Mood Management Dynamics:

The Interrelationship between Consumer Mood and Behavior

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Abstract

People actively attempt to create and maintain positive moods and to escape from negative moods by engaging in various consumption activities. The principle of homeostasis explains the essence of this mood-management behavior: that consumers adjust their mood and activities to preserve constant the conditions of life. We model the dynamics of consumer mood and mood-management behavior through a pair of interdependent, linear differential equations and estimate the equations using mood and consumption data collected from an adult consumer panel. Because empirically fitting continuous-time differential equations to intermittent observations is uncommon in the marketing literature, we show how to transform differential equations into equations that can be estimated using simultaneous equation regression methods. Our consumer panel shows strong homeostasis in mood management and no evidence of endogenous mood cycles.

Key Words: Mood, Consumer Behavior, Dynamics, Homeostasis

Consumers are increasingly turning to the marketplace for products that will help them to manage their moods and marketers are responding to consumers' buying behavior with more and more feel-good products. Hundreds of food, beverage, personal care, and home products that promote the idea of relaxation, positive mood states, and other forms of emotional well-being have been introduced into the marketplace in the past few years. Celestial Seasonings' "Tension Tamer" tea, Bath & Body Works' scented candles, bath salts, and other aromatherapeutic body products, as well as home accessories and feng-shui kits encourage consumers to actively manage their mood states.

Gardner's (1985) seminal article on consumer mood states recognized the important role that mood management plays in a variety of consumer behaviors including service encounters, selection of retail environments, and shopping. A few marketing studies have sought to investigate explicitly this process of consumer mood management, that is, to explain the activities and behaviors undertaken by consumers to maintain a positive mood or repair a negative mood and the impact of these behaviors on mood (e.g., Kacen 1994; Luomala 1999). These qualitative studies provide a conceptual understanding of how consumers use consumption behaviors to manage their moods, but they do not measure the dynamics of this process of mood management. Mood affects behavior and behavior affects mood in a constantly updating intertwined system. How, and to what degree, consumer moods motivate particular behaviors and concomitantly, how engaging in certain behaviors changes a consumer's mood state are issues that have not been explored empirically. It is worthwhile to supplement our conceptual understanding of consumer mood management with an empirical model that measures the dynamic interrelationship between mood and behavior.

In this paper, we address the difficult task of measuring the dynamics of consumers' mood states and illustrating the corresponding interrelationships between mood and behavior. We base our study on the key tenet that consumers adjust their mood in accordance with the principle of homeostasis: that individuals strive to regulate their internal environment to preserve constant the conditions of life. Given that consumers prefer a relatively constant mood state, when internal or external events disrupt their natural mood state, consumers engage in behaviors to help them restore their mood to its normal (i.e., homeostatic) level.

Our methodology for identifying and explaining the process of mood management integrates panel data collected from an adult consumer sample with a model for data analysis that incorporates simultaneous differential equations. The model in our study accommodates several aspects important to demonstrating the dynamics of consumer moods and mood management:

1. The model captures the active nature of the mood-management process. Not only does our model clarify how mood responds to consumption behaviors, but it also illuminates how consumption behaviors are chosen with mood improvement in mind.

2. Mood, a transient affective state, adjusts continuously over time. Yet, at best, mood can only be measured at intermittent times. We show how the continuous mood adjustment process can be understood from discrete mood observations.

3. Psychological homeostasis interlinks mood and consumption behavior, so we use a two-stage least-squares estimation procedure to avoid biased parameter estimates.

This model is applied to multiple daily measures of mood and behavior data collected from our consumer panel over a period of five days. We describe how we fit the differential equations to the model, discuss the empirical findings and their implications for consumer research, and evaluate the contribution of the model to our understanding of consumer behavior. Finally, we present limitations and issues for further research.

MOODS AND MOOD MANAGEMENT

Moods and mood management are widely recognized phenomena in both the psychological and marketing literatures. Moods are generalized feeling states that are transient in nature (Gardner 1985). This definition distinguishes moods from emotions, which are object-focused as opposed to generalized, and from attitudes or temperaments, which are enduring states (Clore et al. 2000). A critical element of this definition of mood is that it is transient; therefore, moods are subject to change over time.

People manage their moods when they experience them and many of the responses are directly related to consumption and purchases, as the examples at the beginning of the paper demonstrate. Research has shown that people actively attempt to maintain positive mood states and to escape from negative moods states by engaging in various consumption activities including eating, watching television, shopping, socializing with friends, going to a movie, listening to music or exercising (Eliashberg and Sawhney 1994; Faber and Christenson 1996; Holbrook and Gardner 2000; Morris and Reilly 1987; Thayer, Newman, and McClain 1994; Zillmann 1988). The operational conceptualization of mood management is that consumers' moods prompt mood-managing behaviors, and that engaging in mood-managing behavior induces changes in mood, which subsequently elicits changes in behavior. *Psychological Inquiry* recently dedicated an entire issue to the topic of mood management (2000, Vol. 11, No. 3), presenting several theories of mood regulation (none offered empirical data concerning the dynamic interrelationship between mood and behavior).

Most mood studies focus only on the effect of moods in one time period, treating mood as a simple independent or dependent variable within a before-and-after experimental design (e.g., Barone, Miniard, and Romeo 2000; Batra and Stayman 1990; Lee and Sternthal 1999; Swinyard 1993). Moods are a dynamic phenomenon. The interaction between mood and behavior necessarily causes changes over time. Yet this dynamic and evolving nature of mood and behavior largely has been ignored in previous marketing studies. Two notable exceptions are Holbrook and Gardner's (2000) study that examined how people's mood changed over time as a result of listening to music, and Eliashberg and Sawhney's (1994) study that explored the dynamic effects between initial mood state and the emotional characteristics of scenes from a movie on participants' subsequent mood state and overall enjoyment of the movie. Baumgartner, Sujan, and Padgett (1997) examined students' moment-to-moment emotional responses to television ads in a single-variate correlational analysis, but did not measure the dynamics of participants' affective reactions.

However, even while the Holbrook and Gardner (2000), Eliashberg and Sawhney (1994), and Baumgartner et al. (1997) studies focused on the effects of the consumption experience on mood changes over time, the affective stimuli and the consumption experiences were exogenous variables determined by the experimental research design. How do mood dynamics play out in a naturally occurring setting? How does mood change when consumers are allowed to freely choose the consumption experience? How do different types of consumption experiences affect changes in consumers' moods?

The objective of the present study was to investigate the dynamic nature of mood in a naturally occurring context, and to explain how consumers adjust their mood-managing behaviors in response to the moods they experience in their daily lives. Because many of these mood-managing behaviors are related to consumption activities, the present study provides insights into understanding the choices consumers make and the affective characteristics of select consumption activities. Drawing upon the experiential view suggested by Holbrook and Hirschman (1982), the mood maintenance/mood repair hypothesis described by Isen (1984), the two-dimensional measure of mood promulgated by Russell, Weiss, and Mendelsohn (1989), and the concept of psychological homeostasis promoted by Schulze (1995), we propose a model for measuring the dynamic process of mood management.

MODELING THE DYNAMIC PROCESS OF MOOD MANAGEMENT

Homeostasis

Homeostasis is the process by which individuals seek to regulate their internal environment. This construct's origin is in physiology and biochemistry (see Canon 1932): when an organism is cold (the state) it shivers (the behavior) to generate heat and thus move toward the normal temperature. The theory behind homeostasis is that an organism can survive only if the physiological system linking the state to the behavior is internally stable.

Psychologists expanded the concept of homeostasis to include psychophysiological states (such as moods and feelings) recognizing the interrelationship between biological factors and psychological factors (see Berntson and Cacioppo 2000; Weisfeld 1982). According to this approach, human survival depends in part on the stability of the psychological system linking moods and behavior. This process creates physical and psychological needs that influence mood and affect-related behaviors (Edlund 1987; Parker and Tavassoli 2000). Studies of psychological homeostasis (Headey and Wearing 1989) support the theoretical foundation of our model, especially Headey and Wearing's (1989) dynamic equilibrium model of well-being in which individuals are assumed to have "normal" equilibrium levels of subjective well-being (SWB). Their study investigated the dynamic relationship between personality, life events, and SWB using data from an Australian panel.

Applying the concept of psychological homeostasis to the process of mood management suggests the following description of the dynamics by which moods are managed. People want to remain in a comfortable affective state. In order to achieve stability, their unconscious and conscious psychological systems have built-in error-correction capabilities. The homeostatic dynamic system proposed here assumes that the farther away an individual is from the most comfortable levels of mood and behavior, the more rapidly s/he returns toward these normal mood and behavior states. The normal level of mood (or behavior) is a state that leaves the person most comfortable and satisfied.[1] This implies that as a consumer approaches normal states of mood and behavior, the speed of closure (i.e., rate of change of mood or behavior) naturally diminishes to prevent overshooting.

