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A Brief Explanation and Scientific Background of the Neurensics Methods

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Why use neuromarketing?

For years, market researchers have used similar methodologies to find out the needs, motivations, preferences and thoughts of consumers: the consumer was expected to give answers to specific questions. Marketers implicitly assumed that with focus groups, interviews and questionnaires they truthfully tapped into the consumer's mind and motives. This assumption however turns out to be unfounded. A plurality of behavioral research proves that consumers are unable to truly report what they think, want or like. There is a large discrepancy between consumers' intentions and what they actually do, so that it is incredibly difficult to predict which products will be successful in the market, no matter how much traditional research has preceded their launch. Behavior appears to be determined by mostly unconscious processes, over which our conscious awareness has limited control. This applies all the more to the buying behavior of consumers when confronted with brand names, advertising, commercials and cleverly designed packaging. Whoever wishes to unravel consumer behavior will need to look into the unconscious brain.

Fortunately for a decade now, it has been possible to take a direct look into the living brain with a technique called functional MRI. This revolutionary technology allows us to track the activity of the entire brain from second to second, and map the brain in detail. This allows us to see how our brain values marketing stimuli like a brand, logo or selling proposition.

From neural activity to predicting consumer behavior

When confronted with a stimulus, such as a product, packaging, a TV commercial or a magazine cover, the brain automatically assigns value to that stimulus. It is this automatic valuation that determines whether people will 'buy' the product or the message, and it has been show that this process occurs even when consumers are not aware of the stimulus (Tusche et al., 2010).

Neuromarketing is the recording of these internal valuation signals from the human brain, to predict and understand consumer behavior, in a way that is not possible using traditional marketing research techniques, such as surveys, focus groups or questionnaires. The most powerful neuromarketing technique to date is full-brain scanning using functional MRI. It has been repeatedly shown that with this technique, consumer behavior can be predicted above and beyond self report, so that neural measurements are a better predictor of marketing success than traditional ways of questioning subjects (Falk et al., 2010, 2012; Demos et al., 2012; Berns & Moore, 2011). It has even been shown that one can predict the behavior of large groups of consumers (up to the entire US population) from the neural activity recorded in a relatively small set of (~30) subjects (see below 'target audience and sampling' for more detail).

Note that these remarkable results where all obtained using functional MRI (where blood oxygenation and hence neural activity of about 40.000 small brain regions is recorded simultaneously). The main reason for that is that the valuation systems of the human brain are relatively small and buried in deep parts of the brain (Knutson et al., 2006), inaccessible to surface recording techniques such as MEG, EEG or NIRS.

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The reverse inference problem

A central – but often neglected - concept in understanding neuromarketing research is the 'reverse inference' problem. Traditionally, neuroscience studies the brain areas 'associated' with a particular cognitive process. For example, it has been shown that the showing of faces on average evokes stronger activity in a region of the brain called the 'fusiform face area' (FFA) than the showing of other stimuli[1]. It is inferred that the FFA is involved in face processing. Key to the concept of neuromarketing is whether this finding can be *reversed:* when we see activity in the FFA, does this imply that the subject is seeing a face? This is not generally true. It turns out that the FFA is in fact activated by many other objects, and FFA activity in itself is only a weak indicator (Hanson & Schmidt 2011). The reverse inference of seeing a face from FFA activity is weak[2].

It is in solving this reverse inference problem that fMRI shows its real strength. In fMRI we simultaneously record the activity of about 40.000 voxels (3x3x3mm brain areas), and from the *pattern* of activity that is obtained reverse inference is possible. Faces turn out to evoke a pattern of activity in these voxels that is sufficiently unique to classify the presence or absence of faces with an accuracy of 100% (Hanson & Schmidt 2011). Successful reverse inference critically relies on this technique of pattern classification of fMRI data[3].

The Neurensics method

Neurensics has developed 13 fMRI 'mappers' for emotions that are important for consumer behavior (see figure 1). Using proprietary methods, we have extracted multi-voxel networks from the human brain from which the reverse inference of these emotions is possible, a process we call *mapping*. On the basis of these neural mappers, Neurensics developed its unique 3D Brain Rating™ technology to determine the appreciation of all sorts of marketing stimuli.

Mapping 13 emotions and 4 main categories of emotions

The 3D Brain Rating™ method allows us to trace the activation of brain dimensions – emotional and behavioral responses to marketing stimuli – that are related to buying behavior. After calibrating the brain dimensions using the neural mappers, the test subjects are exposed to the marketing stimuli. Consequently, we measure which of the areas become active when the subjects view a marketing stimulus (such as a commercial, product or packaging design) and to what intensity, whereby we can give a relative score of the effect of the marketing stimuli on the brain. The 13 dimensions are associated to emotions and behavioral intentions – both positive and negative, but also in relation to their relative impact and to what extent they activate a feeling of personal involvement and attraction to a given stimuli. More specifically, the 3D Brain Rating™ method measures 13 different emotions, classified in 4 main categories. Below you will find a description of these emotions and the behavioral responses that

[1] An often reported similar finding is the activation in the *insula* found for nauseating stimuli. The insula is also activated by images of loved ones. So insula activation can imply a variety of very different things, and cannot by itself be used to know whether a stimulus is nauseating or loved.

