Cardiac Vagal Tone and Risky Decision Making

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Making risky decisions can be stressful, because the possibility of undesirable outcomes elicits negative emotional responses, which affect our risk preferences. We investigate how risk aversion is modulated by the physiological regulation of emotion. Individual differences in vagal tone predict risk aversion, and manipulating vagal tone experimentally changes risk preferences.

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What Can Brains and Bodies Tell us That Consumers Won’t?

Neurophysiological Processes Underlying Consumer Judgment and Choice

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Paper #1: Neural Responses to Functional and Experiential Ad Appeals: Explaining Ad Effectiveness
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Paper #3: Cardiac Vagal Tone and Risky Decision Making
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Paper #4: Modulation of Judgments by Incidental Affect: the Dynamic Integration of Affect and its Temporal Sustainability
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SESSION OVERVIEW
Recent developments of neurophysiological measurement techniques and growing interest in their use in marketing research have advanced our understanding of how consumers process information and make decisions. The papers in this session showcase the variety and richness in accessible neurophysiological methods that can inform marketing theory, and provide novel evidence on important drivers of consumer behavior that are inaccessible to a marketing researcher using self-report measures or purely behavioral metrics alone. The current session will exemplify how multimethod approaches such as psychophysiological measurements (fMRI, ECG, respiration), pharmacological interventions, and facial affective encoding can illuminate how consumers process, value and decide among the wide variety of options they encounter in the marketplace.

In the first paper, Couwenberg, Boksem, Dietvorst, Worm, Verbeke and Smidts explore the neural processes evoked by functional and experiential ad appeals in television advertisements, using functional magnetic resonance imaging (fMRI). They demonstrate that functional and experiential ad appeals for the same brand engage different brain regions, and that these activation patterns predict subsequent advertisement effectiveness.

In the second paper, Nave, Nadler, Dubois, Camerer, and Plassmann investigate the causal relationship between testosterone and preference for status goods. Using double-blind placebo controlled exogenous testosterone administration and subsequent hormonal measurements extracted from saliva samples, they reveal that testosterone drives status- but not quality- or power-seeking motivation underlying consumers’ product evaluations.

In the third paper, Acikalin and Shiv explore the role of the physiological regulation of emotion in decision making under risk and uncertainty. By quantifying and manipulating vagal tone, a physiological marker of autonomic flexibility and stress vulnerability, they show that increased parasympathetic activity decreases risk aversion.

In the fourth paper, Ling, Shiv, and Plassmann use facial affective encoding in order to investigate the temporal dynamics of affect-as-information effects in consumer judgments. Online measurement of facial responses to incidental rewards during aesthetic evaluations allowed for rapid tracking of when incidental affect was being used as information.

Taken together, these papers provide an overview of how different types of neurophysiological measures can be applied to answer both theoretically and managerially important questions in the field of consumer behavior. In doing so, this session offers novel insights into the neurophysiological processes underlying judgement and choice, raising fundamental questions such as “What can we learn about decisions from consumers’ neurophysiological states?”. Thereby, not only do we advance the theoretical understanding of the drivers of behavior, but we also generate novel hypotheses for further research. Notably, these papers appeal to a broad audience, as they intersect in their utilization of neurophysiological methods and focus on consumer decision-making, but also tackle central questions in a variety of popular areas in consumer behavior such as advertising efficacy, conspicuous consumption, risky decision-making, and the role of affect in consumer choice.

Neural Responses to Functional and Experiential Ad Appeals: Explaining Ad Effectiveness

EXTENDED ABSTRACT
An advertising appeal - the central idea of a message that highlights specific attributes of the product - can be described in terms of its functional and experiential elements. Ads with a predominant functional appeal typically convey a message that relates to a rational or utilitarian focus on product features, by including references to the product attributes, its use and performance, as well as the benefits and value that come with these features (Abernethy and Franke 1996). In contrast, one of the key ideas of an experiential advertising appeal is that value does not only reside in the advertised good and its utilitarian and functional benefits, but that value also lies in the emotional, sensory and experiential elements associated with the good, and in the (indirect) experience of it (e.g., through advertisements; Holbrook and Hirschman 1982).