Specifically, suppose that the measurement of mood has been scaled so that the normal mood level is $\hat{M}$. If the mood state is M(t) at time t, then the time rate of change of mood is in direct proportion to the discrepancy between current mood and normal mood, $\hat{M} - M(t)$. If the current mood falls short of normal, then this difference is positive and the time rate of change of

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[1] The normal mood state should not be thought of as some hypothetical zero point on a dimensional map of mood. Findings from psychological research indicate that some individuals have higher natural arousal states (Diener et al. 1985; Kohn 1987; Steenkamp, Baumgartner, and van der Wulp 1996) or higher levels of negative affectivity (Larsen and Ketelaar 1991; Watson and Clark 1984). Isen (1984) argues that, in general, we prefer to be in slightly positive mood states (cf. Zuckerman's [1994] research into sensation-seeking which characterizes the ideal level of stimulation as the amount of stimulation a person prefers in general. Similarly, Steenkamp and colleagues [Steenkamp et al. 1996; Steenkamp and Baumgartner 1992] found that psychological pleasantness is highest at the level of stimulation at which a person feels most comfortable, what they refer to as the Optimal Stimulation Level. Their Need for Stimulation scale measures a person's distance from the OSL. Individuals may have different normal mood states and therefore, different homeostatic mood levels.

mood is positive: mood levels rise. The greater the degree to which the current mood level falls below normal, the greater is the feeling of deficiency, and the more rapidly the system self-corrects the situation. Conversely, if current mood is only slightly below normal, the consumer feels less urgency and the psychological homeostasis system moves more slowly. This system reverses itself if the current mood exceeds the normal mood level.

The principle of homeostasis suggests more than the existence of equilibrium levels of physiological and psychological variables. It implies that individuals have powerfully stable self-correcting systems. If the time rate of correction of mood were a constant, then the momentum of mood improvement would certainly carry the consumer past the normal mood level. If the psychological system has evolved to make people affectively stable in the normal course of their lives, it makes sense that the speed adjusts as the mood level approaches normal.

The proposed dynamic homeostasis system can be represented as a differential equation. In the simplest version of our homeostatic dynamic model, $\frac{dM(t)}{dt} = \alpha(0 - M(t)) = -\alpha M(t)$, the normal mood level is zero for simplicity of exposition, and α is a positive parameter that measures the innate rate of mood correction. The negative sign in this equation indicates that the mood system is self-correcting: when the mood state is positive, mood will be reduced; when it is negative, it will be increased. The more intense the current mood is, the faster its adjustment.

This differential equation may be rearranged algebraically to read $\frac{dM/dt}{M} = -\alpha$. On the left hand side of this formula is the <u>percentage</u> rate of change of mood. Homeostasis dynamics indicates that the percentage rate of change of mood is a constant. When the mood is less intense, then the absolute speed of mood correction is slower in order to maintain a constant percentage rate of change, as previously noted.

Mood Dynamics

The above description provides our basic translation of homeostasis into a dynamical mood system. The simple model can be modified to incorporate mood management. Let B(t) be the current level of behavior that influences the person's mood state. Details of such behaviors will be provided below, but they can be thought of as either endogenous mood-managing behaviors (e.g., going shopping, buying an ice cream cone) or exogenous activities that influence the person but are not guided by the mood state (e.g., hearing a favorite song on the radio). Such behaviors occur in the normal course of everyday life, so $\hat{B}$ denotes the baseline level at which this behavior, or set of behaviors, is performed. For example, $\hat{B}$ might represent the typical quantity of ice cream or sweets consumed per period.

Active mood management is captured in our model by including behavior in our differential equation for mood:

$$\frac{dM(t)}{dt} = \alpha[\hat{M} - M(t)] + \beta[B(t) - \hat{B}], \tag{1}$$

where α and β are parametric constants. The first term on the right hand side follows directly from the previous discussion of mood homeostasis: $\hat{M}$ is the normal mood level and α is the innate rate of mood correction. The second term indicates that when behavior exceeds the baseline level, it contributes to a more rapid adjustment upward in mood state: $\hat{B}$ is the baseline behavior level and β is the responsiveness of mood to behavior. If behavior is at its baseline level, B(t)= $\hat{B}$, then the mood adjustment follows the basic homeostatic mood dynamics alone. However, if behavior is more intense than typical in the sense that B(t) - $\hat{B}$ is positive and the parameter β is positive (e.g., larger quantities of ice cream are consumed), then the behavior contributes to an increase in mood velocity (e.g., more rapid mood improvement).[2] On the other hand, if behavior falls below the baseline level, mood velocity is diminished. So people in negative moods can repair them by engaging in positive behaviors, while people in positive moods can prolong their mood by increasing positive behaviors. The inhibiting rather than stimulating nature of some behaviors also would be reflected in a negative value for the parameter β.

Mood-Managing Behavior Dynamics

The mood dynamics equation (1) explains the dynamics of internal mood state changes as the consequence of both the natural homeostasis of moods and the reaction of moods to overt behaviors and activities. But the equation does not provide an explanation of how behavior may change over time. Because prior studies indicate that people actively manipulate their behavior to influence their moods, we model the dynamics of mood behavior using the following differential equation to explain the rate of change of behavior:

$$\frac{dB(t)}{dt} = \gamma\left[\hat{M} - M(t)\right] + \delta\left[\hat{B} - B(t)\right]. \qquad (2)$$

The first term on the right hand side of (2) describes the way that mood influences adjustments in behavior. The parameter γ is a measure of the combination of a consumer's motivation and capability to manage mood. It could be large because the consumer has a strong desire to control mood by his or her actions. Alternatively, γ could be small if the consumer has time or other resource constraints that make behavioral adjustments to mood difficult.

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[2] Velocity has speed and direction. If the mood level is increasing, then more-intense-than-baseline behavior causes the mood to change at an even faster rate. Less obviously, if the mood level is declining, then more-intense-than-baseline behavior causes the mood to decline at a slower rate, or even to change directions to an upward trajectory. If the mood level is increasing, then less-intense-than-baseline behavior causes the mood to rise at a slower rate, and if the mood level is declining, then less-intense-than-baseline behavior causes it to fall at an even faster rate.

The parameter $\hat{M}$ denotes the normal level of mood for the individual, as discussed above (see footnote 1). Implicit in the term "normal" is the idea that affective states can be either too low or too high. Arousal and pleasure may reach such high levels as to create mood states of excruciating agitation or euphoria in the over-stimulated individual, and they may reach such low levels as to produce mood states of dreary sadness. The parameter $\hat{M}$ quantifies the level of mood that would leave the individual most comfortably satisfied in the end (see footnote 1).

If the mood is below the normal level, the velocity of behavior increases, but if it is above the normal level, then velocity of behavior diminishes. As in footnote 2, if the behavior level is diminishing, an increase in velocity means that the rate of decline drops or even switches from a declining to an increasing trajectory.

The second term on the right hand side of equation (2) describes the way that current behavior level influences adjustment in behavior. Just as the internal psychology of moods is driven by homeostasis, we assume that homeostasis also applies to behavior. In particular, if the current level of behavior falls short of the baseline behavior, $\hat{B}$, then the person attempts to correct this situation. The more current behavior differs from the baseline, as measured by B(t) - $\hat{B}$, the faster is the speed of adjustment; conversely, the more the current behavior approximates the baseline behavior, the slower is the speed (again, this is suggested by homeostasis).

The behaviors individuals employ to manage their moods are not cost-free. Shopping requires time and money; eating too much ice cream may entail psychological cost in the form of guilt or regret. Such costs are captured by a positive parameter δ in equation (2), which denotes an innate rate of behavior correction. The more costly deviations from normal behaviors are to individuals, the more intensely they correct them.

In conclusion, differential equations (1) and (2) model the dynamic interdependence of mood and the behaviors employed to manage the mood. The interdependency of mood and behavior can lead to interesting patterns, including endogenous mood cycles, as demonstrated in the next section.

DYNAMIC PATTERNS OF MOOD MANAGEMENT

In analyzing the dynamics of mood and behavior that result from equations (1) and (2), there are two distinct issues to be considered: what is equilibrium and what is the path toward equilibrium? Equilibrium consists of values of mood and behavior adjusted to one another so there is no inherent tendency for either to change. The equilibrium mood level, the level toward which homeostasis drives mood, is the individual's normal mood level, $\hat{M}$ (recall that this normal mood level may be different for each individual). The equilibrium behavior level is the baseline behavior for each individual, $\hat{B}$. At these baseline levels, equations (1) and (2) indicate that the time rate of changes are zero.

Time Paths of Mood and Behavior

The equilibrium levels of mood and behavior have been described above. We now describe the time path out of equilibrium implied by equations (1) and (2). Given that linear differential equations have solutions that are of an exponential form, $M(t) = me^{at}$ and $B(t) = be^{at}$, the value of the parameters in these functions are identified by studying the homogenous version of the system of differential equations:

$$\begin{bmatrix} \frac{dM(t)}{dt} \\ \frac{dB(t)}{dt} \end{bmatrix} = \begin{bmatrix} -\alpha & \beta \\ -\gamma & -\delta \end{bmatrix} \begin{bmatrix} M(t) \\ B(t) \end{bmatrix}. \quad (3)$$

The derivatives of the above exponential functions are $M'(t) = mae^{at}$, $B'(t) = bae^{at}$.

