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WHAT CAN TOBACCO ADDICTION TEACH US ABOUT CONSUMER DECISION MAKING?

CONSUMER BEHAVIOR, HEDONIC FORECAST AND REWARD

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INTRODUCTION

The decision making process involves biological, cultural and social variables which converge in the brain (Lee, 2008). Recent developments have shed new light on the relationship between economics and psychology and thus on how we decide and select products, brands and why and how our expectations shift (Gigerenzer, 2008). These new developments explain why in some scenarios the effect of products and campaigns is weaker than was predicted by market research.

Understanding the role of uncertainty, time limitations during decisions, and consumers' proficiency at handling excess or limited information is crucial in explaining, firstly, the weak predictability of research methods regarding consumer behavior in some contexts, and secondly that the path to understand consumer decisions is deeply rooted in brain function. All in all, there are still aspects that are not being considered and neuromarketing has created a partial explanation regarding how emotion, attention and memory are interconnected and related to decision making processes.

Addiction research has addressed key points that should be taken into account when studying and understanding consumer behavior. One point is that error is a fundamental component in reward and reinforcement, since it provides contrast between failure and success; and this system is being modified in the brain of the chronic drug consumer. This also leads to an alteration of how hedonic (pleasure) forecast mechanisms interpret sensory information and past experience (Kringelbach, 2005).

Tobacco addiction, which is mainly produced by nicotine, generates neuroadaptations in key systems which constitute the core of reward, reinforcement and hedonic forecast (Haber and Knutson, 2010). These brain areas are also structurally and functionally related to emotional systems and anxiety (Lowry, Johnson, Hay-Schmidt, Mikkelsen and Shekhar, 2005), suggesting that research on addiction provides insights as to how consumers respond to products and services, while experiencing different emotions and affective states as well as under different levels of anxiety.

Alterations in reward systems modify either the perceived effect that a stimulus will generate or the magnitude of the reinforcement affecting information processing. This can be caused by addiction, but also via emotion and anxiety (Raghunathan and Pham, 1999), reducing or increasing the propensity to take action or make decisions. It points out new ways to approach consumer behavior, enhance brand value and product placement, and ultimately increase return of investment (ROI).

We seek to establish if there are changes in information processing in the brain of chronic consumers of tobacco and non-consumers while being exposed to anti-tobacco advertising. This allows us to develop a model that facilitates the understanding of how hedonic forecasting, reward and anxiety modulate information processing and consumer decision making. For this purpose we developed a two stage study using various physiological and behavioral measures.

REWARD SYSTEMS

Reward systems are linked to several cognitive and behavioral processes. Reward comprises the actual pleasure either with or without awareness (Berridge and Kringelbach, 2008) and can be modified by cognitive control (attention), motivation to seek pleasure and hedonic forecasting. This means that the consumer's experience includes conscious and non-conscious components that influence future purchase behavior as well as brand positioning.

Versatile environments (e.g. consuming environment) require the ability to behave and decide quickly. This ability is related to reward value of environmental stimuli, which may help defining choices (Navalpakkam, Koch, Rangel and Perona, 2010). Levy, Lazzaro, Rutledge and Glimcher (2011) carried out a study in which they showed that automatic estimations of reward and valuation representations may take place even in the absence of active choices. In particular, they showed that

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the activation of two areas involved in the reward systems, the striatum and medial prefrontal cortex, can predict later choice.

Consumers' choices can happen in a very fast and automatic manner; however choices and decisions are not solely based on automatic processes. They also involve higher executive processes for decision making related to the prefrontal and cigulate cortex (Rushworth and Behrens, 2008). Plassmann, O'Doherty, Shiv and Rangel (2008), for example, provided evidence for the relation between the reward systems and the perceived pleasantness regarding products and showed that pleasantness can be modulated by marketing actions such as pricing and the subjective value it implies.

Moreover, as Ariely and Burns (2010) point out, the expected pleasure generated by a product or service as well as the overall experience influences the consumer's perception of pricing and quality. Recent studies have shown that consumers' experiences caused by advertising, price offers, status images, or faces (Hubert and Kenning, 2008); attractive packaging (Stoll, Beacke and Kenning, 2008) and attractive products (Lin, Tuan, Chiu, 2010) can activate reward systems. Altogether, reward systems seem to be involved in consumers' experience and behavior.