[2] Another example would be judging whether someone is male or female from body size. On average, men have smaller hips than women. But what is the gender of a person with hip circumference of 90 cm?

[3] Translated into the problem mentioned in note 2: we cannot reliably judge gender from hip size. Nor can we do so from breast or waist size alone. But when we combine these measures (so that they form a *pattern)* we can: when we find a person with sizes 90-60-90, there is a fair chance we are dealing with a female. In fMRI we can compare thousands of values.

these emotions may elicit. This classification serves as a guide in the interpretation of the results.

Positive Emotions (generally evoking or facilitating approach behavior)

Desire:	A feeling of wanting or longing (one's inclination to buy, pick up).
Lust:	A passionate or overwhelming (sexual) desire, strong and immediate approach.
Expectation:	The brain is in anticipation of a reward, active approach to seek the outcome.
Trust:	The brain trusts the shown stimulus, approach is more likely.

Negative Emotions (generally evoking avoidance behavior)

Danger:	The stimulus activates a strong avoidance response.
Disgust:	Activates a physical aversion, 'hurts' or nauseates, also loss (of money, a loved one etc)
Anger:	A strong negative arousal to respond with aggression.
Fear:	Distress related to the uncertainty of outcome (e.g., an unclear proposition).

Personal Appeal (generally strengthening the positive- negative emotional balance)

Value:	The stimulus is esteemed as directly rewarding
Involvement:	Also known as 'self-relevance'; the stimulus has personal relevance.
Familiarity:	To what extent does the consumer know the stimulus?

General Impact (generally strengthening all signals, evoking memory formation)

Novelty:	A sense of newness, or an element of surprise.
Attention:	The stimulus evoked (or requires) an engaged or alert viewer.

Plotting the 13 emotions

The strength of activation of these emotions is displayed in a diagram as scores between approximately 60 and 140 (figure 1). This is a standardized value comparable to the score used to express a person's IQ. A score of 100 is an average activation of the emotion; 115 means the activation is 1 standard deviation (SD) above the average (or the top 15,9% of all scores), 85 stands for 1 standard deviation below the mean (the lower 15.9% of all scores).

For moving/temporal stimuli (e.g., TV- or radio commercials, jingles) the score is an aggregate of the activation of the duration of the stimuli. Below is an example of the 13 emotions in response to a television commercial stimulus.

Figure 1.
3D Brain Rating™ of a TV commercial. The black line indicates an average brain activation response. A score above or below 100 for one of the emotions suggest above or below average activation.

To establish whether this activation will elicit a positive effect for one's product/service, we aggregate these results across the 4 main emotional categories (positive emotions, negative emotions, personal appeal, and general impact) (figure 2).

Finally, the results are calculated as a single point to establish the effectiveness of the stimulus (figure 3). The brain response to the different marketing stimuli will be measured and reported in this manner. Examples that are displayed below are for the same TV commercial stimulus as used above.

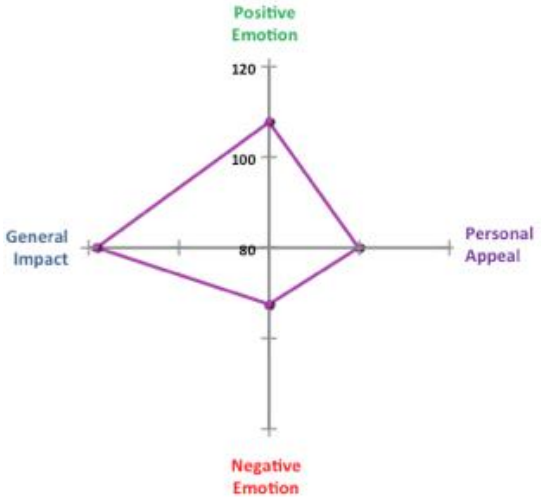

Figure 2.
3D Brain Rating™ of a stimulus aggregated across the 4 main categories of emotions.

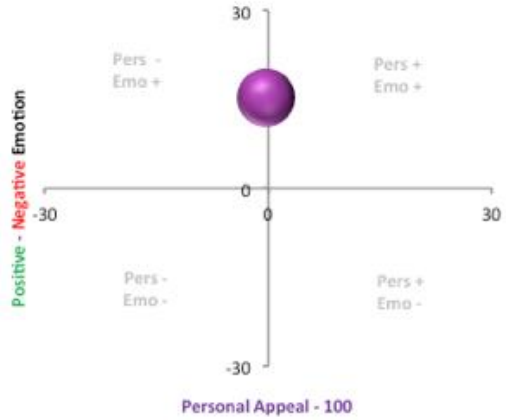

Figure 3.
3D Brain Rating™ of a stimulus showing its positive versus negative emotional balance and personal appeal relative to the mean of 100.