Substituting into the matrix equation (3) and canceling the common term e^{at} results in:

$$\begin{bmatrix} -\alpha & \beta \\ -\gamma & -\delta \end{bmatrix}\begin{bmatrix} m \\ b \end{bmatrix} = a\begin{bmatrix} m \\ b \end{bmatrix} \quad \text{or}$$
$$\left(\begin{bmatrix} -\alpha & \beta \\ -\gamma & -\delta \end{bmatrix} - a\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}\right)\begin{bmatrix} m \\ b \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix} \tag{4}$$

The values of a and [m b]' that satisfy these equations are the characteristic values and characteristic vectors of the dynamics matrix $C \equiv \begin{bmatrix} -\alpha & \beta \\ -\gamma & -\delta \end{bmatrix}$ (sometimes called the eigenvalues and eigenvectors of C).[3] In particular, the coefficient a in the exponential solution e^{at} is a characteristic value of C, and it can take on two values:

$$a_1, a_2 = -\frac{\alpha + \delta \pm \sqrt{(\alpha - \delta)^2 - 4\beta\gamma}}{2}. \tag{5}$$

In the normal course of events, both characteristic values a_1 and a_2 are negative real numbers (they are real numbers when $(\alpha\text{-}\delta)^2\text{-}4\beta\gamma>0$). Specifically, if $a_1 \cdot a_2=\alpha\delta+\beta\gamma>0$, then the two characteristic values have the same sign; if, in addition, $a_1+a_2= -(\alpha+\delta)<0$, then the coefficients' common sign is negative. Negative exponential functions asymptotically approach zero; if this is the case, it would indicate that both mood and behavior move steadily toward their equilibrium values as predicted by homeostasis.[4]

Mood Cycles

The radical in formula (5) suggests the other possibility: that the interplay between behavioral adjustments and internal mood states can create mood cycles. Specifically, if the term

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[3] The dynamics matrix C has built-in sign patterns; e.g., the diagonal elements are negative.

under the radical, $(\alpha-\delta)^2-4\beta\gamma$, is negative then the characteristic values are complex numbers with a real part $(\alpha+\delta)/2$ and an imaginary part $\pm\, i\,\sqrt{\beta\gamma-(\alpha-\delta)^2/4}$, where $i \equiv \sqrt{-1}$. This does not imply that moods or behavior are "imaginary," but rather that mood dynamics involve cycles. This is because exponential functions and sinusoidal functions are linked through imaginary numbers by the fundamental identity: $e^{-it} = \cos(t) - i\sin(t)$. When $(\alpha-\delta)^2-4\beta\gamma<0$, then mood management will involve sinusoidal paths oscillating above and below the equilibrium mood levels (see Figure 1).

Insert figure 1 about here

Cyclical moods occur when the term $(\alpha-\delta)^2$ is small in comparison to the term $\beta\gamma$. Recall that the values of α and δ measure the innate strength of the homeostatic system for mood and behavior, respectively. Even if moods return rapidly to normal levels (α is large), if the cost of making behavioral adjustments is similarly large ($\delta\approx\alpha$), then mood is stable but difficult to control. Recalling that the values of β and γ measure the responsiveness of mood to behavior and the motivation/capability to manage behavior, respectively, if these parameters are positive and large, then consumers will be active mood managers. Vigorously manipulating a difficult-to-control mood management system results in "oversteer" that creates endogenous mood cycles. These cycles are not necessarily pathological, but could represent the problems of coordinating the cognitive, affective, and behavioral changes of normal, healthy life.

[4] The solution is a weighted combination of two negative exponential functions. If one weight is positive and the other negative, the solution can overshoot the equilibrium once before converging exponentially from the other side.

DATA

Consumer Mood Panel

To discover the actual dynamic patterns of mood-management behavior through an empirical test of our model, 93 consumers over the age of 21 were recruited to participate in a "Consumer Mood Panel Survey" in which mood and behavior data were collected by telephone three times a day over a five-day period. After agreeing to participate in the study, panelists received a wallet-sized Mood Grid card (see below) and a general explanation of the study.

Prior to the start of the panel interviews, panelists were asked about their likely participation in a number of activities and behaviors, responded to demographic questions, and were given instructions on use of the Mood Grid. The average panelist was 39 years old, college-educated, and working in a professional or managerial occupation. Seventy percent were female. See Table 1 for a detailed description of the panelists.

Insert Table 1 about here

Mood and behavior data collection for all participants began on Monday morning and ended on Friday evening. The recurring panel interviews were scheduled at the convenience of the panelist but always included a morning, an afternoon, and an evening contact. In total, 1,395 interviews were completed, each lasting approximately five minutes. These short phone interviews measured consumers' current mood and their participation in any of a variety of activities since the last contact, as described in the next section.

Measuring Mood and Behavior

The underlying dimensional structure of mood is not a settled question, but most researchers agree that moods can be described in terms of their degree of arousal, whether one feels excited or relaxed, and their valence, whether they are pleasant or unpleasant (e.g., Cohen and Areni 1991; Holbrook and Gardner 2000; Mano and Oliver 1993; Parkinson et al. 1996). As Holbrook and Gardner (2000, p. 167) state, "Although the structure of moods, emotions, and other affective states is somewhat controversial, several studies have found consistent evidence for the existence of two primary dimensions – pleasure and arousal (Russell 1980)."

For this study, we used Russell et al.'s (1989) Affect Grid to measure mood. It consists of a nine-by-nine grid labeled (1) "high arousal" to (9) "sleepiness" on the vertical dimension and (A) "unpleasant feelings" to (I) "pleasant feelings" on the horizontal dimension. During each phone interview, panelists indicated their current mood by providing the row and column coordinates (e.g., "D, 4") on the wallet-sized Mood Grid card that responded to their feelings at the moment. From this, two mood measures were constructed on a 9-point scale: a **pleasure** component, where 9 indicates high pleasure, and an **arousal** component, where 9 indicates high arousal.

The Russell et al. (1989) Affect Grid was chosen for its ease of use in this panel study, where repeated measures of consumers' mood and behavior were gathered via a phone interview. Unlike time-consuming multiple-item questionnaires or checklists, the Affect Grid is ideal for repeated observations (Russell et al. 1989, p. 493). Russell and his colleagues found that scores from the Affect Grid were highly correlated with scores obtained using longer, more time-consuming verbal self-report scales. The Affect Grid has been used in other marketing studies as a reliable measure of consumer mood states (see Dubé, Chebat, and Morin 1995; Holbrook and Gardner 2000).

A variety of activities are available to help consumers manage their moods including eating something, watching television, shopping, calling a friend, listening to music, or going for a run. Consumers may aggregate activities based on their "affective benefits" or similarity of impact on mood. For example, watching television or listening to music may have comparable influences on arousal, and act as substitutes for each other on other non-mood related wants. Previous researchers (Morris and Reilly1987; Thayer et al. 1994; and Zillmann 1988) have suggested particular groupings of behaviors based on consumer self-report or factor analyses of behavioral data. However, the identified groupings are neither mutually exclusive nor consistent across studies. Rather than relying exclusively on prior research, we conducted a preliminary survey of 220 students, asking them to evaluate how a variety of activities make them feel on a 9-point scale of unhappy-happy (pleasure) and relaxed-excited (aroused). Our research focused on five aggregate activities (shop, socialize, watch TV, listen to music, and eat out).

Figure 2 displays respondents' beliefs concerning how these activities influence their mood dimensions of arousal and pleasure. The activities Shop and Socialize are more pleasing than the average pleasure provided by each of the other items in the survey but they are not significantly different than the average arousal of all other items.[5] The activities Music and TV are significantly less arousing (that is, more calming) than the other behaviors but not more pleasing. As a result of our student survey results, we created two behavior category variables from the activities measured in our consumer panel survey: Amusement and Relaxation. Amusement consists of shopping or socializing with others. Relaxation consists of watching television or listening to music.

Insert figure 2 about here

[5] The differences discussed here are all significant at the 1% level.

In our consumer panel survey each of these common behaviors were measured with a three-item scale. The number of behaviors was limited to keep the questionnaire short to prevent panelist fatigue and dropout. The first scale item for each behavior measured the length of time (in minutes) that panelists participated in the activity. The other two scale items measured the intensity with which panelists engaged in the activity. See Table 2 for a list of the behavior item measures used in the consumer panel study. We do not try to explain a consumer's selection between TV or music activities, but rather try to understand the total amount of relaxing activities selected. Our independent data indicates that Eating Out is both more pleasing and less arousing than other behaviors, so the Dining behavior of panelists is used as a covariate in the empirical mood model.

Insert Table 2 about here

It is important to note that in each interview we measured the current mood state of the panelist, and the behaviors the panelist engaged in since the last interview. As a result, mood and behavior data are not contemporaneous. To illustrate, in the dinnertime interview panelists reported their current evening mood but they reported behaviors that occurred in the early afternoon. We account for this asynchronism in the empirical estimation of the mood management dynamics, described in the next section.

Predicted Relationships Between Measured Variables and Derivatives

Homeostasis implies that both moods and behaviors are self-correcting. In terms of the general parameters of the simple two-variable model presented in equations (1) and (2), this corresponds to the hypotheses $-\alpha<0$ and $-\delta<0$. Applying these theoretical restrictions to the specific measures of mood (Pleasure and Arousal) and mood-management behaviors (Amusement and Relaxation) constructed from our data set, all the elements on the diagonal equation (3) are hypothesized to be negative.