DECISION MAKING

Neuroscience research has provided empirical evidence about many assumptions that previously were unclear regarding the decision making process (Camerer, Loewenstein and Prelec, 2005). While the frontal cortex (mainly orbitofrontal) has been regarded as the center for decision processes, emotion, memory and reward also participate in weighting decisions (Bechara, Damasio and Damasio, 2000; Brand, Heinze, Labudda, Markowitsch, 2008).

However, only recently has the brain been taken into account to understand and predict consumer behavior. There are social, chemical and sensory cues that are processed by our nervous system that enhance or diminish the consumer's experience. Decision making, then, is a complex process that is linked to brain structures involved in memory retrieval and formation, emotion and motivation, attention, reward and forecasting.

Recent research (Hikosaka and Isoda, 2010; Martin and Morich, 2011), has shown that consumers deploy automatic and irrational behaviors on a daily basis, broadening the scope of research practices in neuroscience, marketing, psychology and economics. This implies that decision making in, for example, brand preference, sensory evaluation of products and services, as well as brand choice and loyalty, involve conscious and non-conscious information processing.

Furthermore, there are numerous variables that influence decision making that have not been taken into account in predictive models. For example, uncertainty, time limitation and information handling should be included in these models. Uncertainty can be caused by the inability to predict future choices, when the circumstances require quick action or have time restrictions (Gigerenzer, 2011).

Consumers' perception of time, evaluation of sensory information, memory retrieval and emotional state affect the level of uncertainty, which in turn influences product selection. This suggests the inherent relation between decision making, affective systems, and anxiety, and could explain a significant portion of consumer behavior variability. The inclusion of these aspects in the study of consumer behavior could increase ROI and enhance the predictive capacity of market research.

EMOTION AND ANXIETY

As Sanfey, Rilling, Aronson, Nystrom and Cohen (2003) point out, the importance of emotion in the decision making process continues to grow as the fields of economics and neuroscience interact. Another key component in decision making is anxiety, which together with emotion, comprises a system that provides relevant information for decisions. Anxiety can highlight different goals, details and characteristics of a situation or product and increase or reduce their importance.

Research done by Raghunathan and Pham (1999) have shown that negative affect, particularly sadness, biases decisions, making people prone to high risk and high reward options; while anxiety increases bias in favor of low risk and low reward options. This suggests that consumer's decisions are altered by affective states and anxiety, which change the saliency of products and brands according to their perceived attributes and benefits. This process includes both a conscious and non-conscious component (Martin and Morich, 2011) and explains why consumers might not include, when verbalizing, all the information necessary to predict how consumption of products or services will take place.

REWARD SYSTEMS, DECISION MAKING AND TOBACCO ADDICTION

Evaluation of reward implies emotion (Zak, 2004), suggesting that hedonic forecasting includes an affective dimension. This is consistent with research performed by Raghunathan, Pham and Corfman (2006) who understand affect and

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anxiety as information. This indicates that reward and decision making systems influence each other and that emotion and anxiety, regarded as information, are involved in both. In synthesis, emotion and anxiety lie at the center of reward and decision making; their understanding sheds light on how and why the choices (decisions) consumers perform change and what influences these changes (reward).

As Volkow, Baler and Goldstein (2011) point out, addiction hijacks brain circuits involved in cognitive control, reward and social behavior. These systems are implicated in motivation, emotion and memory; their alteration is responsible for maintaining the consumption of a drug by changing cognitive control and value. It is likely that the exacerbation in anxiety and negative affect caused by withdrawal increases the propensity to seek and consume nicotine (Koob, 2009) since it will reduce uncertainty and increase reward at the same time.

In synthesis, addiction modifies the same systems that are used in decision making and product selection (Bechara, 2003), moreover transient changes in emotional state and anxiety during consumption can be studied by understanding the different phases that the chronic drug consumer undergoes and how decisions and choices change during these stages. This raises the question of whether intense or fast changes in anxiety and emotion can temporally hijack brain circuits, in a way similar to that of the drug addict.

In both market and addiction research these topics are of great importance due to its impact on decision making.