The diagram in figure 3 is based on the balance between positive and negative emotions, elicited by the stimulus (y-axis) and the amount of personal appeal it triggers (x-axis). The resultant graph displays 4 quadrants in which personal appeal is either high (Pers+) or low (Pers–), and the ratio of positive-to-negative emotions is either positive (Emo+) or negative (Emo–). Neuroscientific research has shown that a positive emotional ratio combined with high levels of personal appeal is a good predictor of behavioral change, or the 'buying intent'. Whereas the first graph (displaying the 13 emotions related to consumer behavior) shows the effect of the stimulus on the brain in detail, the above resemble to overall effectiveness of the stimulus.

Target Audience & Sampling

One of the unique features of neuroscience research is that with relatively few subjects reliable results can be obtained about the quality of a product, brand, advertisement, packaging design or sales promotion. This has a special reason: the measurement of a single brain of a subject from a particular group is representative for that group as a whole.

A study by Engell et al (2007) on the measurement of the reliability of faces demonstrated this. Participants were shown human faces that seemed more or less 'reliable'. Each subject had to rate these faces on reliability. With this, every face got an average 'reliability score'. Some faces were more reliable than others, for example face A had an average score of 7 and face B an average score of 3. Opinions nonetheless varied: where one subject scored face A with a 10, another participant scored the same face with a 4 (and face B received

a 6 and a 0). Simultaneously, the experienced reliability activated by the different faces was measured using an MRI scanner. This brought up a rather startling discovery: the reliability of a given face correlated with the *average* reliability of that face, not with the individual score awarded by the participant recorded from. It seems that verbal / explicit opinions are relatively 'noisy', and that differences in brain activations between subjects are much smaller than the variability in rating scores would suggest.

There are several other scientific studies that show that it is possible to predict the behavior of people with a relatively small sample size. Gregory Berns (2011) was able to predict the USA wide hit potential or flop rate of pop songs, after scanning just 32 subjects. In other words, Burns has shown that neuromarketing can predict the behavior of 300 million people (the U.S population) based on a very small sample size. In another publication Emily Falk (2012) predicted the effectiveness of anti-smoking campaigns by scanning the brain activation of only 30 smokers. Moreover, advertising experts and the research participants themselves could not accurately predict the effectiveness of these campaigns. We ourselves showed that one can predict National TV commercial success (effectiveness as gauged by Effie award winning) with 88% accuracy using the methods explained above (Lamme & Scholte 2013). Highly significant differences in TV commercial effectiveness can be obtained using ~20 subjects (figure 4).

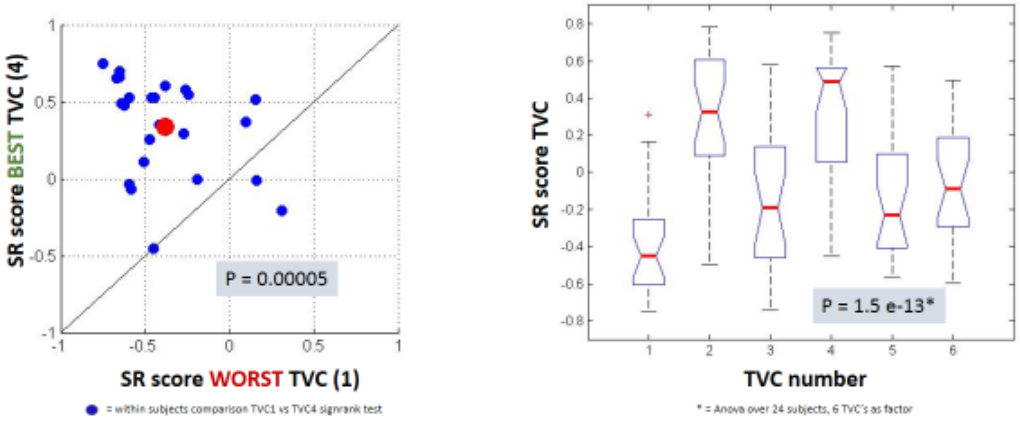

Figure 4: Highly significant Effectiveness Score (SR score) differences (Anova p = 1.5 e-15) between 6 TV commercials, recorded from 24 subjects (right panel). Note how almost all subjects have a higher SR score for the best versus the worst TV commercial (left panel).

We know from multiple previous published scientific studies that a target group of at least 15 subjects is sufficient for conducting MRI research. This also holds true for commercial research (Esomar, 2012). Neurensics adheres to these guidelines, and has therefore chosen for 24 subjects (*the average consumer*) in the Multi Client research. The average consumer is a man or woman, between the ages of 20 and 45 years old.

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