Our preliminary student survey indicated that Amusement activities (shopping or socializing) have an influence only on Pleasure (see Figure 2), while Relaxation activities (watching television or listening to music) have an influence only on Arousal (see also Csikszentmihalyi and Kubey 1981; Thayer et al. 1994; Zillmann 1988)[6]. Dining influences both mood dimensions according to our data, but while one's mood may influence what is ordered and consumed, the activity of dining probably is driven more by non-mood factors (time of day, business, family activities), so we treat it as an independent covariate.

Homeostasis, which implies that the entire mood-management system is stable, requires assumptions about the non-diagonal parameters as well as the diagonal ones. For the simple two-variable model, stability requires that $\alpha\delta+\beta\gamma>0$; in other words, the diagonal elements of the dynamics matrix $C \equiv \begin{bmatrix} -\alpha & \beta \\ -\gamma & -\delta \end{bmatrix}$ dominate the off-diagonal elements (in magnitude).[7] The stability of the entire mood-management system is investigated through a Monte Carlo simulation of the characteristic values using the estimated statistics of C.

Whether or not the parameters of responsiveness of mood to behavior (β) or the motivation/capability to manage behavior to correct mood (γ) are positive or negative depends on the particular measures of mood and behavior. We first discuss mood adjustments to behavior.

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[6] It should be noted that although in some circumstances pleasure and arousal have common causes and hence are correlated, they do not have a direct causal link and have been found to be independent dimensions of mood (Diener and Emmons 1984; Green and Salovey 1999; Russell et al. 1989, Russell and Pratt 1980). As a result, Pleasure and Arousal are treated as independent constructs in our model and are not linked through the differential equations.

[7] The necessary and sufficient Routh-Hurwitz conditions for stability are more complicated to formulate for more than two variables (Samuelson 1947).

The rate of change of Pleasure should increase if Amusement behaviors (shop or socialize) occur since these specific activities are inherently enjoyable ($\beta_{amusement}>0$). The Relaxation behaviors (watch TV, listen to music) are sedentary behaviors that are likely to decrease changes in arousal rates ($\beta_{relaxation}<0$; see Bryant and Zillmann 1984; Csikszentmihalyi and Kubey 1981; Thayer et al. 1994; Zillmann 1988).[8]

A similar pattern is manifest in the model's predictions concerning behavioral adjustments to mood levels. If a person is feeling less pleased than is normal, s/he is motivated to increase the rate of Amusement behaviors ($\gamma_{pleasure}>0$). The rate of change of Amusement is influenced positively by $\gamma_{pleasure}(\hat{P} - P(t))$, but that means that it is negatively impacted by increases in the current level of Pleasure. This can be confusing at first blush. If a person's Arousal level is at a less than normal level, homeostasis requires that s/he decrease the rate of increase in Relaxation behaviors ($\gamma_{arousal}<0$). This implies that the sign of the response of Relaxation behavior to increases in Arousal is positive.

FITTING CONTINOUS DIFFERENTIAL EQUATIONS TO INTERMITTENT DATA

The dynamic mood-management process is assumed to adjust continuously in time although our measures of mood and behavior reflect data collected at intermittent times. The empirical estimation of such continuous-time models, while common in economics (Bergstrom 1976; Gandolfo 1993; Phillips 1974), is less common in the marketing literature (one exception

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[8] Of course, watching television or listening to music can be either stimulating or relaxing depending on the genre of the material. An action-adventure show produces a different affective response than a nature documentary (Zillmann 1988). We accounted for this in our three-item activity measures by measuring the type of entertainment chosen, and coding the Relaxing behaviors so that higher values represent more engaging, relaxing fare. Music tempo was reverse coded for this reason.

is Dubé and Morgan 1998). For clarity of exposition, we present a simple version of our mood differential equation:

$$\frac{dM(t)}{dt} = -\alpha M(t) + \beta B(t) + u(t). \tag{6}$$

The normal levels of mood and behavior do not appear in equation (6), but the error term, u(t), is assumed to be an independent random variable with mean zero, variance σ_u^2 and zero autocorrelation (that is, E[u(s)u(t)]=0, s≠t). Suppose that mood is observed at equally spaced times $t_1,..,t_N$, with one time unit between observations. For times between observations the dynamic mood-behavior process continues unabated but unmeasured.

Integrating the differential equation from time t_{i-1} to t_i:

$$\begin{aligned} &\int_{t_{i-1}}^{t_i} \frac{dM(t)}{dt} dt = \int_{t_{i-1}}^{t_i} \left(-\alpha M(t) + \beta B(t) + u(t)\right) dt, \text{ or} \\ &M(t_i) - M(t_{i-1}) = -\alpha \int_{t_{i-1}}^{t_i} M(t)dt + \beta \int_{t_{i-1}}^{t_i} B(t)dt + \int_{t_{i-1}}^{t_i} u(t)dt. \end{aligned} \tag{7}$$

The integral of the derivative of mood on the left-hand side equals the change in mood from t_{i-1} to t_i by the Fundamental Theorem of Calculus.

To explain the change in mood in this time interval, we compute the cumulative recent history of mood $\int_{t_{i-1}}^{t_i} M(t)dt$ and cumulative behavior $\int_{t_{i-1}}^{t_i} B(t)dt$ from time t_{i-1} to t_i. Although the values of M(t) and B(t) are not known in the interval between t_{i-1} and t_i, the cumulative mood can be approximated by the trapezoid seen in Figure 3, which requires only knowledge of mood at the ends of the interval. The trapezoid rule implies that $\int_{t_{i-1}}^{t_i} M(t)dt \cong (M(t_i) + M(t_{i-1}))/2$.

Insert figure 3 about here

As noted in the description of the panel data, measured behavior chronologically predates measured mood: when we interviewed the panelists at time t_i we asked about their mood at that time, but asked about behavior that had occurred between the prior interview at time t_{i-1} and the current interview at t_i. In other words, the measured behavior occurred neither at t_i nor at $t_{i-1,}$ but rather in the interval $[t_{i-1},t_i]$. In our model estimation, we assume that the measured behavior corresponds to the midpoint, $\frac{1}{2}t_{i-1} + \frac{1}{2}t_i$ and consider this asynchronicity, as follows.

The cumulative behavior is represented by the shaded area $t_{i-1}VKUt_i$ in Figure 4. The behavior measured during the interview at time t_i occurred earlier, at point K. The above trapezoid rule produces the trapezoid CIKD, but the area represented by CIKD is a poor approximation of the desired cumulative behavior measure. A better approximation is the sum of the two trapezoids $t_{i-1}JKD$ and $DKLt_i$ (the second is a rectangular trapezoid). This double trapezoid approximation of cumulative behavior is $\int_{t_{i-1}}^{t_i} B(t)dt \cong \frac{1}{8}B(t_{i-1}) + \frac{7}{8}B(t_i)$.

Insert figure 4 about here

Using these trapezoidal approximations of cumulative mood and behavior measures, the discrete version of the continuous differential equation (6) is

$$M_i - M_{i-1} = -\alpha\left(\frac{1}{2}M_i + \frac{1}{2}M_{i-1}\right) + \beta\left(\frac{1}{8}B_{i-1} + \frac{7}{8}B_i\right) + \varepsilon_i \,, \tag{8}$$

where M_i denotes the observed value $M(t_i)$, and so forth. Because in equation (6) u(t)'s mean is zero, the mean of the cumulative error in equation (8), $\varepsilon_i \equiv \int_{t_{i-1}}^{t_i} u(t)dt$ is also zero. The variance of ε_i equals σ_u^2 and zero autocorrelation implies cumulative errors are uncorrelated. By similar reasoning, the equation that explains the change in behavior at time t_i is

$$B_i - B_{i-1} = -\gamma\left(\frac{7}{8}M_{i-1} + \frac{1}{8}M_{i-2}\right) + \delta\left(\frac{1}{2}B_i + \frac{1}{2}B_{i-1}\right) + \theta_i \,. \tag{9}$$

The mood equation (8) and the behavior equation (9) form the proper basis for the empirical estimation of the continuous-time differential equations (1) and (2).

A much simpler, but less faithful, translation of the continuous-time mood dynamics model into a discrete time model involves replacing the derivative by the difference and replacing mood and behavior by lagged discrete values:

$$M_i - M_{i-1} = -\alpha M_{i-1} + \beta B_i + \varepsilon_i \,, \tag{10}$$

$$B_i - B_{i-1} = -\gamma M_{i-1} + \delta B_{i-1} + \theta_i \,. \tag{11}$$

(Note that the lagged value of behavior was measured at time t_i in our panel.) For example, Kim, Bridges, and Srivasta (1999) employed this discrete-time estimation method in their model of sales diffusion. In this discrete version, cumulative mood and behavior are tacitly measured by rectangular rather than trapezoidal approximations. This implicitly assumes that mood and behavior are not changing in the time interval $[t_{i-1}, t_i]$. For exponential functions (the basic solution for the equations), the rectangular approximation is less accurate than the trapezoidal approximations in proportion to the exponential coefficient and the square of the time between observations. For our intermittent observations of rapidly adjusting moods, the trapezoidal approximations are superior to rectangular approximations (Bergstrom 1993).