Despite the large body of research that has investigated the effect of ad appeals of television advertisements on consumers’ internal responses and behavior, our understanding of how different ad appeals are processed remains limited. Neuroimaging methods, such as functional magnetic resonance imaging (fMRI), can serve as a valuable complement to conventional self-report methods, providing more explicit and immediate insights into ongoing mental processes that are typically difficult to access using other approaches.
In the present study, we explore how novel insights from neuro-imaging techniques can advance our understanding of how functional and experiential ad appeals are processed by consumers and how these processes are, in turn, related to advertisement effectiveness.

We compared a unique set of eleven different television commercials for the same brand (i.e., a well-known muscle and joint gel) to investigate the influence of differences in advertisement appeal, in terms of functional and experiential executional elements, on brain responses and subsequent advertisement effectiveness. The selected commercials were of comparable professional quality, equal length (all 20 seconds) and did not differ in terms of lower-level visual features.

In our experimental design, we combine data from three independent samples: (1) an fMRI neural focus group (N = 24), to measure immediate neural responses to the television commercials; (2) a large sample of consumers in the population (N = 1239), to measure ad effectiveness for each commercial; and (3) a sample of advertising experts (N = 9) who assessed each commercial’s appeal. We used the expert judgments scale from Zarantonello, Jedidi, and Schmitt (2013), which includes items that pertain to the functional and experiential dimensions of an ad. Advertising effectiveness was measured by the consumer’s online information search behavior in direct response to a television commercial (i.e., click-through-rate to the product website (CTR)).

To investigate the neural processes evoked by functional and experiential executional elements, and how these processes relate to ad effectiveness, we conducted a series of analyses. First, we assessed to what extent the expert-rated executional elements were related to population-level ad effectiveness. Results of a stepwise linear regression model reveal that ads that demonstrate the functional benefits of the product (i.e., focus on the advantages for the consumer), and appeal to imagination (i.e., thinking in a different, original and innovative way, approaching things from a new angle) were most effective in stimulating click-through behavior ($R^2 = .169$, $F(1,96) = 5.204$, $p < .05$).

As a second step, we examined the brain regions engaged by these effective functional and experiential executional elements. While the functional element was particularly associated with responses in the temporal cortex (i.e., inferior temporal gyrus (ITG) and middle temporal gyrus), the experiential element evoked neural responses in the dorsolateral prefrontal cortex (i.e., DLPFC: precentral gyrus, extending into inferior frontal gyrus and middle frontal gyrus). Results exceeded the threshold of $p < .05$ FWE corrected on the cluster-level.

Third, we analyzed whether activity in these specific brain regions in direct response to the commercials was predictive of CTR in an independent sample of consumers. Results of a multi-level linear regression model indicate that the extent to which the brain regions associated with the most effective functional element (i.e., activity in a region-of-interest within the ITG) and experiential element (i.e., activity in a region-of-interest within the DLPFC) were activated while viewing the commercials, predicted the successfulness of the commercials (i.e., DLPFC significantly: $b = .014$, $p = .013$; ITG marginally significantly: $b = .008$, $p = .086$).

Additionally, we conducted a psychophysiological interaction analysis to assess how functional connectivity between brain regions is altered in response to more effective commercials. Findings revealed interactions between the ITG and the DLPFC, and between the DLPFC and the amygdala, for higher levels of CTR.

Exploring the neural responses to different ad appeals, we dissociated brain regions responding to functional and experiential executional elements in television ads. We found that a functional appeal engaged the temporal cortex. Previous neuroimaging studies demonstrated that the temporal cortex is involved in higher-level perceptual processes, such as object identification, recognition and interpretation (e.g., Bar et al. 2001). The temporal cortex thus plays an important role in identifying ‘what’ things are, and constitutes an important hub in the so-called ventral stream, or the ‘what pathway’, of visual processing (Goodale and Milder 1992). This potentially indicates that effective processing of information on the product itself, but also of how the product should be used may lead to increased success of the commercial.