METHOD

Participants

During the first stage of the study a data base comprised of students from five different universities of Bogotá, Colombia, was set up. Forty participants aged 18 to 30 years (mean = 21 years, 50% = men) were selected; seven participants were discarded because they did not meet the selection criteria of not having smoked two hours before the study. Initially they were asked if they had ever smoked, if they continued and the number of cigarettes that they had consumed during their life span. The World Health Organization (WHO) criterion for chronic smoking was taken into account, which states that a person is a chronic consumer after having smoked 100 or more cigarettes during his life. The participants were divided in addicts - chronic smokers (n = 15) and non addicts - non-smokers (n = 18).

During the second stage, Twitter and Facebook were used to invite people to participate in the study. The selection criteria were the same as in the previous stage and the age range was maintained. The first 30 participants that met the criteria for the study were selected (mean = 25 years, 73.33% = women) and where divided evenly into two groups using the same standard as in the first stage of the study (chronic smokers = 15, non-smokers = 15).

Instruments

Twenty images, which included non-traditional and traditional anti-tobacco advertising, were collected.

Non-traditional anti-tobacco images consist of creative concepts that display a high range of colors, and show a variety of elements, for example, dry fruits, ashes and broken cigarettes. The traditional anti-tobacco images consist of red, white and black colors, and include crossed out cigarettes, “no smoking” ads and organs affected by smoking.

The Facial Action Coding System (FACS) allows recognizing and measuring facial action units (AUs) which are transitory changes generated by facial muscles. Forty-two AUs can be identified using this system and can be used to measure emotional expression via facial muscles (Ekman and Friesen, 1978). Facial microexpressions of emotion are motor responses that last between 1/20th and 1/5th of a second.

Electroencephalography (EEG) technology allows the measurement of brain activity; by using mathematical analysis it is possible to quantify and classify the signal produced by neurons at different frequencies. A 14-electrode Emotiv Epoc EEG was used. Following the International 10-20 locations, the signal of AF3, F7, F3, FC5, FC6, F4, F8, AF4 was processed using Burg’s structural analysis of power, which allows to perform a spectral analysis of the brain’s electrical activity in the frontal cortex. Particularly, alpha band power (8-13 Hz) was measured since evidence suggests that it is a reliable indicator of motivational and emotional processing (Coan and Allen, 2004).

A Tobii X120 Eye tracker was used to assess the motion path and position of the eyes on the screen, as well as the mean time on each area of the screen, the number of fixations and observations, and the global oculomotor behavior, which was used to assess attentional shifts. The Tobii studio 2.2 software was used to present the stimuli and record facial expression and oculomotor behavior.

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Procedure

All procedures, data collection and research designs were carried out in accordance with the APA's code of conduct, the ICC/ESOMAR International Code on Market and Social Research, as well as local legislation. All participants signed an informed consent.

Images were carefully selected and compiled randomly in three videos; each image was followed by a geometric figure with the intention of minimizing the emotional impact between stimuli. The videos were edited using Adobe Premier CS4.

During the first stage of the study, participants were recruited by phone and directly at the universities' campuses following the selection criteria. Once selected, each participant signed an informed consent and completed a demographic survey. The test was carried out in a quiet room with standard illumination and sound conditions. Each participant was seated 30cm from the screen, camera and the Emotiv Epoc EEG receptor; the EEG was set up following the International 10-20 position and synchronized with the Emotiv Test Bench v1.5.0.3 software. After that, instructions were given, participants were told not to restrain from moving and keep their hands on a table located in front of them; the procedure was explained and one of the three videos was presented.

The second stage of the study followed a similar procedure. Participants were recruited, signed an informed consent and completed the demographic survey. The test was carried out in a quiet room with standard illumination and sound conditions. Each participant was seated 30 cm from the X120 Tobii eye tracker and screen. The eye tracker was synchronized with the Tobii studio 2.2 software. The same instructions were given and images were randomly presented.

Data analysis

The Kolmogorov-Smirnov and Kruskal Wallis tests were used to discard differences related to age and gender. EEG recordings were analyzed using MatLab R2008b Software; Burg method was used to perform a spectral analysis and quantify frontal lobe alpha power. SPSS Statistics v17.0 was used for statistical analysis. A paired sample t-test was used to compare intragroup right and left frontal activity of smokers and non-smokers and an independent t-test was used for inter group comparisons.

