesions prevent a person from being able to ‘decide advantageously in situations involving risk and conflict…[or] to resonate emotionally’ in such situations (p.41).
Clearly the choice task with which our subjects were presented, where familiarity is strong, is likely to engage just those processes that are damaged by right parietal lesions.

A further, not necessarily alternative, explanation draws on the role of the right parietal cortex in selective and sustained attention processes (Cabeza and Nyberg 1997; Vallar 1997) as well as higher levels of motor control (Kandel, Schwartz and Jessel 1991). Accordingly, right parietal activity may signify a (final) attentional focus on the item already chosen, in order to visually ‘hold’ it during ensuing or already initiated motor control necessary for the key-press. However, the key-press itself occurs more than 1.6 seconds after the right parietal activation, implying that this region is likely to be engaged in the conscious and emotionally charged processes of choosing and preparing to indicate the more familiar brand. Since this activation was less marked in the low salience condition, the alternative (attentional) explanation seems less likely.

Finally, it was reassuring to find that salience was biased towards 1 (0.62 compared with 0.5, the random outcome, p<.001), i.e. in most triplets one brand was recognized and consumers are more inclined to choose the ones with which they are familiar. Only 15 percent of brand choices were those indicated by the later questionnaire not to be the most familiar. Given the “noise” that could be expected from gathering this amount of data in this way, we consider these results consistent with expectations.

**Managerial Implications**
Behavioral researchers regard intermediate effects as too difficult, or too unreliable, to serve as their main focus. They study what marketers do and the outcomes in terms of observable consumer actions, not what happens in their heads. The competing and evolving theories of psychology may have inadvertently added to the appeal of staying with behavior. Neuroscience may now be in a position to change that.

Nevertheless intermediate effects have attracted much attention over the last 100 years. The literature reveals a large volume of research into the ways advertising and other sales communications are presumed to work but less coverage of the consequential consumer choice-making processes. In other words, we have been more intrigued by input than output. The prevailing assumption has been Cartesian: the brain assembles information and makes trade-offs according to attribute preferences in an orderly, if not rational, manner. Other choice-making concepts have appeared from time to time, e.g. Veblen (1899) pointed to conspicuous waste (consumption) as a social phenomenon although economists might argue that social status is itself a utility.

Decisions are unlikely all to be made in the same way. Some are habitual and others are difficult; some require the long and careful balancing of facts and others can be made quickly on the basis of “feel”. After a court case, a judge may follow the methodological route whereas someone in a jury may just follow an initial intuition. But it is also possible the reverse is true, under which the marshalling of facts simply reinforces a choice already made in order to remove cognitive dissonance.

In this research the type of decision was tightly focussed to the routine supermarket visit, or as close to that as we could synthesize.
From the point of view of practitioners, we have demonstrated that brain imaging of decision-making is now possible. That brand choice engages the brain longer, and in more complex, ways than height discrimination is not surprising. More interesting is the way the brain appears to use vocalization actively in that choice process; that re-affirms the importance of brand names. Most important of all, as is discussed below, is the possible identification of a key area for brand equity.

The brain is vastly more than a computer-like reasoning device. This research does not indicate the relative importance of feelings and rationality but it is clear that reasoning is at most part of the process. As confirmed by the research reviewed early in this paper, individual differ in their reliance on cognitive and affective stimuli. The relative importance of reasoning, feelings and memory differ also between product types (e.g. high and low involvement categories). Nevertheless we can now begin to assess the effects of marketing in terms of brain correlates across multiple subjects.

For example, advertising activates certain areas in sequence and, if it is to have any impact beyond a few hours, the effects must be stored in long-term memory. It seems likely, from this research, that the integration of advertising and memory of brand/product experience with consumer choice takes place in the right parietal region. Linking these events through the advertising, experience and choice processes requires further research.
This research shows the importance of salience for a brand. It is not just a question of better recollection; the decision process in conditions of high salience is itself different. In particular the right parietal cortex appears to be a crucial area for brand equity. This research found activation of the right parietal cortex only for relatively familiar brands. Furthermore it was being accessed at the time of decision-making rather than at the time ads were received or subsequently tracked in the absence of decision-making. It is this juxtaposition of brand equity with the choice being made which is crucial. Brand memories lie in many parts of the brain but the Damasio (2000) linkage with intentionality indicates that the right parietal region may form the bridge between these brand memories and decision-making. This is probably the first time brand equity has been directly measured.

Conclusions

Subjects choosing packaged goods appear to reveal a striking temporal sequence of consistent neural responses following the presentation of the product images. The sequence suggests that the neural processes associated with choice making may be heuristically decomposed into identifiable stages, despite considerable overall inter-subject variability.

