Applying Neuroscience to Understand Consumer Preferences*

By measuring the non-conscious consumer response to products, concepts and before/after results, it is possible to make decisions for product development and marketing, as well as develop product claims. These possibilities are discussed herein, as are two case studies.

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Neuroscience has become a hot topic in consumer research. The high failure rate of new market introductions—despite initial successful sensory and consumer tests, as is often seen in food development—necessitates the development of new approaches and methodologies.[1, 2] This might be due to a low predictive validity of traditional sensory and consumer tests, which include analytical profiling and liking tests. These tests require cognitive information processing and rational reasoning, whereas consumer behavior might be based more on unarticulated/unconscious motives and associations.

Neuroscience can help market researchers and product developers better understand their consumers as well as how their product is performing. Through measuring the non-conscious consumer response to products, concepts and before/after results, it is possible to make decisions for product development and marketing, as well as develop product claims.

Defining Neuroscience

First, it is important to clarify what using applied consumer neuroscience means. In the purest of definitions, neuroscience is the study of the nervous system.[3] It can be seen as a branch of biology or psychology, but is truly an interdisciplinary approach combining the fields of chemistry, computer science, engineering, linguistics, mathematics, medicine, genetics, philosophy and physics. Technologies and methodologies of neuroscience can range from molecular and cellular approaches, to brain imaging and behavioral analysis. Clearly, neuroscience is a broad field.

Applied consumer neuroscience, a term coined and defined by the present authors, can be described as a combination of neuroscientific, psychological and traditional market research methodologies to better understand consumer behavior and non-conscious interactions with products. The more popular evaluation methods include biometrics such as heart rate (HR) variability, galvanic skin response (GSR), facial electromyography (fEMG), etc., as well as functional magnetic resonance imaging (fMRI) of the brain.

However, the usefulness and validity of some technologies, specifically fMRI and electroencephalography (EEG), for consumer research is a topic of debate, as the results can depend on cost and variability in the quality of the technology. Psychological methods, such as implicit association, priming paradigms and state-and-trait batteries, can also be used to assess consumer responses and emotion.

The combined effect of all these factors on product choice is mediated by emotional responses. Frijda[4] distinguishes the following elements of emotions: *affect* or the hedonic pleasure of products; *appraisal* of products, in terms of good/bad or pleasant/unpleasant; *action-readiness*, i.e., whether or not the product is used/purchased; and *autonomic arousal*, reflecting the degree of motor preparation for the actions of using or purchasing a product.

Affect and appraisal typically are assessed explicitly via questionnaires. Action-readiness and autonomic arousal are often assessed implicitly, with physiological measures of the autonomic nervous system (ANS).[5]

More recently, it has been suggested that various aspects of stimuli are appraised sequentially,[6] whereby each type of appraisal is associated with specific physiological, expressive and motivational changes. Aue and colleagues[7] presented study participants with pictures that displayed biological and cultural threats or neutral stimuli, and demonstrated through EEG and facial muscle activity that relevance appraisal interestingly preceded goal-conduciveness appraisal. Similarly, Delplanque and colleagues,[8] using facial muscle and electrodermal activity with olfactory stimuli, demonstrated that novelty reactions preceded pleasantness reactions.

Psycho-physiological Responses

Charles Darwin theorized that emotions were biologically determined and universal to humans. Emotions are a complex state of feeling that result in physical and psychological changes and influence behavior. By measuring these physiological reactions to stimuli, researchers are able to better understand emotional and unconscious/non-cognitive responses underlying behavior.

In consumer research, it can be difficult to differentiate stimuli such as fragrance, color, texture and taste based on

standard liking and intensity scores alone. Frequently, two or more stimuli are equally liked and not significantly different from one another based on the liking and intensity scales. Therefore, it is important to understand the effects of product attributes beyond the traditional measures of hedonics and quantitative/qualitative testing.

Here, a holistic methodology[a] is described that combines traditional with psycho-physiological measures. It was developed to differentiate the liking and intensity of similarly liked stimuli, to allow researchers to determine product attribute appropriateness for fit-to-concept and higher order psychological benefits.

This approach provides a sensitive and efficient way to better understand consumer behavior and emotion, differentiate changes to product attributes and make more informed product design decisions.

In the present studies, the authors used a combination of biometrics including HR, GSR and fEMG; eye tracking; and psychological assessment. ANS and facial muscle responses to the stimuli were recorded. Responses were monitored continuously during stimulus exposures to allow for the testing of sequential appraisals.