ESTIMATION OF MOOD MANAGEMENT DYNAMICS

Two Stage Least Squares

Simultaneous equation regression methods are required to estimate mood and behavior equations like (8) and (9) because the unobserved error term in each equation is likely correlated with one of the explanatory variables in that equation, and as a result, ordinary least squares estimates are biased. Although a wide variety of simultaneous equation methods exist, we use two-stage least-squares rather than a joint equation technique such as three-stage least-squares, full-information maximum likelihood, or LISREL because in these joint techniques, any specification error in one equation contaminates the estimates of all equations. In our model, a multitude of factors determines consumption activities like shopping, watching television, or listening to music. Recognizing that our panelists did not provide details on the idiosyncratic factors that may have influenced their behavior, we are cautious about the capability of our data to explain these behaviors. To prevent contaminating the estimates of the mood equations by errors from the behavior equations, we use the single-equation method two-stage least-squares.

Pooling Data and Moderator Variables

The Consumer Mood Panel Survey provides cross-sectional and time-series data. In order to estimate the parameters of the mood-management system, we pooled the data for all 93 panelists into a grand time series for our primary analysis. That is, we assume that α, β, γ, δ are identical for all consumers.[9]

Since it is easier for consumers to adjust their behaviors when there are fewer demands on their time resources, consumers' motivation and capability to manage their mood with behavior, γ, may vary with the time of day. This heterogeneity is captured by a time-of-day variable in the moderator formula: $\gamma_i=\gamma^0+\gamma^1\text{Time-of-Day}_i$. Time of day (ToD) takes on three values corresponding to morning, afternoon, and night. We dummy code two of these day-parts

[9] Admittedly, the rate at which mood corrects itself, the responsiveness of mood to behavior, consumers' motivation and capability to manage their moods, and the rate of behavior correction could be different for different consumers. Our model of the dynamics of mood management captures the overall process of the entire panel sample. Panelist-specific estimation of (12) and (13) is not viable because only fourteen useable observations are provided by each panelist and fourteen parameters must be estimated (seven coefficients and their standard errors). However, we present the results of a segmentation analysis of sex differences in mood management in the Discussion section at the end of the paper and we welcome future studies that explore differences among consumer segments.

to estimate the different values of γ in each remaining day-part. Substituting this moderator formula into equations (8) and (9) gives the estimation equations

$$M_i - M_{i-1} = m_0 - \alpha\left(\tfrac{1}{2}M_i + \tfrac{1}{2}M_{i-1}\right) + \beta\left(\tfrac{1}{8}B_{i-1} + \tfrac{7}{8}B_i\right) + + \varepsilon_i\,, \tag{12}$$

$$B_i - B_{i-1} = b_0 - \gamma^0\left(\tfrac{7}{8}M_{i-1} + \tfrac{1}{8}M_{i-2}\right) - \gamma^1 ToD_i\left(\tfrac{7}{8}M_{i-1} + \tfrac{1}{8}M_{i-2}\right) + \delta\left(\tfrac{1}{2}B_i + \tfrac{1}{2}B_{i-1}\right) + \theta_i\,. \tag{13}$$

The interaction term, $ToD_i \cdot \left(\tfrac{7}{8}M_{i-1} + \tfrac{1}{8}M_{i-2}\right)$, allows us to estimate the change in behavior dynamics during different parts of the day.

EMPIRICAL RESULTS

As previously discussed, we measured the mood of our panelists along the two traditional dimensions, pleasure and arousal. We estimated a separate equation for the rate of change in mood for each dimension, using as explanatory variables the trapezoidal approximation of cumulative mood (e.g., Pleasure) and the double trapezoidal approximation of the corresponding cumulative behavior (e.g., Amusement). The measured behavior actually occurred prior to the mood measure, so the cumulative behaviors are exogenous. The cumulative mood is endogenous, justifying the use of two-stage least-squares.[10]

Two separate behavior equations were estimated to explain the rate of change in Amusement and Relaxation behaviors, using as explanatory variables the trapezoidal approximation of cumulative behavior, the double trapezoidal approximation of the corresponding cumulative mood dimension, and the product of day-part dummy variables with cumulative mood (the moderator variable for time of day). The three dummy variables, Morning, Afternoon, and Evening, were rotated through the model specification for behavior dynamics to obtain the relevant t-statistics without the need for more cumbersome (but equivalent) calculations involving the covariances of estimated moderator coefficients (see Kacen and Lee 2002).[11]

Table 3a summarizes the Pleasure management system with Amusement behavior and Table 3b summarizes the Arousal management system with Relaxation behavior. Our spartan

[10] The instruments in our two-stage least-squares regression equations consisted of gender, household size, moods and behaviors lagged one period and interacted with gender, dining and dining interacted with gender, and moods lagged two periods.

[11] Specifically, we used cumulative mood, cumulative mood*Afternoon, and cumulative mood*Evening in one specification. The coefficient and standard error of cumulative mood is then the impact of cumulative mood in the Morning (setting Afternoon and Evening dummy variables equal to zero eliminates these other coefficients). The equation was then re-estimated with Morning and Evening/Morning and Afternoon dummies to measure the influence of mood in the Afternoon and the Evening, respectively. These are equivalent because the three dummies sum to 1.

models of mood-management behavior are able to account for about a third of the variation in consumers' moods and behaviors (0.30 to 0.39 as measured by the ratio of SSR to SSR+SSE). Given all of the idiosyncratic affectively laden events that intervene in the panelists' daily lives and the wide variety of reasons that consumers might undertake specific consumption behaviors, the fact that our model explains approximately a third of variation in behavior is encouraging. In Table 4, the results are presented for each of the three separate parts of the day, where the only difference from one part of the day to the next is the influence of mood on the rate of change of behavior (the remainder of the mood management system is identical to that found in Table 3). The statistics for characteristic values are created from a Monte Carlo simulation of the values of the model parameters using the estimated means and standard errors; one thousand draws of (α, β, γ, δ) from a relevant distribution were made to compute characteristic values.

Insert Table 3 about here

Insert Table 4 about here

We discuss the empirical results of the Pleasure management system in depth below, but because many of the same patterns occur for arousal, to avoid repetition we touch only briefly on the most important findings for Arousal management.

Findings on Pleasure Management

Pleasure dynamics show strong indications of homeostasis. As can be seen in the top row of the dynamics matrix (enclosed in boxes in Table 3a), the coefficient of Pleasure as a determinant of the rate of change of Pleasure is $-\alpha=-1.11$ (statistically significant at $p < 0.01$). The predicted negative sign indicates a homeostatic system. If a person feels less pleased than normal, Pleasure rises. Moreover, the more displeased the person is currently feeling the faster this correction takes place; conversely, the less displeased s/he is currently the slower the adjustment. On the other hand, if the person is feeling more pleased than normal, Pleasure will drop toward normal levels. The more pleased the person is the faster the adjustment toward normal.

Adding behavior into the system, we see that the Amusement behaviors of shopping and socializing have the predicted positive impact on the rate of change of Pleasure, $\beta=+0.78$ (significant at $p < 0.01$). In particular, if a person was to increase the amount of Amusement behavior engaged in, this would increase the time rate of change of Pleasure. This is very reasonable, but it has a slightly different interpretation depending on whether Pleasure is currently rising or falling (see footnote 2).

To illustrate the dynamics of the Pleasure equation, suppose a person is in a very happy mood, which prompts Pleasure to revert to equilibrium levels at a time rate of –2 units of Pleasure per period (on a 9-point scale). If she simultaneously increased her Amusement behavior 1.0 standard deviation by going shopping, the new rate of adjustment of Pleasure would be $-1.22 = -2 + 0.78*1.0$. That is, her Amusement behavior would slow the descent of Pleasure, prolonging her happy mood state. Alternatively, suppose that a person started out feeling very unhappy, but then naturally, due to homeostasis dynamics, her Pleasure is rebounding at a rate of +2 units of Pleasure per period. If she increased her Amusement behavior by one unit by going shopping, then the new rate of mood adjustment would be $+2.78= 2+0.78*1.0$, and Pleasure would rise even quicker. Both of these adjustments of Pleasure to the same behavior make sense, but in one case the magnitude of rate of adjustment diminishes ($-2.0 \rightarrow -1.22$) and in the other the magnitude enlarges ($+2.0 \rightarrow +2.78$). This finding is consistent with the mood-management hypothesis which states that individuals try to maintain or prolong positive moods but try to repair negative ones (Isen 1984; Larsen 2000). However, mood-maintenance and mood-repair behaviors are not cost-free (the parameter δ); without constant activity, over time mood will revert to its normal homeostatic levels.

The behavior dynamics of Pleasure management also exhibit homeostasis, as seen in Table 3a. A one-unit increase in Amusement behavior slows down its rate of adjustment, $-\delta=-2.17$. Left by itself, Amusement behavior exhibits stability and returns to its equilibrium level. Without mood motivations, consumers shop and socialize at normal levels. The influence of the Pleasure mood dimension on the rate of change in Amusement behavior depends on whether it is in the morning, afternoon or evening. It was hypothesized that an increase in Pleasure prompts Amusement behavior to slow down (once our mood picks up, we reduce our shopping or socializing behavior). Our results indicate this is true only in the morning; in the afternoon and evening, more Pleasure causes Amusement behavior to speed up (if we're feeling good, we engage in more shopping or socializing behavior).