Facial expressions' recordings were given to three trained researchers, who analyzed the participants' AUs without knowing which group they belonged to. A Pearson correlation was carried out to measure inter rater reliability ($r = 0.83$). Facial micro expressions were assessed according to their valence (neutral, positive and negative) and frequency. T-tests for independent samples and ANOVAs were used to analyze micro expressions frequencies. For eye tracking data, t-tests for independent samples were used to establish differences between groups regarding number and duration of fixations.

RESULTS

A normal distribution was found when age and gender were compared in both groups. EEG analysis showed changes in the alpha activity of the prefrontal cortex in smokers and non-smokers. Smokers presented higher alpha power in the right frontal lobe while non-smokers showed higher alpha power in the left frontal lobe. Significant differences were found between groups ($t(31)=29$, $p<0.001$) and within groups (non-smokers $t(17)=29$, $p<0.001$; smokers $t(16)=29$, $p<0.001$).

FACS analysis showed no differences between smokers and non-smokers, suggesting that emotional impact is similar in both groups; non emotional AUs were more frequent, followed by negative AUs. Facial expressions of emotion included contempt, disgust, scorn, joy and surprise. There were no differences between the impact produced by traditional and non-traditional advertisings.

The Kolmogorov-Smirnov and Kruskal Wallis tests suggest an even distribution in the data for age and gender.

EEG

EEG activity of the frontal cortex of smokers and non-smokers is presented in table 1.

TABLE 1, ALPHA BAND POWER TAKEN FROM BILATERAL FRONTAL AND FRONTAL-CENTRAL ELECTRODES IN SMOKERS AND NON SMOKERS

	Alpha (8-13Hz)	
Group/Alpha band power	**Left (dB)**	**Right (dB)**
Non Smokers	57.74	33.12
Smokers	78.16	613.2

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Structural analysis of power suggests that the left frontal lobe alpha power of non-smokers is higher than the right frontal lobe activity of the same group. The t-test for independent samples indicates that there is a significant difference between both left and right lobes $t(17)=29$, $p<0.001$; results showed a great effect size ($r=0.99$). Significant differences, $t(16)=29$, $p<0.001$,were also found in the activity of the smokers and non-smokers' frontal lobes, which also showed a great effect size ($r=0.99$). The right frontal lobe presented a higher alpha power.

Data of frontal activity of smokers and non-smokers showed significant differences in the alpha band in both lobes, $t(31)=29$, $p<0.001$, and a great effect size ($r=0.98$), for both groups. Together, these results suggest that smokers and non-smokers process anti-tobacco advertising in a different way.

FACS

Positive, negative and neutral facial configurations were identified which included joy, surprise, contempt, disgust and scorn. Below, frequencies and means are presented. T-test and ANOVA were used and no significant results were found between groups. (See table 2.)

TABLE 2, FACIAL EXPRESSIONS FREQUENCIES AND MEANS

	Code	N	Mean	Standard deviation
Positive	Smokers	15	.80	1.01
	Non-smokers	14	.86	.99
Negative	Smokers	15	6.07	3.47
	Non-smokers	14	5.88	4.94
Neutral	Smokers	15	12.87	3.96
	Non-smokers	14	13.13	4.82

Similar results of facial micro expressions were found in both groups. Results showed a high frequency of neutral, followed by negative (medium) and positive (low) facial configurations. Generally, means suggest that smokers produced more micro expressions compared to non-smokers. There is a prevalence of neutral expressions in both groups. (See table 3.)

TABLE 3, FACIAL MICRO EXPRESSIONS MEANS OF SMOKERS AND NON SMOKERS GENERATED BY TRADITIONAL AND NONTRADITIONAL ADVERTISING

	Code	N	Mean	Standard deviation
Non-traditional Positive	Smokers	15	.60	.91
	Non-smokers	14	.38	.53
Non-traditional Negative	Smokers	15	3.20	1.66
	Non-smokers	14	2	1.77
Non-traditional Neutral	Smokers	15	6	2.27
	Non-smokers	14	7.63	1.92
Traditional Positive	Smokers	15	.20	.41
	Non-smokers	14	.50	.53
Traditional Negative	Smokers	15	2.73	1.79
	Non-smokers	14	2.63	1.77
Traditional Neutral	Smokers	15	7	1.69
	Non-smokers	14	6.75	1.98

Facial micro expressions produced by traditional and non-traditional advertising showed no differences in both groups. Standard deviations and means suggest a low data variability and homogeneity. Muscle configurations are similar in smokers and non-smokers.