Panel Study

Participants: Twenty-five adult female participants between the ages of 18-35 were recruited via an online ad. All participants signed an informed consent form and received incentive for their participation.

Questionnaire: Participants were asked to rate fragrances using the 7-point Likert scale for liking, intensity and appropriateness of the fragrances for a product concept. The product concept included an image of a product along with a description; e.g., "This lotion leaves skin feeling soft and fresh."

Priming: Participants were primed with target fragrances (n = 3), followed by a target concept (n = 1), then exposed to the combination of the target fragrance and concept in order to assess the effect of each alone and combined. The fragrances were all rated as highly liked, but differed in fragrance characteristics; e.g., different types of floral and powder notes.

Psycho-physiological measures: The positive, negative or control priming effect was measured by electrophysiological changes and eye tracking behavior. Assessments included fEMG for emotional valence, HRV for attention and GSR conductance for arousal.

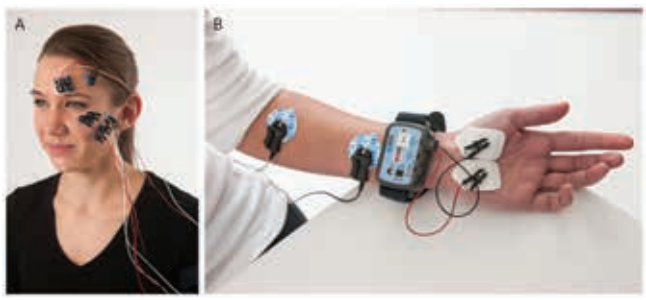
Procedure: The experimental sessions took place in a centrally located testing facility in New Jersey. The experiment leader explained the experiment to the participant, allowed time for questions and asked the participant to sign the informed consent form, after which the electrodes were placed (see **F-1**). Oral instructions were given by the experiment leader and displayed on a computer screen.

After instruction, participants were given a fragrance bottle to squeeze and sniff, followed by 10 sec of physiological measurements. This was followed by a prompt on the computer screen to answer survey questions on liking, intensity and appropriateness.

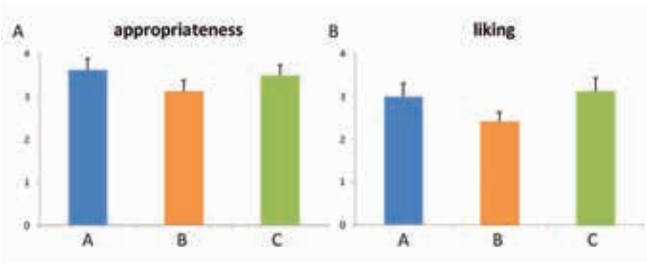
Following fragrance exposure, participants were shown the target concept on the computer screen for 10 sec of physiological measurements. This was again followed by a prompt on the computer screen to answer survey questions on liking and appropriateness.

Following concept exposure and survey, a combination of the target fragrance, introduced via squeeze sniff bottle, with the target concept was presented for 10 sec. Again, this was followed by a prompt on the computer screen to answer survey questions on liking, intensity and appropriateness.

F-1. Psycho-physiological electrode placements for fEMG, on two facial muscle groups (a) and for positive emotional detection (b)



F-2. Liking and appropriateness; no statistical differences were observed among fragrances A, B and C for either appropriateness (a) or liking (b)



Results

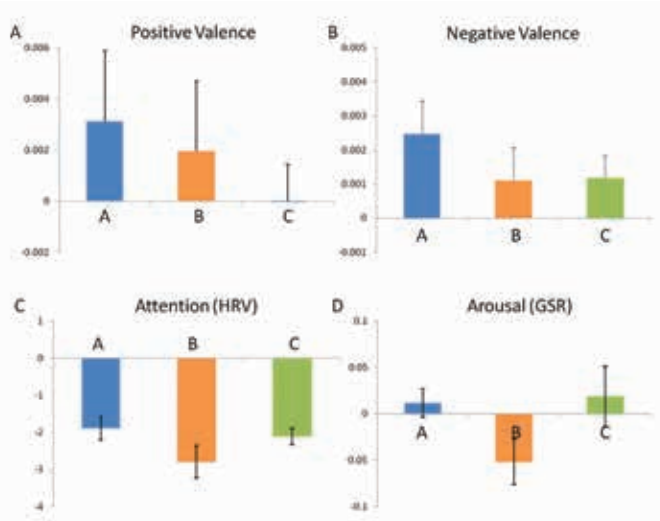
Hedonics and appropriateness for fragrance alone: Analyses showed no differences among the fragrances for appropriateness (see **F-2**).