The above analysis of the system of differential equations presented in equation (3) for Pleasure mood and Amusement behavior illustrates how the process of mood management works, and it provides some indication of how the interdependent variables of mood and behavior interact. However, when we hypothesized above that Amusement behavior increased by 1.0 unit, this did not account for the fact that Amusement behavior is endogenously determined. When we analyze the mood management system as a whole, we find that the characteristic values, which represent the speed at which the system as a whole is adjusting, are approximately –1 and –2 (they vary slightly by time of day, as seen in Table 4). The fact that they are negative implies that the Pleasure management system exhibits strong homeostasis.

Moreover, the fact that the characteristic values are real, not complex, indicates that the typical panelist does not have endogenous mood cycles. In other words, our consumer panelists are fairly talented mood managers, who engage in the "right" amount of behavior to restore their system to its natural homeostatic level.

We also examined whether Pleasure management by Amusement behavior shortens the typical mood "event." The half-life of the Pleasure management system is implicit in the estimated coefficients found in Table 3a. There are two characteristic values that represent the speed of adjustment of the system as a whole, and the speed depends on the beginning deviation from equilibrium. To explore the half-life of the Pleasure management system we set the parameter values for the system equal to those found in Table 3a and numerically solved the differential equations. We set Dining equal to zero and then solved the differential equations with the Morning coefficients (top portion of Table 3a) using a Runge-Kutta start, an Adams-Moulton predictor-corrector continuation, and a step size of 0.01 (Conte 1965), starting at values Pleasure = 4.327 (one unit below the normal level of Pleasure) and Amusement = -1.00 (0.34 units below the normal level of behavior). Figure 5 traces the mood and behavior of the Pleasure management system.

Insert figure 5 about here

When consumers actively adjust their shopping and socializing Amusement behaviors, the half-life of their Pleasure mood (the time to move halfway toward the equilibrium level of mood) is 0.71 time units or 4.3 hours (since our observations are separated by about 6 hours). Notice that in Figure 5, Amusement behaviors increase to help correct the unpleasant mood. If we instead assume that Amusement behaviors remain unchanged, the mood dynamics are still homeostatic, but Pleasure adjusts at a slower pace. It takes 5.8 hours to achieve the same gain in

Pleasure that occurred in only 4.3 hours when behavior was managed in response to the mood. In other words, consumers who don't do anything to improve their moods (like shopping or socializing) will still experience an improvement in mood because the natural homeostatic system is at work; however, active mood managers will be in better moods 27% faster.

The increase in the speed of adjustment of mood depends, of course, on the initial conditions of mood management. Since the behavior cannot change instantaneously, but rather at the measured pace of its own dynamic, mood-management consumption can act either as a sail or as an anchor depending on whether the starting behavior is high or low. If the mood management system started very close to equilibrium, the speed of adjustment would necessarily be very slow since not much change in mood is required to reach homeostasis.

Findings on Arousal Management

We only briefly discuss the Arousal mood management system because many of issues are identical. Like pleasure dynamics, arousal dynamics also show strong indications of homeostasis. The top row of the arousal dynamics matrix (enclosed in boxes in Table 3b) indicates that the coefficient of Arousal as a determinant of the rate of change of Arousal is $-\alpha=-1.26$ (statistically significant at $p < .01$). This means that a person who is more excited than normal naturally calms down over time. The negative characteristic values in Table 3b indicate the strong homeostasis of the Arousal management system and that the equilibrium is stable. There is no evidence of endogenous mood cycles.

Using the estimated coefficients for the Morning Arousal management system, the numerical solution of the Arousal-Relaxation differential equations was calculated starting the system 1.0 units below the equilibrium Arousal level and 0.34 units above on Relaxation behavior (as was done above for the equivalent Pleasure-Amusement system). When active mood management is allowed, the time needed for Arousal to close half the gap to equilibrium is 0.66 time units (3.9 hours). When Relaxation behaviors (watching television and listening to music) are not allowed to change, it takes 1.15 time units (6.9 hours) to achieve an equal gain in Arousal. Active management of Relaxation behaviors speed up Arousal adjustment by 42%.

Comparing the two mood dimensions, the half-life of Pleasure management (4.3 hours) is 10% longer than Arousal management (3.9 hours). This is consistent with the characteristic values of the Arousal system which are slightly more negative than those of the Pleasure system. Unhappiness drags on, but excitement disappears more rapidly.

Comparison of Estimates with Predicted Signs

The critical prediction of the homeostatic mood-management system is that the characteristic values given in equation (5) have negative real parts. We found this to be true for all estimated models. Moreover, we found no indication that the mood-management system resulted in endogenous mood cycles. The mood dynamics system may overshoot equilibrium once, but then it steadily converges to equilibrium levels of mood and behavior.

Table 5 compares the theoretical predictions with the empirical findings in Tables 3 and 4. All the signs are in the predicted direction for α, β, and δ. All are statistically significant. The predicted values of γ are supported roughly half the time, but afternoon behavior is distinctly different than predicted. Dining's influence on mood adjustment was insignificant.

Insert Table 5 about here

DISCUSSION

This paper presents the first fully dynamic modeling of both mood and mood-managing behavior in a naturally occurring setting. Our goal in designing and implementing this research was to move past conceptual models of consumer mood management and further an empirical understanding of the process of mood management.

The challenge addressed was to simultaneously model the psychological reaction of mood to behaviors, but also to recognize and measure the relationship between mood and the activities chosen specifically to manage the mood. Our basic theory was that the mood-management system of interlinked, dual causation, mood and behavior followed a homeostatic dynamic path. Since moods are transient feeling states by definition, we modeled the adjustment of moods as occurring continuously over time. This operationalization of mood dynamics presented difficulties because mood and mood-managing behaviors can at best be measured only intermittently. We solved this dilemma by using continuous-time differential equations in our model, and estimating cumulative mood and behavior using a double-trapezoidal approximation. Through a two-stage least-squares estimation procedure, we were able to estimate the interdependent effects of mood and behavior, and the time-path of mood and behavior to equilibrium. With our model, we were able to explain about one-third of the period-to-period changes in consumers' moods and behaviors. The findings strongly supported the principle of homeostasis as the dynamic process underlying the mood-management system.

Our continuous time model is superior to discrete time models used in previous research in several ways. Mood is a phenomenon that changes over time and that continually interacts with other dynamic aspects of the psychological system and the environment (Parkinson et al. 1996). Our model is a more authentic representation of mood and mood-management dynamics, it provides information about the system at all times (rather than at discrete points in time), and it can demonstrate the expected effects of a parameter or input value change to the system.

A panel of 93 adults was interviewed three times per day for five days to obtain measures of mood and behavior. This intermittent data was then used to estimate the coefficients of the continuous time mood-behavior process. Our method of empirically fitting continuous-time models to intermittent data could be used to measure the differences between typical consumers and compulsive consumers, for example, by changing the parameter value of the amount of shopping behavior engaged in and the period-to-period changes in mood. Such a model also may be of use in other marketing domains, such as consumer learning (Gregan-Paxton and Roedder John 1997), adoption of innovations (Fisher and Price 1992), product diffusion models (Bass, Krishnan, and Jain 1994; Kim et al. 1999), real-time customer satisfaction (Bolton and Drew 1991; Dubé and Morgan 1998; Johnson, Anderson, and Fornell 1995), and the dynamics of advertising persuasiveness (Baumgartner et al. 1997; Burke and Edell 1986).

The new substantive findings of this research include the following.

a. The full mood-management system (mood and behavior) is very stable, as predicted by homeostasis.

b. Even without behavioral adjustments, mood is inherently stable.

c. The arousal dimension of mood returns 10% more rapidly to normal levels than does the pleasure dimension of mood.

d. There is no indication of long endogenous mood cycles created by the effort to manage moods.

e. The management of amusement behaviors (shopping and socializing) speeds up the return of pleasure to normal levels by about 30%, while the management of relaxing behaviors (watching TV and listening to music) speeds up the return of arousal to normal levels by about 40%.

f. Mood management is somewhat slower in the afternoon and evening than in the morning.

g. Media-oriented behavior (watching TV, listening to music) is more powerful and homeostatic than socially-oriented consumer behavior (shopping, socializing) in managing mood.

h. Dining out does not have a measurable effect on mood dynamics.

These findings have implications for consumer mood researchers and marketing practitioners. Our results suggest that experimental designs that induce moods need to account for the differential effects of stimuli that create pleasurable feelings and arousing feelings. The longer-lasting mood effects of pleasure may impact dependent measures. Further, time-of-day effects may impact experimental results and researchers may want to treat time-of-day as a blocking variable in studies that manipulate mood.

That the media-oriented behavior (independent activities such as watching TV and listening to music) is more effective than socially-oriented behavior (interdependent activities such as shopping and socializing) has implications for service providers, as well as cross-cultural researchers who explore individualist and collectivist consumer behaviors. Future research might explore the effectiveness of various behaviors at prolonging or repairing a consumer's mood among different consumer segments.

Marketing practitioners also gain insight into consumers as a result of our study. The longer lasting effects of a pleasurable mood experience compared to an exciting mood experience suggest different "windows of opportunity" in which advertisers, service providers, and retailers can benefit from consumers' efforts at managing their moods. Arousal disappears 10% faster than pleasure, so advertising that is aimed at immediate behaviors may disappoint if copy and execution focus on stimulating arousal, rather than on creating feelings of pleasure.

