Simple Morning and Complex Night: Time of Day and Complex Sensory Experiences

ABSTRACT

Consumers' multisensory preferences bring new ideas to service and experience design—yet do consumers always react favorably to sensory complexity? This research examines variation by time of day in how consumers respond to complex sensory experiences (e.g., purchase behavior, choice, liking). Specifically, we theorize that arousal levels increase over the course of the day, which increases the perceived fit of complex sensory experiences, leading to more favorable reactions—a pattern that is more prominent among evening than morning chronotypes. A set of five studies provides support for this theorizing and provides important implications for service providers regarding how to vary their sensory offerings and promotions over the course of the day.

INTRODUCTION

Do consumer responses to certain experiences or service offerings vary by time of day, and if so, how should companies take into account temporal variation? A coffee shop may vary music and lighting throughout the day to create a cozy and relaxed or more vibrant and lively atmosphere. Likewise, restaurants may vary menu complexity at breakfast, lunch, dinner, and happy hour to better serve consumers' preferences. Doing so strategically requires a comprehensive understanding of how consumers' needs and responses vary over the course of the day. Indeed, marketing research suggests that temporal factors are necessary to explain consumer behaviors (Gullo et al. 2019; Hoch and Loewenstein 1991; Hornik and Miniero 2009) and that, importantly, consumer responses to experiences and service offerings can vary over time (Huang and Wong 2007; Kimes and Wirtz 2002; Tsao and Vu 2019). Considering the variation in consumer responses over time of day helps service providers determine the right prices, products, and promotion strategies (Huang and Wong 2007; Kimes

and Wirtz 2002; Tsao and Vu 2019). The present research, therefore, examines how time of day affects consumers' responses to sensory complexity—in particular, consumer responses to complex sensory experiences.

Complex sensory experiences are increasingly prevalent in today's marketplace (Crawford 2016; Hensel 2019). Complex sensory experiences can either provide multiple variations within one sense or stimulate consumers' multiple senses (vision, smell, taste, sounds, and touch) at once (Palczak et al. 2019; Schreuder et al. 2016). Consider foods that combine multiple sensory flavors and textures in each bite: for example, Talenti Gelato Layers creates a complex taste experience by combining five layers of gelato, delicious pieces, and sauces (Nuffoods Spectrum 2019; Meredith 2019). Or consider service experiences that stimulate multiple senses simultaneously: to create a complex multi-sensory experience, spas integrate multidimensional sound, vibration, and visual imagery (Kirk 2019), and restaurants use state-of-the-art sensory technology, projection mapping, and sounds (Bogunovich 2017; Achille 2017). In general, sensory complexity is a sensory property that refers to the number of different sensory attributes that individuals can simultaneously experience (Palczak et al., 2019). Sensory complexity can exist in the environment, service offerings, and products, and many service providers are designing their service experiences to maximize sensory complexity, as mentioned above—but will consumers always respond positively to such experiences, or might their responses vary by time of day?

Little is known about how consumers respond to complex sensory experiences over the course of the day—a gap that the present research addresses. In doing so, we make three key contributions to the literature. First, we identify systematic variation in consumer responses to sensory complexity by time of day. Prior research has examined the influence of time of day on ethical behaviors, self-control behaviors, and variety-seeking (Gullo et al. 2019; Kouchaki

and Smith 2014; Zor, Kim, and Monga 2022). Likewise, prior research has examined consumers' responses to sensory complexity based on individual and situational differences (e.g., optimal stimulation level, sensation-seeking, cognitive depletion; Giacalone et al. 2014; Wang et al. 2015; Hildebrand et al. 2021). We combine these streams of research by examining time of day as a critical antecedent that creates circadian patterns in consumer responses to sensory complexity. Second, drawing upon the Theory of Arousal (Berlyne 1967), we provide insight into the underlying mechanism through sequential mediation and moderation. Specifically, individuals tend to match their internal stimulation levels with external stimulation, so consumers' responses to complex sensory experiences tend to become increasingly favorable over the course of the day due to circadian variation in arousal levels. As a result, variation by time of day is sequentially mediated by arousal and perceived fit, with chronotype serving as an important boundary condition. Finally, we contribute to the services literature by identifying important implications for service providers regarding how to vary their offerings and promotions of simple and complex experiences over the course of the day (to be elaborated further in the General Discussion).