Fragrance alone on psycho-physiological measures: The fragrances (A, B and C) had no significant effect on either positive or negative emotional feedback obtained by fEMG. Time-averaged means of positive valence fEMG to the fragrances alone showed no significant differences (see **F-3**). Participants felt slightly more positive with fragrance A, followed by B, but little positive emotional reaction to fragrance C. Time-averaged means of negative valence fEMG to the fragrances alone also showed no significant differences, and both fragrances A and B evoked a slightly positive emotional valence, while fragrance C remained neutral.

Further, the fragrances (A, B and C) had no significant effect on either attention (HRV) or arousal (GSR) measurements. Time-averaged means of attention (HRV) to the fragrances alone showed no significant differences (see **F-5**). Participants felt slightly more focused with fragrance B, but not significantly. Time-averaged means of arousal (GSR) to the fragrances alone

[a] Beyond Hedonics, HCD Research

F-3. Fragrance-only psycho-physiological results for fragrance A (blue), B (orange) and C (green)



also showed no significant differences (see **F-3**). Fragrance B was more relaxing, while fragrances A and C were more neutral in arousal.

Concept alone on psycho-physiological measures: The concept had no significant effect on either positive or negative emotion feedback obtained from fEMG for each fragrance group (A, B or C). Time-averaged means of positive valence fEMG to the concept alone showed no significant differences (see **F-4**). Participants felt slightly less positive with fragrance A and B, but little positive emotional reaction to fragrance C. Time-averaged means of negative valence fEMG to the concept alone also showed no significant differences. The concept drove decreases in negative emotion for all fragrance groups.

However, the concept elicited significantly different levels of attention (HRV) and arousal (GSR) measures among the different fragrance groups. Time-averaged means of attention (HRV) to the concept alone showed significant differences (see **F-4**). Participants in fragrance group A felt significantly less focused on the concept than fragrance groups B and C. Time-averaged means of arousal (GSR) to the concept alone showed no significant differences. Participants in fragrance group A felt more neutrally aroused, while fragrance groups B and C felt significantly more relaxed examining the concept alone.

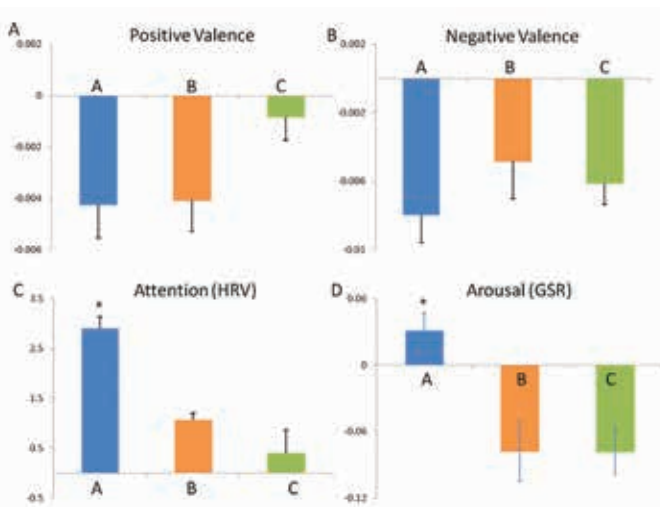
Concept + fragrance on psycho-physiological measures: The combination of the concept + fragrance had a significant effect on both positive and negative emotional feedback obtained from fEMG. Time-averaged means of positive feedback fEMG to the concept + fragrance showed significant differences (see **F-5**). Participants felt slightly more positive with the concept + fragrance C while fragrances A and B had little effect on positive emotional valence. In contrast, time-averaged means of negative valence fEMG to the concept alone showed no significant differences. The combination of the concept + fragrance drove increases in negative emotion for all fragrance groups, though significantly only for the concept + fragrance B.