The initial, primary visual cortex response, at around 90 ms following stimulus onset is compatible with the timing found in a variety of studies involving visual responses. This primary visual response was stronger in the choice than the control condition. One
interpretation would be that a complex stimulus has to be strongly represented in striate cortex for subsequent higher analysis. This view would be in accordance with recent findings that a high working memory load in a task requiring visual selective attention entails increased activity in occipital cortices (de Fockert et al. 2001).

The later response, at 325 ms in the left anterior and medial temporal cortices, is also stronger in the choice condition. These regions are known, from a variety of intracranial, MEG, and functional imaging studies, to be engaged in semantic processing and the memory-based interpretation of visually presented material. The finding is thus compatible with the hypothesis that at this time the images are being recognized and compared with data concerning the brands and products being retrieved from memory in order to solve the task. In this the current images must be matched against past actual experience of using, purchasing or seeing advertised the specific brands. Activity in right extra-striate cortex may further aid object recognition as part of this process.

However, matching at this latency seems to be of a rather general character in that the precise relationship between the item(s) and the recalled memory is not a factor, as evidenced by the indifference of the effect to the salience measure. Working memory is likely to be engaged, as some of the weaker generators in left frontal regions match recent observations (de Fockert et al. 2001).

Whether such memories are semantic (general experience of product) or episodic (recall of a specific time purchased or used), and their affective versus cognitive valence cannot be distinguished; they are likely to differ between subjects and for particular
triplet sets of images. The implications of the salience measure are relevant here. The basis for the measure was the responses of subjects to the familiarity questionnaire. Each item was individually rated on that questionnaire, but in the test situation subjects had to choose one out of three competing items. The salience measure is then a comparative rating of the three, and is high only when there is asymmetry between them and one item stands out compared with the other two. If all three items are equally, even if strongly, familiar on the questionnaire, salience is low, and choice may be harder. The item finally chosen may indeed have competed successfully with two with higher scores on the questionnaire. As the results show, where salience was low, time to key-press was increased, thus confirming that choice was more difficult.

This discrepancy between high and low salience was reflected in the MEG data, beginning with the third robust response in the choice situation, occurring at around 510 ms and mapping onto Broca's area. There is prior evidence of silent vocalization occurring in interpreting such visual presentations. The signal is stronger in the low salience stimuli compared with high salience image.. These ambiguities may reflect greater difficulty in making a choice in such circumstances, as is also indicated by the longer time before key-press. Vocalization, then, could be an aid to reach a choice decision in the absence of easily retrieved brand recall.

However perhaps the most important response is that found at 885 ms in the right parietal cortex, in high salience conditions, and thus where the subject indicated a strong
familiarity for one of the three brands. Whilst this strongly lateraled parietal signal can not be conclusively explained here, previous research supports a linkage between choice making and brand recall. It seems probable, but further research will be needed before it is conclusive, that this is a key location for brand equity.

Clearly, the neural mechanisms, underlying shopping choices are complex. They draw on the specificities of individuals' past experience and engage many interacting psychological and social processes with, doubtless, appropriate brain correlates. A question for future research is whether there are identifiable sex/gender differences in neural responses to shopping stimuli. The shopping 'experience' was artificial in the sense that subjects were instructed to ignore any knowledge they might have about price differentials between products/brands. However, this study has provided evidence that relevant behavioral measures (salience) associated with choosing consumer items may translate into specific neural stages.

We have suggested that decision-making research tends to focus on the immediate stimuli, especially research that assumes “rational man”, rather than finding the balance between the new stimuli and what is already in the brain. One may decide to buy a certain brand of car, for example, irrespective of any new information. Having established a bridgehead in tentatively identifying the location of brand equity, we can now scan the effects of new information. This can now be down by studying behavior but what is going on in the mind to drive that behavior has to be uncertain. This uncertainty will be reduced as we start to track the changing decision-pathways as new
information is introduced and interacts, or not, with brand equity, and then the differences in activations when decisions are changed. Using these techniques, when cost-efficiency improves, will help marketers better select what consumers want and find relevant.

This research confirms, in the context of frequently purchased packaged goods, the view that experience (memories or brand equity) dominates decision-making. Consumers, prompted by package images, found familiarity (brand salience) enough information for decision purposes without price or other information. And this triggers, for high salience brands only, brain activations associated with intentionality.

References


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Figure 1: Brain areas mentioned in this article
Figure 2: Four brand choice triplets

Figure 3: Helmet to brain image transfers

Figure 4: The four distinct brain activation