Eye tracking

No significant results were found between smokers and non-smokers in overall fixations number and fixation duration on non-traditional anti-tobacco advertising. No significant results were found in overall fixation duration on traditional anti-tobacco advertising; however, significant results were found in overall number of fixations in three of the traditional images. The first image has a crossed out cigarette with a "no smoking" text ($t(28)=0.13$, $p<0.001$), the second shows a bent cigarette suggesting impotence and a crossed out cigarette ($t(28)=2,772$, $p<0.01$) and the third shows a raised crossed out cigarette ($t(28)=-3,944$, $p<0.001$).

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Further analysis was carried out taking into account functional areas (visual components that communicate the anti-tobacco message) and non-functional areas. Significant differences were found in fixation duration between smokers and non-smokers on the functional areas of one non-traditional image showing a toothpaste and a toothbrush with ashes ($t(28)=-4{,}791$, $p<0.001$). No significant differences were found between smokers and non-smokers in the number and duration of fixations on non-functional areas.

DISCUSSION

Data showed relatively greater right and left frontal alpha power in smokers and non-smokers respectively. Alpha power has been inversely correlated to cortical activity. Consequently the chronic smoker group presented higher left frontal activity, suggesting that while being exposed to anti-tobacco advertising, information processing can be related with approach and seeking behaviors, as well as to positive valence emotions (Coan and Allen, 2004). In the non-smoker group there was relatively greater right frontal EEG activity, which corresponds to negative valence emotions; its connection with avoidance and withdrawal behaviors is still inconclusive (Coan and Allen, 2004).

EEG asymmetry presented significant intra and inter group differences as well as a large effect size. This suggests that information processing in the chronic smoker and non-smoker groups presents differences and could account for some of the behavioral patterns of addicts during abstinence and withdrawal.

Based on research done by (Mansvelder, Mertz and Role, 2009) the differences found could be caused by neuroadaptations that affect the way neurons communicate and process information, caused by long-term potentiation and synaptic plasticity. The main systems that are affected by chronic nicotine consumption are the meso-limbic and meso-cortical circuits, the amygdala, the hippocampus and the prefrontal cortex. These pathways and systems are involved in reward, decision making, hedonic forecasting, stimulus saliency, emotional valence, and anxiety.

Loewenstein and Lerner (2003) suggest that emotions strongly influence decision making. Particularly, they consider two ways in which this happens; firstly, through immediate emotions and secondly through expected emotions. Impact is modulated by various components of emotion including valence, intensity, duration and particular emotion or category (Wilson and Gilbert, 2003). For example, there is evidence showing that positive affect may change perceived risk and benefits; positive affect may reduce risk and increase benefit perception while negative affect may do the opposite (Slovic, Peters, Finucane and MacGregor, 2005). Consequently experiencing positive affect while being exposed to anti-tobacco advertising may cause a reduced risk perception in addicts even when they acknowledge the physical and psychological risks of consuming tobacco. Experiencing negative emotions while being exposed to anti-tobacco advertising can bias addicts into avoiding risk. However, research has shown that discrete emotions may have a differential influence on decision making (Angie, Connelly, Waples and Kligyte, 2011) and addiction may influence the underlying systems. Research is needed, though, to broaden knowledge and create predictive models regarding the particular influence of discrete emotions on decision making.