The concept + fragrances also significantly affected levels of attention (HRV) and arousal (GSR) measures. Time-averaged means of attention (HRV) to the concept alone showed significant differences (see **F-5c**). All combinations of concept and fragrances, however, increased attention and focus; notably, the concept paired with fragrance B drove the most increase in attention and focus. Time-averaged means of arousal (GSR) to the concept + fragrances also showed significant differences. The concept + fragrance B was again significantly more arousing, and the concept + fragrance C was more relaxing.

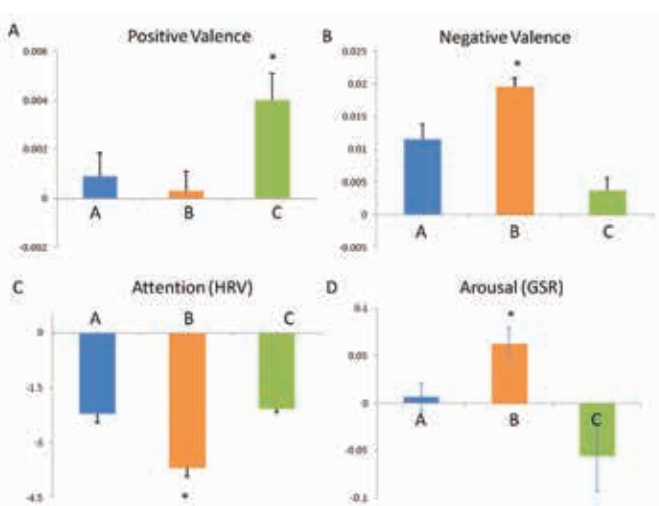
Discussion

Products are experienced via sensory systems including sight, smell, taste and touch. This experience forms impressions in the brain that affect mood and arousal levels while setting a context for the product. Product experiences can have distinct emotional messages that support brand and positioning,

F-4. Concept-only psycho-physiological results for fragrance A (blue), B (orange) and C (green); * indicates statistical significance ($p < 0.05$)



F-5. Concept + fragrance psycho-physiological results for fragrance A (blue), B (orange) and C (green); * indicates statistical significance ($p < 0.05$)



enabling differentiation of samples and product attributes within a product category based on liking, intensity and appropriateness. Creating an experience based on mood, arousal and context is therefore key to product development success.

As is shown here, the new methodology described differentiates the liking/intensity of similarly liked stimuli by combining traditional with psycho-physiological. This approach captures the emotional message of products that is not detected by traditional measures.

Participants reported liking fragrance B the most of the three fragrances presented, although fragrance A, as a fragrance alone, had a positive effect on emotion. However, when the concept was "primed" with fragrance A, this decreased the effect. So while fragrance A was a liked fragrance, it may not have been suitable fit for the concept/product.

Fragrance B, as a fragrance alone, was a liked fragrance and had a positive effect on emotion, was relaxing and increased attention. However, when the concept was "primed" with fragrance B, it decreased this effect on emotion while still driving attention. When paired with the concept, fragrance B increased negative emotion—possibly as a sign of "novelty" or "incongruence"—while increasing arousal and increasing attention toward the product. Fragrance B may have been novel and therefore not initially recognized for the concept. However, it did draw attention/focus and increase arousal to the concept.

Fragrance C did not have a strong effect emotionally or physiologically alone. However, when the concept was "primed" with fragrance C, it did drive attention up. When paired with the concept, fragrance C increased positive emotions while decreasing arousal. Fragrance C may have been the most recognizable and familiar to the participants, and thus a comfortable match for the product.

In this study, the fragrance was presented first, then the concept, followed by the combination of the fragrance + concept. However, it may be interesting, depending on the goals of the development team, to investigate a different order of effects on the holistic experience; for example, had the concept been tested first, then the fragrance, then the combination. This reversed order may result in different priming effects.

Conclusions

This study successfully differentiated stimuli based on psycho-physiological measures for liking and intensity, as well as assessed attribute appropriateness for fit to concept. This novel methodology provides a sensitive and efficient way to differentiate changes to product attributes.

In a larger view, it is clear how understanding consumer needs for products can help to build better products—i.e., a top-down as opposed to a bottom-up approach. If researchers start by understanding the consumer using qualitative and quantitative research, along with applied consumer neuroscience, a real story into the drivers of behavior and liking of consumer products can be built.

The avenues for applying neuroscience in product research are countless. The over-arching theme is that by starting with the question, i.e., what the researcher wants to know about a product, communication or the consumer, then a proper study can be designed to answer that question in a way that is useful and actionable to business needs.

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