Moreover, we found that an experiential appeal engaged the DLPFC. The DLPFC has been related to sustained attention and working memory, processes which are critical for enabling creative thought (Dietrich 2004). Its functional connectivity with the amygdala, a brain structure associated with emotional processing (e.g., Davis and Whalen 2001), may potentially suggest higher emotional engagement for more successful ads.

Furthermore, we show that not only activation in, but also interaction between, the ITG and the DLPFC was related to higher ad effectiveness. Our findings generate hypotheses for a richer understanding of how consumers effectively process functional and experiential ad appeals.

**Peacocks, Testosterone and Status Seeking: Single-dose Testosterone Administration Increases Preference for Status Brands and Products**

**EXTENDED ABSTRACT**

Desire for social status is a universal human motive (Maslow, 1943) that is preserved across species, and should therefore have biological signatures (Kenrick et al. 2010). One way in which humans in complex societies obtain, maintain or display their social status is the consumption of status goods (Veblen 1899). Status products represent social markers that elevate humans in the social hierarchy, either through increasing status (respect in the eyes of others) or power (desire for control over valued resources, Magee and Galinsky 2008). Yet, the biological drivers of such (costly) preference for luxury goods remain poorly understood.

The androgenic hormone testosterone (abbreviated ‘T’) is produced in the male testes and in smaller quantities in female ovaries. T affects physiology, brain development and behavior throughout life. In many non-human species, T levels rise amid breeding season and facilitate behaviors such as intra-male fighting, mating and display of dominance (Eisenegger, Haushofer & Fehr 2011). In humans, T is released into the bloodstream and in the brain in response to external stimuli such as the presence of an attractive mate or in anticipation of a competitive challenge, modulating physiological and cognitive processes in a context-sensitive manner. Correlational studies have further showed that status-related behaviors, such as winning competitions (Booth et al. 1989) or driving Porches (compared to a family Sedan, Saad & Vongas 2009) also increase T levels, making it a prime biological candidate for modulating preferences for status goods.

In the current study, we hypothesized that (1) elevated T levels increase preferences for high status vs. low status goods and (2) that these effects are driven by T-induced status-seeking rather than quality-seeking or power-seeking.

We randomly assigned 243 male students to receive either topical T or placebo (P) gel in a double blind exogenous administration protocol. Participants returned to the lab five hours later, when the T group experienced stable and elevated T levels as compared to the P group ($p<0.001$, manipulation was checked using saliva samples). Each participant took part in two tasks.
In the first task, subjects were shown five pairs of brands in a randomized, counter-balanced order. Pairs were chosen based on a pretest conducted in a demographically similar population (N=387), such that each pair consisted of pre-tested “high” and “low” social status brands (e.g., Levi’s versus Lacoste), where the difference in status association between the two was reliably greater than the difference in quality association. Subjects indicated which of the two brands they preferred, and to what extent, using three 10-point likert rating scale.

In the second task, participants were shown text ads of six different products (e.g., sunglasses, a car), and indicated their attitudes towards the goods. For each product, we composed and pre-tested three different text ads that were identical, except specific phrases, that either emphasized the product’s quality, power or status enhancing characteristics. We randomized each product’s ads between subjects, such that every subject saw two quality, power and status ads in a counter-balanced fashion. This resulted a 2 (testosterone/placebo, between-subjects) x 3 (quality/ power/ status, between-subjects) x 6 (product, within-subject) design.

We estimated mixed-effect linear models with preference ratings as the dependent variable (such that higher rating implied greater preference for the high, over the low status brand) controlling for subject and brands pair random effects. In line with our main hypothesis, subjects who received T showed greater preference for the high status brands (β=0.45±0.24, p=0.04). Further analysis corroborated the effect’s robustness to control for age, mood, treatment expectancy, the 2D:4D digit ratio (a proxy of prenatal T exposure) and the levels of 14 other hormones (measured in saliva) that were not affected by T treatment.