The fact that our model provides information about the mood-management system at all times, as well as demonstrating the expected effects of a parameter or input value change to the system means our model, with some modifications, can provide marketers valuable information that will more directly help them to create more efficient and more effective advertising campaigns, product offerings, or retail environments. Understanding how much (in terms of both duration and degree) pleasing or arousing stimuli will be sought before consumers switch to less pleasing or calming activities will help marketers of many products such as amusement parks, media programs, retail entertainment centers (e.g., ESPN Zone) or tour packages to design better product offerings with more appealing sequences of activities or programs that prolong consumption time and enhance consumers' experience.

We also recognize some limitations to this study. First, our panelists were only interviewed every six hours. Our calculations tell us that the half-life of a mood episode is between 4 and 6 hours, but more frequent observations of mood might capture more transient mood states. Our data shows no evidence of endogenous mood cycles. However, the theory of Nyquist sampling says that only if mood cycles had a length of twelve hours would our sample intervals of six hours correctly identify the cycle (Nyquist 1928).[12] We recognize that more evidence is needed to determine the length of a typical naturally occurring mood cycle. On the other hand, even given the generous time between mood and behavior measures in our study, we can still explain a significant portion of the mood-management system.

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[12] We thank James Heyman, University of California-Berkeley, for this observation.

Second, some of the affective states measured in our panel study may be emotions rather than moods; in some instances we may have captured displeasure focused at a coworker rather than mood. As Clore et al. (2000, p. 30) said, “It is useful to think of emotions as affective states with objects and moods as affective states without objects. *But it is important to recognize that emotions act like moods when their object states are not focal* [italics added].” Bagozzi, Gopinath, and Nyer (1999, p. 184) said, “The line between an emotion and mood is frequently difficult to draw but often by convention involves conceiving of a mood as being longer lasting (from a few hours up to days) and lower in intensity than an emotion.” Given the short-run nature of such emotion states (as Bagozzi et al. implies) it is probable that any emotion experienced by our panelists was diffused into the background and was without a direct object focus (as Clore et al. implies) at the time of the interview. For example, if the displeasure at a coworker occurred fifteen minutes before our telephone interview, the panelist may have retained the affect, but lost the focus on the coworker during the interview. Therefore, the affect we measured is more likely mood rather than emotion, in this technical sense.

Third, behaviors have a host of driving forces other than mood (or time of day) and these other factors should be measured and accounted for in future research. The authenticity of field research leaves one with the dilemma that other relevant but unmeasured variables get swept into the error term. Sixty to seventy percent of behavior is left unexplained in our model estimation. If other variables not included in the model are correlated with some of our independent variables, then a confound exists. We might be interpreting a coefficient as the influence of relaxation behavior on changes in arousal, when it is really caused by an auto accident on the way home from work, a telephone call from an old friend, or some other unmeasured event. All such events admittedly can cause substantial adjustments to moods, but unless there is a strong correlation between these events and the other included variables, no bias exists in estimates of the other coefficients. We do believe that there may be events that occur on a regular schedule that affect mood and behavior, and we have used the time-of-day (morning, afternoon, evening) variable to act as a proxy for them in our model.

Fourth, each night our panelists went to sleep. Certainly sleep must have a pronounced effect on moods as well as on cumulative behaviors (or the recollection of those behaviors) but our model does not account for the effects of sleep on mood or behavior. We look forward to other studies that might guide methods of incorporating sleep interruptions in continuous time events.

Fifth, we only interviewed panelists Monday through Friday. What about weekends? A longer longitudinal study would help to improve our understanding of mood dynamics by accounting for day-of-week effects or other seasonalities. For example, research indicates that between 92 and 95% of the U.S. general population demonstrate seasonal mood and behavior changes characteristic of Seasonal Affective Disorder (Spoont, Depue, and Krauss 1991). A longer mood study might provide some valuable insights into the dynamics of S.A.D.

Sixth, the estimated coefficients of the mood dynamics system come from a pooled data set that treats all subjects as essentially identical in the across-subjects study (see footnote 9). There is a common but controversial belief that women are more emotional than men, and some psychological studies do indicate that women are more prone than men to depression and depressive moods (Weissman and Klerman 1977). Other studies have shown that men have greater physiological reactivity to stress than do women (Gottman and Levenson 1988). These findings suggest the possibility of sex differences in the dynamics of mood-management.

We tested whether males and females have identical mood-management systems (details available upon request from the authors) and found that for all the mood or behavior equations the fit was improved when the coefficients of males and females were allowed to differ. However, with only 29 males and 64 females it was difficult to distinguish the sexes on all parameters. We found that men's mood adjustments are more responsive to behavior than are women's. In addition, when a woman's Pleasure is pushed above or below its equilibrium level by outside events, she will naturally adjust mood and Amusement behaviors (shopping and socializing) to return more quickly than a man to the equilibrium level of Pleasure. On the other hand, men's Arousal management system is more homeostatic than women's. Future research might explore further the differences between men's and women's mood-management systems, or incorporate other demographic and psychographic variables into the model, such as age or affective responsiveness (Larsen and Diener 1987).

A major challenge facing marketing academics and practitioners is to understand the dynamics of consumer mood management, to analyze the products and behaviors that consumers use to regulate their mood states, and to design marketing programs that are responsive to the needs of consumers seeking to maintain or to change their moods. This requires that the characteristics of consumers' mood states and their mood-management behaviors be identified and measured, and the dynamic process by which moods and behaviors adjust be described and modeled. We hope that this study has furthered these goals.

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Table 1: General Description of Panelists

Entire Sample (N=93: 1395 total observations)					
Age (years)	Mean	38.9	Occupation	Managerial	20.4%
	Range	21-73		Professional	37.6%
				Non-manual skilled	19.4%
Gender	Male	31 %		Manual skilled	6.5%
	Female	69 %		Partly- or unskilled	1.1%
				Unemployed	6.5%
Marital Status	Single or Divorced	41.9 %		Other	8.6%
	Married	58.1 %			
			Education	Some high school	1.1%
Income	Under $15,000	5.4%		High school	10.8%
	$15,000-$24,999	7.5%		Some college	21.5%
	$25.000-$49,999	28.0%		Undergraduate degree	39.8%
	$50,000-$74,999	19.4%		Graduate degree	23.7%
	$75,000-$99,999	14.0%		Ph.D.	3.2%
	$100,000 & above	25.8%			
Household Size	Mean	2.3			
	Range	1-5			

Table 2: Behavior Classification System

Category	*Variables*	*Measures*		
		Item 1	*Item 2*	*Item 3*
Amusement	**Shop**	Time	Number items	Dollars spent
	Socialize with others	Time	Private-Public*	Number people
Relaxation	**Watch TV**	Time	Involvement*	Subject matter*
	Listen to music	Time	Tempo*(r)	Variety*
Dining	**Eat out**	Time	Quality*	Dollars spent

* Measured on a 7-point scale where 7 indicates higher or more seriously engaging level/value.
(r) indicates reverse-coded item.

Table 3
Two Stage Least Squares Estimates (t-statistics)

a. Pleasure Management in Morning

Derivatives of Mood/ Behavior	Pleasure Mood	Amusement Behavior [a]	Dining	Intercept	R^2 [c]
$\frac{d}{dt}$ Pleasure	-1.11*** (-14.72)	0.78*** (3.80)	-.07 (-1.36)	6.43*** (14.48)	0.30
$\frac{d}{dt}$ Amusement	-0.18**, b (2.58)	-2.17*** (-16.21)		-0.48 (-1.21)	0.36
			Characteristic values[d]	-1.29*** (-8.43)	-1.98*** (-9.57)

.b. Arousal Management in Morning

Derivatives of Mood/ Behavior	Arousal Mood	Relaxation Behavior[e]	Dining	Intercept	R^2 [c]
$\frac{d}{dt}$ Arousal	-1.26*** (-13.60)	-1.29*** (-6.19)	-.02 (-0.32)	6.32*** (13.08)	0.35
$\frac{d}{dt}$ Relaxation	0.20**, b (2.40)	-2.69*** (-16.92)		-0.10 (-0.27)	0.39
			Characteristic values[d]	-1.51*** (-7.86)	-2.44*** (-9.75)

* Significant at 10%, ** Significant at 5%, *** Significant at 1%, N=1170
[a] Amusement behaviors are shopping and socializing.
[b] The coefficient for the Morning. This coefficient varies by time-of-day as seen in Table 7.
[c] R^2 is calculated as SSR/(SSR+SSE) with both regression and error sum of squares calculated using the estimated coefficients and the actual values of explanatory variables.
[d] Solutions are linear combinations of exp(at), where a is a characteristic value of the dynamics matrix (found in the box). Statistics for a were computed using a Monte Carlo simulation of 1000 values of the dynamics matrix drawn from a distribution with its estimated mean and standard error.
[e] Relaxation behaviors are watching television and listening to music.