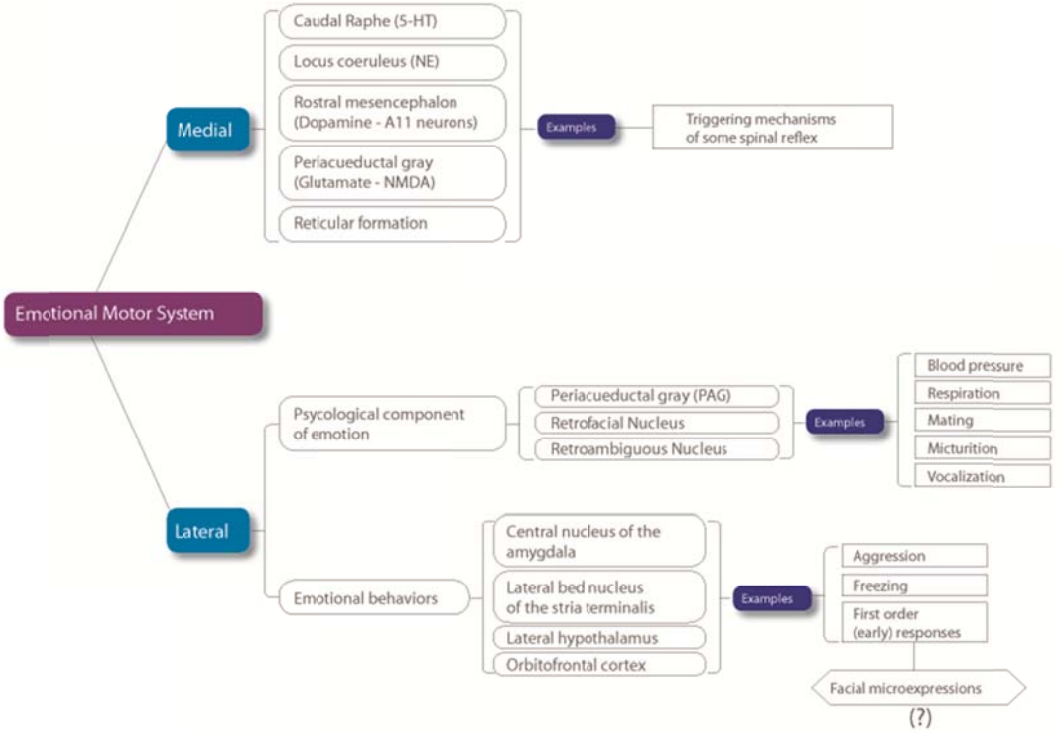
The predominant emotions elicited by participants, in both groups, were contempt, disgust and scorn, which are associated with rejection in this particular context (Dalgleish and Power, 2000). We found high consistency between EEG activity and facial microexpressions in the non-smoker group. Frontal asymmetry in the chronic tobacco group appears at first glance contradictory with FACS coding data; however the emotional information provided by the EEG and facial microexpressions is not governed by the same circuits and possess important temporal differences that could account for the disparity in the data.

The basal forebrain functions as a relay center between the prefrontal cortex and subcortical areas (Alheid, 2003). Therefore EEG frontal activity reflects the process of integrating information from different neural structures and circuits involved in emotion, motivation, anxiety, moral judgment, reward and hedonic forecasting. In this way, the differences found in alpha power between groups indicate that smokers and non-smokers are valuing and integrating the available information in a different way while being exposed to anti-tobacco advertising.

Facial microexpressions, on the other hand, are early emotional responses and provide feedback to the frontal cortex similar to other emotional responses in which the amygdala is involved (Holstege, Bandler and Saper, 1996; Carmona, Holland and Harrison, 2009). Although the neural circuits involved in the production of microexpressions are still unclear, it is very likely that the emotional motor system is involved (Holstege and Bandler, 1996; Holstege, 2009; Holstege, 2010) which would indicate that facial microexpressions are being deployed during or before cortical integration takes places. (See figure 1.)

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FIGURE 1, THE EMOTIONAL MOTOR SYSTEM ACCORDING TO DATA REPORTED BY HOLSTEGE (2010)



For this reason the neuroadaptations caused by chronic tobacco consumption do not alter the valence or type of emotion of the facial microexpression. Since data shows negative valence microexpressions in the chronic smoker group, the addict's brain can acknowledge the risk of consuming tobacco. This early appraisal is then modified in the frontal cortex and the end result is a cognitive reappraisal of the situation that could favor tobacco consumption. This would explain the discrepancy found in the data and raises questions about which dimension of consumer behavior and decision making are facial microexpressions measuring and predicting. It is also of interest to determine how and if brain enhancing and altering drugs influence consumer behavior.

Recent studies have suggested that smokers are biased in their visual orientation to smoking-related cues (Mogg, Bradly, Field and De Houwer, 2003), however, our eye tracking data shows that chronic smokers and non-smokers had similar exploration and fixation patterns on anti-smoking-related cues and may indicate that addicts are not employing bottom-up modulation to regulate emotion and anxiety. Rather they employ top-down regulation and reappraise sensory cues altering the value of the information (Beck and Kastner, 2008).