In an analogous manner to task 1, we estimated mixed-effect linear models with products’ liking as the dependent variable, controlling for subject and product random effects. We found that the T group subjects liked the products advertised as status-enhancing more than placebo (β=0.63±0.25, p=0.01). On the contrary, there were no reliable differences between the two groups in liking of products advertised as high in quality or power. The effects (and their absence) prevailed when including additional controls for age, mood, treatment expectancy, 2D:4D and 14 other hormones that were unaffected by T treatment.

Our results show that preference for status enhancing brands and products in humans have indeed biological roots: pharmacologically elevated T levels increased consumer’s preferences for status vs. non-status brands and goods. Our findings are the first to show a causal relationship between T administration and preference for status brands and products, and that T drives status- but not quality- or power-seeking motivation underlying consumer’s product evaluations. The latter distinction is an important contribution for two reasons. First, most previous studies do not control for potential higher quality attributes of status products and are thus confounded. Second, as costly signals such as status brand consumption may contribute both to one’s power and status in the social hierarchy, our results are the first to show that T acts specifically on status- but not power-seeking motivation.

**Cardiac Vagal Tone and Risky Decision Making**

**EXTENDED ABSTRACT**

When we make risky decisions, the possibility of undesirable outcomes can elicit negative emotional responses that influence our risk preferences (Loewenstein et al., 2001). For this reason, how we regulate these emotions can determine the how much risk we are willing to take. Emotions are regulated by both higher-level cognitive and lower-level physiological processes. For instance, we can regulate how we feel at the higher-cognitive level by reappraising the source of an emotion or by suppressing it (Ochsner & Gross, 2005). Such regulation strategies have been demonstrated to influence decision-making (Gross, 2013). In addition to these cognitive strategies, which require conscious effort, emotions are also regulated automatically at the physiological level by the autonomic nervous system (ANS). The parasympathetic subdivision of the ANS regulates arousal, respiration, heart rate, and attention; aiding emotion-regulation by controlling visceral states (Porges et al., 1994).

Unlike cognitive emotion-regulation strategies, the impact of which has been examined in various decision-making contexts, little has been documented about the role of the physiological regulation of emotion in decision-making. The primary goal of this research is to fill this gap in the literature. Specifically, our aim is to delve into the role of emotion-regulation on decision-making from a physiological perspective, focusing on the effects of parasympathetic activity on risk aversion.

In order to understand how the physiological regulation of emotion can influence decision-making, we draw upon the well-documented work on to the vagus nerve, the key component of the parasympathetic nervous system (Critchley & Harrison, 2013). We specifically focus on a non-invasive measure, cardiac vagal tone (VT), measured via respiratory sinus arrhythmia (RSA; Berntson et al., 2007). RSA is a non-invasive proxy for vagal—and thus, parasympathetic—activity and autonomic flexibility (Porges et al., 1994). The regulatory effect of vagal activity on emotional function is ubiquitous in the literature and, thus, VT is widely accepted as an indicator of parasympathetic involvement in the regulation of emotion by physiological means (e.g. Porges, 1996; Gottman & Katz, 2002). Naturally, VT is a strong predictor of stress vulnerability (Porges, 1995). For example, higher resting VT has been shown to protect children from marital conflict (El-Sheikh et al., 2001).

In this research, we examine whether the influence of VT extends to decision-making under risk and uncertainty. Akin to how cognitive reappraisal strategies reduce arousal (Sokol-Hessner et al., 2009) and loss-aversion (Sokol-Hessner et al., 2012) in risky decisions, we posit that increases in VT, indicating improved physiological regulation of emotion, ought to similarly predict reduced risk aversion. In three experiments, where we either measure VT as an individual difference or experimentally manipulate VT using specific breathing techniques, we assess risk preferences in two risky decision-making tasks with built-in incentive compatibility, the Balloon Analog Risk Task (BART; Lejuez et al., 2002) and the Gneezy Risk Task (GRT; Gneezy & Potters, 1997).