Table 4
Two Stage Least Squares Estimates (t-statistics)[a]

a. Amusement Dynamics by Time-of-Day

Derivatives of Behavior $\frac{d}{dt}$ Amusement	Variables: Pleasure Mood	Variables: Amusement Behavior[b]	Characteristic values[c]	
Morning	-0.18** † (2.58)	-2.17*** (-16.21)	-1.29*** (-8.43)	-1.98*** (-9.57)
Afternoon	0.15** † (2.02)	"	-1.01*** (-11.15)	-2.26*** (-16.99)
Evening	0.27*** † (3.62)	"	-0.94*** (-10.48)	-2.33*** (-17.63)

b. Relaxation Dynamics by Time-of-Day

Derivatives of Behavior $\frac{d}{dt}$ Relaxation	Variables: Arousal Mood	Variables: Relaxation Behavior[d]	Characteristic values[c]	
Morning	0.20** †† (2.40)	-2.69*** (-16.92)	-1.51*** (-7.86)	-2.44*** (-9.75)
Afternoon	-0.39*** † (-4.76)	"	-0.97*** (-9.17)	-2.98*** (-19.65)
Evening	0.13* †† (1.75)	"	-1.40*** (-9.82)	-2.55** (-12.41)

* Significant at 10%, ** Significant at 5%, *** Significant at 1%, N=1170

† The coefficient for this time-of-day is different from the coefficients at other times at 1%.

†† Morning and evening coefficients are not different statistically, but are different from the afternoon coefficient at 1%.

[a] The remainder of the mood-management statistics are identical to those of Table 5.

[b] Amusement behaviors are shopping and socializing.

[c] Solutions are linear combinations of exp(at), where a is a characteristic value of the dynamics matrix (found in the box). Statistics for a were computed using a Monte Carlo simulation of 1000 values of the dynamics matrix drawn from a distribution with its estimated mean and standard error.

[d] Relaxation behaviors are watching television and listening to music.

Table 5: Empirical Support of Theoretical Predictions

Derivatives	Pleasure Mood Management		Arousal Mood Management		
	Pleasure (mood)	Amusement (behavior)	Arousal (mood)	Relaxation (behavior)	Dining (behavior)
$\frac{d}{dt}$ Pleasure	$-^{*}$	$+^{*}$	NA	NA	$+^{i}$
$\frac{d}{dt}$ Amusement	$-^{a}$	$-^{*}$	NA	NA	NA
$\frac{d}{dt}$ Arousal	NA	NA	$-^{*}$	$-^{*}$	$-^{i}$
$\frac{d}{dt}$ Relaxation	NA	NA	$+^{b}$	$-^{*}$	NA

[*] Supported by the evidence
[a] Supported in Morning, Rejected in Afternoon and Evening
[b] Supported in Morning and Evening, Rejected in Afternoon
[i] Statistically insignificant

Figure 1. Mood Cycles

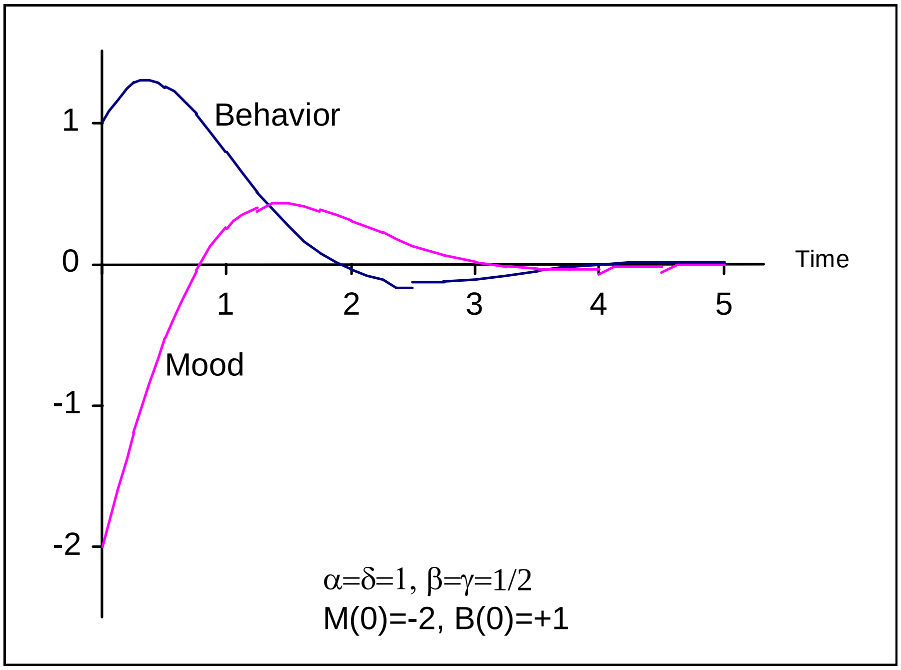

Figure 2. Influence of Activities on Pleasure and Arousal (Preliminary Survey)

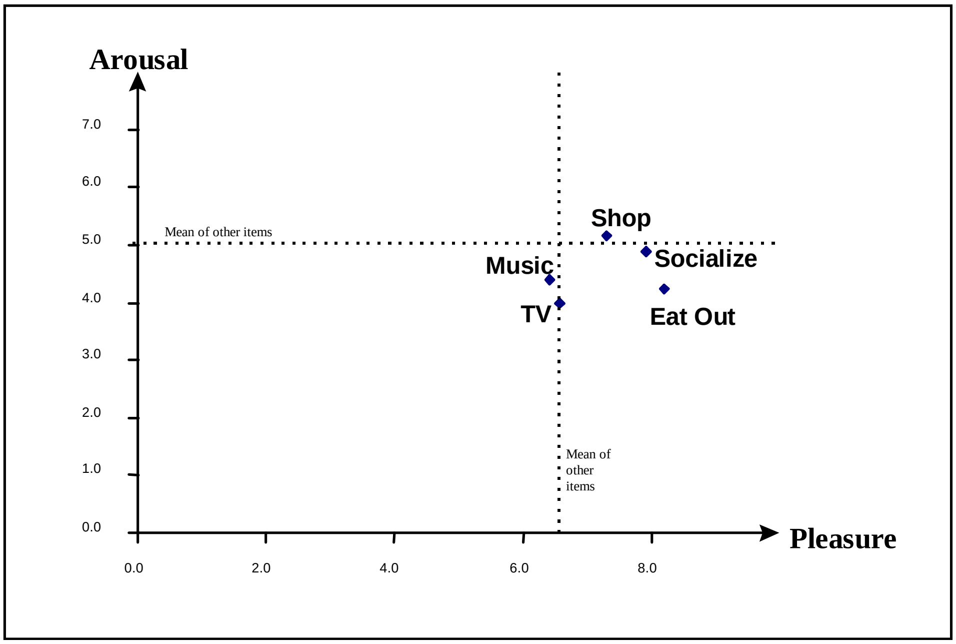

Figure 3. Trapezoid Approximation of Cumulative Mood

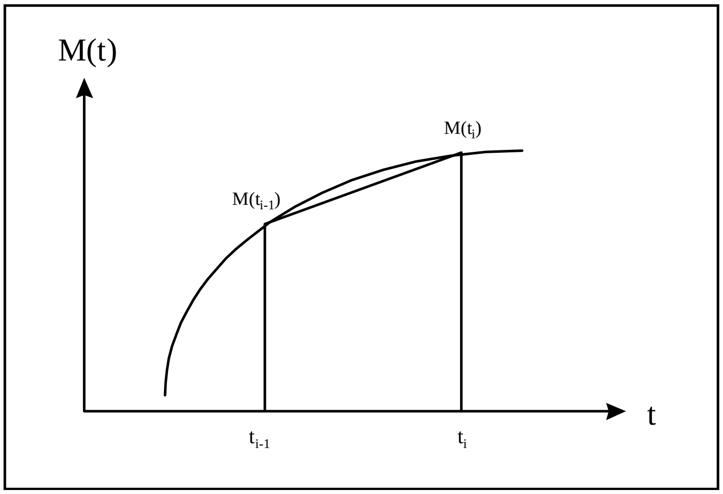

Figure 4. Double Trapezoid Approximation of Cumulative Behavior

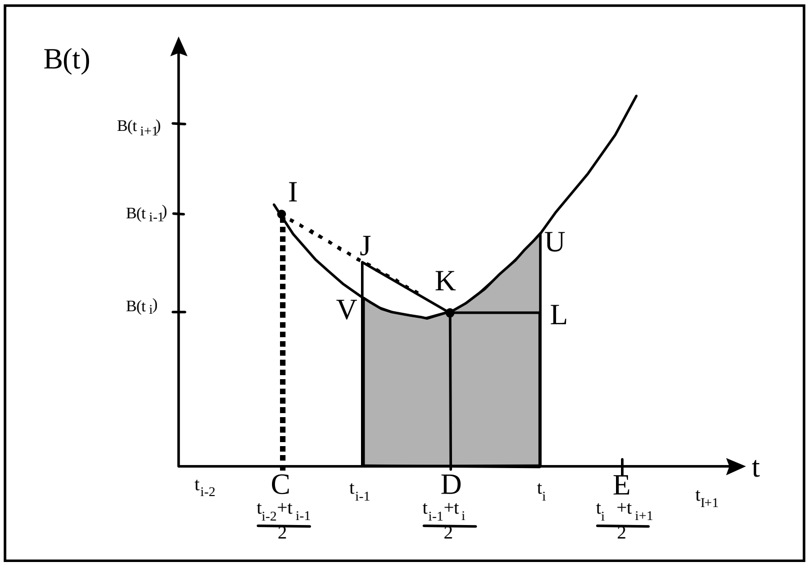

Figure 5. Solution of Pleasure-Amusement Differential Equations (Morning) Beginning Below Equilibrium