Traditionally, the neurobiology of addiction has not been regarded as part of anti-tobacco advertising design and implementation. The success in the mass reduction of tobacco consumption can be attributed to punitive rather than to preventive measures (Samet and Wipfli, 2010). Advertising, then, has been directed to a general public and has left aside several fundamental aspects of the addicts' brain, for example, specific neural and psychological processes. Addiction biases information processing and affects cognitive regulation (Laux, 2000; Bernheim and Rangel, 2004).

As the research data shows, addiction research provides insights into neural and behavioral process involved in decision making and consumer behavior. It is of key importance to include anxiety, emotion, reward, hedonic forecasting and uncertainty as part of the decision making process since it will allow for more robust models to predict consumer behavior.

Mogg and Bradley (1999) show that anxiety biases selective attention, increasing the importance of threat stimuli in a process known as preattentive vigilance (prior awareness or preparation). This seems to be a form of anticipation, a prediction, which would be associated with forecasting and backcasting (Ebert, Gilbert and Wilson, 2009).

Mogg and Bradley (1999) also suggest that the brain employs an affective decision mechanism (ADM) to assess threat value; its main purpose is to weight stimuli and determine how threatening they are. A task demand unit (TDU) determines how processing resources will be distributed. This is dependent on the ADM, since it will signal the threat value of a stimulus and cue the TDU to allocate resources accordingly. In consumer behavior threat can be seen as a risk evaluation

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during purchase, for example when the consumer weights quality, price and functionality and contrasts this with needs and available resources. Consumers with high anxiety will increase attention on threat or risk related signals (e.g. price).

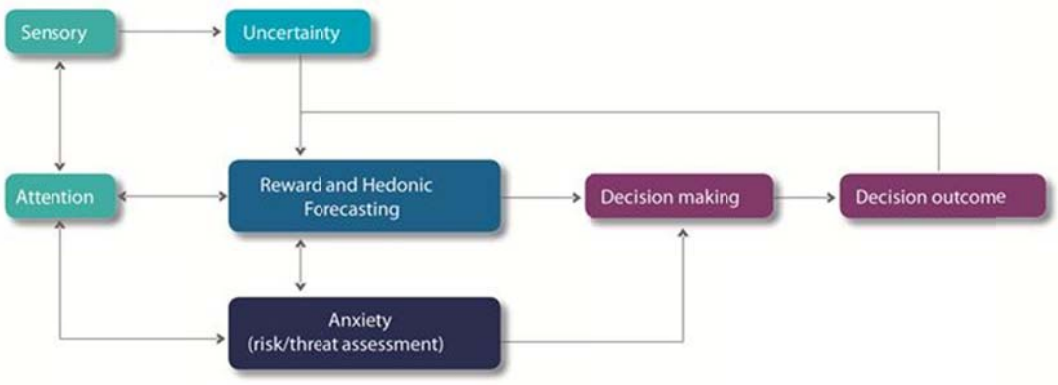
When individuals that are more likely to become anxious are stressed they are prone to increase vigilance to threat, while people who are less likely to become anxious increase avoidance to threat during high stress scenarios (White, Ratcliff, Vasey and McKoon, 2010). During product exploration and selection, information that implies risk or threat can be filtered by attention or cognitive control and can have higher or lower saliency. This implies that pricing, product benefits, interaction with sales representatives and sensory information might not have the same impact on the consumer, depending on its anxiety and stress level. When anxiety is low, differences in consumer decision making might not be apparent but as anxiety rises, threat response behavior patterns appear.

Another key component in the impact anxiety has on the consumer is emotional regulation. The strategies employed to reduce anxiety and negative emotions participate in understanding how the consumer controls information and environmental restrictions (e.g. time, budget, product availability, product congruency to needs). This also collaborates in determining how proficient the consumer is in omitting information (Gigerenzer and Brighton, 2009) and making choices.

First time experiences weight more in the brain (Weierich, Wright, Negreira, Dickerson and Barret, 2009). Therefore if the consumer perceives that it was a bad judgment to buy a particular product it will negatively affect reward mechanisms and mark that particular decision as an error. First time experiences are a key issue in brand positioning, and understanding the relationship between reward, forecasting and error can clarify how the consumer values brands, products and experiences.

It is important to understand that error judgment involves past experiences and is not an objective process. The employment of qualitative research methods as well as physiological and behavioral measures can be of great help to offer empirical evidence for clients. Non-verbal behavior and voice analysis combined with ethnographic surveys could be an effective mixed method to understand this triad in context (reward, forecasting and error). The employment of eye tracking and EEG can be used as reliable pre testing methods to ensure that these aspects are taken into account. Taking the latter into consideration, we developed a model that explains the interaction between the different brain systems and cognitive processes discussed in light of their importance in consumer behavior. (See figure 2.)