Together, these experiments document the modulation of risk aversion by vagal activity, as indicated by VT.

In Experiment 1, a correlational study, by measuring VT of free-breathing participants while completing BART, we found that confirming our hypothesis, participants with higher levels of VT showed less risk aversion, indicated by a significant positive relationship between RSA and the adjusted number of pumps (p < 0.0005).

In Experiment 2, we manipulated VT experimentally by regulating the breathing of participants, randomly assigning them to a regular-breathing (control-normal VT) or a deep-breathing (high VT) condition. A manipulation-check confirmed that the breathing manipulations were effective. Participants in the deep-breathing condition had significantly higher RSA levels compared to the control condition (p < 0.0001), which did not differ from the average RSA of the free-breathing participants in Experiment 1 (p > 0.36).

The results confirmed our hypothesis, and participants in the deep-breathing condition took significantly more risk than participants in
the regular-breathing condition in both BART (p < 0.021) and GRT (p < 0.027).

In Experiment 3, we investigated whether our breathing manipulations caused any mood effects using the Brief Mood Introspection Scale (BMIS), in addition to addressing whether our main finding in GRT holds controlling for mood measurements. The results replicated our GRT findings in Experiment 2 (p < 0.04). There were no significant differences between groups in the Arousal-Calm dimension (p > 0.30 for both), the pleasant-unpleasant dimension (p > 0.60) of BMIS. Controlling for mood effects, which had non-significant coefficients (p > 0.30 for both), breathing manipulation was still a marginally significant predictor of risk taking in GRT (p = 0.09).

These findings are congruent with previously limited and correlational research indicating that VT might predict how individuals deal with stressors in decision-making contexts. For instance, resting VT has previously been found to correlate with the magnitude of stress response to (Dulleck et al., 2011) and the likelihood of rejecting unfair offers in ultimatum games (Sütlüner et al., 2011). Further, this pattern of results is consistent with studies on risky decisions that focus on emotion-regulation from a higher-level cognitive perspective such as cognitive reappraisal modulating the experience of negative emotions and influencing loss aversion (Heilman et al., 2010).

Our experimental manipulation of VT using breathing exercises highlights how immediate the cognitive and behavioral consequences of a change in parasympathetic activity can be. Our participants started eliciting differential behavior in sophisticated decision-making tasks beginning merely a minute after a getting in sync with a deep-breathing rhythm, before they even detected any breathing-driven influences in their emotional states. This can have important implications in a myriad of consequential contexts, such as risky decisions in the medical, political, and business domains.

In sum, we demonstrate that the regulatory effects of VT on emotional function extend to risky decision making contexts. Put simply, how good our bodies are at handling the affective consequences of experiencing uncertainty predicts risk aversion.

**Modulation of Judgments by Incidental Affect: the Dynamic Integration of Affect and its Temporal Sustainability**

EXTENDED ABSTRACT

Consumer psychology research has suggested that affect plays a central role in consumers’ judgments and evaluation processes. A substantial body of studies has found that even accidental affect, i.e. affect unrelated to the decision at hand, can execute a significant impact on judgments and evaluations. This has been known as the “affect-as-information effect” (AIE) (e.g. Pham 1998, 2014; Schwarz and Clore 1983). Specifically in a marketing context, the affect-as-information effect suggests that consumers evaluate products by inspecting their preexisting feelings rather than conducting attribute-based evaluations. For instance, Naylor, Raghunathan and Ramanathan (2006) reported that exposure to promotional stimuli would evoke a positive feeling and subsequently enhanced the evaluation of unrelated products. Since incidental affect is ubiquitously related to consumer evaluations, it is critical for marketing researchers to understand how exactly incidental affect could influence consumers’ judgments and evaluations.