FIGURE 2, SHORT VERSION OF THE VELSAL MODEL DEVELOPED BY THE AUTHORS BY UNDERSTANDING THE RESPONSES OF CHRONIC TOBACCO CONSUMERS AND NON-CONSUMERS TO ANTI TOBACCO ADVERTISEMENTS



Sensory cues can modulate attention, showing that packaging (e.g. size, shape, color and sound), shelf distribution, noise and music, facial expressions and spatial organization can alter information processing in the brain. Evaluation of uncertainty is context based and can be understood as a lack of sufficient information for the evaluation of the amount of pleasure (reward) that the decision will bring. Restrictions (e.g. time, product availability) contribute to uncertainty.

Attention is a gateway; a selection, filtering, and structuring system that enables the consumer to organize and integrate information. It can alter sensory processing, change exploration patterns and saliency altering the perception the consumer has about products and services. Understanding the link between attention and sensory systems is a key aspect to develop strategies that increase research reliability and ROI. The development of sensory cues that effectively catch and modulate attention can increase brand value and positioning.

As neurons interact and communicate, different neural structures and circuits combine external (sensory) information with memories and conditioned responses. This process of "information sharing" enables the brain to process the same

information with different results and purposes. While hedonic forecasting determines the expected pleasure, reward systems determine the actual pleasure that a stimulus will produce.

The contrast between the predicted and the experienced pleasure determines if a particular strategy or choice was effective. Hedonic forecasting and reward are key component in evaluating sensory error; they are biased when anxiety levels are high. These systems are not only involved in decision making, but also in how we store memories.

In this sense, the outcome of a decision provides the necessary contrast between expectation and experience and will determine the margin of error between forecast and reward; this tuning process happens throughout consumers' experiences and praises the importance of packaging which reduces the distance between forecast and reward. It also shows the relevance of testing the brain responses to odors, flavors and colors and their congruency with packaging, brand communication strategy and consumer expectations.

Reward and hedonic forecasting systems together with anxiety can reallocate attentional resources that change the saliency of stimuli and contextual cues. If a particular product was highly rewarding, uncertainty and anxiety will be low and forecasting will be high; the challenge of quality products is to maintain an adequate balance between expected reward and actual reward.

Anxiety is not an actual system, but the response of defense mechanisms and risk/threat assessment systems. Anxiety highlights aspects that might pose a risk during the decision process increasing attention. Depending on emotion regulation strategies employed by the consumer, attention towards risk cues could increase or conscious avoidance can occur as an attempt to reduce discomfort and negative feelings.

After the consumers makes a decision, the brain will weigh the outcome and impact mainly reward and forecasting and through them the rest of the system. This explains the difference between frequent purchase and brand loyalty. Loyalty requires a reduction in uncertainty via outcome feedback as well as a sustained high forecasting and reward, that is, a narrow gap between expected and experienced pleasure. Frequent purchase requires only low uncertainty and allows a bigger margin between forecasting and reward.

Measuring the gap between forecasting and reward could be an effective predictor of ROI since the comprehension of these systems can provide knowledge on how to enhance consumer experience and welfare during consumption, increasing the perceived and real benefits of products and services. These systems are at the heart of decision making, enabling the consumer to make judgments about pleasure, effectiveness and congruence with necessities and expectations. Therefore performing market research with reward and forecasting in mind can lead to strategies that increase purchase probability, brand positioning, consumer behavior towards the targeted products and services and as a result, an increase in ROI. The message behind reward and hedonic forecasting is that to increase ROI it is important to enhance consumers' experience and welfare using sensory design and contexts that reduce anxiety, enabling long term returns and increasing brand loyalty and value.

Research on the relationship between reward systems and ROI needs more data; studies relating hedonic enjoyment and purchase using mixed models can increase knowledge about the different variables that intervene in brand positioning. It is important to compare these results in other contexts and countries to account for cultural variability. Moreover, galvanic skin response and EEG can be a powerful dyad to assess reward and forecasting. Research with fMRI can give insights about the relationship between facial microexpressions, reward systems and decision making.

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