Despite decades of research, however, our understanding of the affect-as-information effects is still incomplete. For example, we have limited understanding of the dynamic processes of how incidental affect is integrated while consumers are making judgments or evaluations. It is also unknown whether the integration of affect is purely a psychological process or underlies a neurophysiological foundation. These questions remain unclear because of the methodological limitations in manipulating affect, tracking affect and measuring evaluations in the previous research. Such methodological limitations might have resulted in further confusions in the past research concerning how sustainable the influence of affect on judgments and evaluations are. Some studies suggested that the affective influences fade away after a short period of time (e.g. Dutton and Aron 1974; Gneezy and Imas 2014; Isen, Clark and Schwartz 1976), whereas others suggested that they endure and persist for hours or even days (e.g. Andrade and Ariely 2009; Ottati and Isbell 1996; Pocheptsova and Novemsky 2010).

In order to address these above questions, we conducted a series of studies to understand the dynamic integration of affect and its temporal sustainability using both neurophysiological and behavioral approaches.

We manipulated affect by delivering or not delivering incidental monetary rewards that was shown previously as an effective way to alter one’s affective states (e.g. Eldar and Niv 2015; Isen, Daubman and Nowicki 1987) in each trial, and asked participants to subsequently make aesthetic evaluations of images in a seemingly unrelated task. In the first study, we employed facial affective encoding using NOLDUS Facereader to track “online” affective alterations, which allowed us to examine the dynamic neurophysiological integration of affect during aesthetic evaluation processes. Behaviorally, the study replicated the affect-as-information effects showing that receiving vs. not receiving an incidental reward increased subsequent aesthetic evaluations of both positive and neutral images (βreward = 1.45, p < .001). In addition, our findings revealed that the behavioral AIE were mediated by the online facial happiness responses triggered by winning money (β = 0.61, 95% CI = [0.016 0.152]). More importantly, analyzing the time courses of the facial happiness response, we further found that the affect integration took place rapidly (i.e. second-based) and could be amplified and attenuated on a trial-to-trial basis.

In the next study, we examined the sustainability of AIE by introducing two different lengths of temporal delays (i.e. 2-min or 5-min) during the aesthetic evaluation task. After receiving money, participants evaluated images before and after an affectively neutral filler task. Both studies replicated AIEs such that participants liked images more after receiving vs. not receiving money (βreward = 3.42, p < .004; βreward = 0.348, p < .001). Critically, however, two moderated mediation analyses showed that the AIEs were preserved after a short period of delay (βdelay = 357, 95% CI = [271.491]), whereas the AIEs were attenuated after a longer delay (βdelay = 1.4, 95% CI = [.161 .296]).

In the third study, we further examined the cause of attenuation of the affect-as-information effects. We reasoned that a long temporal delay did not dilute affect per se, but instead, it attenuated the perceived representativeness of affect (i.e. the affective state is less attended than other source of information) to subsequent evaluations. Using the same paradigm as in study 2, we asked participants to report their happiness of winning vs. not winning money either right after disclosure of the lottery outcome or after a 5-min delay. Conceptually, assessing the happiness of the lottery outcomes re-directed participants’ awareness to their affective states. We first found that there was no effect of timing on reported happiness of winning or not winning money (t = 1.52, p = .127; t = .25, p = .6). This demonstrated that the induced affect was still preserved after a 5-min delay. We further found that by reminding participants of their affective states after the temporal delay, the perceived representativeness
of affect was reassigned, and the affect-as-information effects were recovered (moderated mediation analysis coefficients: $\beta_{\text{immediate}}=-.423$, 95% CI=[.273 .587]; $\beta_{\text{time-delay}}=.461$, 95% CI=[.294 .614]).

Taken together, our research has contributed to understand the temporal mechanisms of the affect-as-information effects. Using facial affective encoding, we captured the online facial happiness during the occurrence of AIEs. We provided first evidence that integration of affect into subsequent evaluations is mediated by a fast neurophysiological dynamics on a trial-to-trial basis.

Exploring the temporal sustainability of the AIEs, we found that affective influences could be attenuated after 5 min but not 2 min interval. We further showed that this was not due to the dissipation of affect but because of the dissipation of the perceived representativeness of affect along the time course. By re-directing participants’ awareness to their affective states, we showed that the affect-as-information effects could be recovered even after a long interval.

REFERENCES