THEORETICAL BACKGROUND

Sensory Complexity

Sensory complexity depends on the number of discernible independent sensory elements within a stimulus and their ability to coexist (Palczak et al. 2019). It can refer to the complexity and richness induced by the variations within one sense (e.g., a combination of different flavors within taste, such as mixed flavored juice) or the simultaneous presence of multiple senses (e.g., a spa with stimulating scents, lights, and music) (Palczak et al. 2019; Schreuder et al. 2016). In sensory complexity, the multiple sensory elements coexist within one stimulus and are experienced simultaneously; that is, sensory complexity involves multiple sensory elements, details, and nuances, contributing to a more intricate stimulus

(Palczak et al. 2019; Roose and Mulier 2020). In contrast, variety refers to the number of options that enrich consumers' choices but are not experienced simultaneously (ElMaraghy et al. 2013; Gullo et al. 2019). For example, sensory complexity would refer to a mixed-berry yogurt (comprising multiple berry flavors within one option), whereas variety would refer to a yogurt multi-pack (featuring several different single-flavor berry options).[1] Likewise, sensory complexity refers to a spa treatment combining multiple sensory elements (e.g., music, light, and massage) that are experienced simultaneously, whereas variety refers to different spa treatments, such as dry brushing and hydrotherapy, that can not be experienced simultaneously.

Prior research has found an inverted U relationship between complexity and consumer preference. Consumer preference for a stimulus increases with the complexity level until it reaches the individual's optimal level, then declines (Berlyne 1971; Giacalone et al. 2014). In other words, the optimal level is the key factor in predicting consumer preference for complex stimuli. According to the arousal theory of motivation, each person has a unique arousal level that is right for them (Berlyne 1960; Palczak et al. 2019). People seek stimulation when their arousal level drops below their optimal level. Thus, those with higher optimal arousal levels seek more external stimulation, while those with low optimal levels seek less (Berlyne 1971). Complexity involves an evaluation of similarities and differences between a stimulus' different elements, and therefore, it can make the stimulus arousal-inducing. Thus, those with higher optimal arousal levels will seek more complex stimuli, while those with low optimal levels will seek less complex stimuli (Berlyne 1971).

Variation by Time of Day

Given this backdrop, how might consumers' responses to complex sensory experiences

[1] Should the consumer choose to mix the various single-flavor yogurts from the multi-pack and consume that mixture, then we would refer to it as sensory complexity. The key is whether the multiple sensory elements coexist within the stimulus and are experienced simultaneously.

vary by time of day? One possibility is that consumers' responses do not vary because consumers are predominantly driven by optimal stimulation levels (as previously noted) that are relatively stable and unaffected by time of day. Another possibility is that the time-of-day variation favors *decreasing* positive consumers' responses to complex sensory experiences over the course of the day. For example, consumers have limited mental resources and cognitive energy to devote to decision-making and self-control (Baumeister et al. 2008; Salmon et al. 2014; Vohs et al. 2018). Complex stimuli require more cognitive effort to process (Hildebrand et al. 2021), so if lay beliefs anticipate cognitive depletion for decisions and knowledge-seeking during the day (e.g., due to work experiences) (Burmeister et al. 2022; Chow, Hui and Lau 2015; Graham, Bray and Martin Ginis 2014; Salmon et al. 2014) or over the course of the day due to physical fatigue (Ma, He and Liao 2021), then consumers may respond positively to complex sensory experiences in the morning prior to anticipated depletion. In contrast, we propose a novel phenomenon that time-of-day variation will favor *increasing* positive consumers' responses to complex sensory experiences over the course of the day. The rationale for this prediction is based on the influence of circadian rhythms.

Circadian rhythms, functioning as a "biological clock" (Hofstra and de Weerd 2008), help organisms coordinate their physiology and evoke different functions at different times (Hastings, Reddy and Maywood 2003). Since circadian rhythms synchronize with external time cues such as sunlight (Bass 2012), most people's circadian rhythms are very similar, allowing time of day to be used as a proxy for the circadian phase. Based on the categorization of time of day in the work of Gullo et al. (2019), the morning is from 5 a.m. to 11 a.m., and the evening is from 5 p.m. to 11 p.m. Previous research suggests that circadian rhythms not only help coordinate internal body functions (e.g., sleeping) but also assist people's interactions with the external world (e.g., perceiving stimuli and forming reactions) (Hornik 1988; Hornik and Miniero 2009). For example, individuals employ different

information processing strategies over time of day (Hornik 1988), learn more rapidly (Ebbinghaus 1885), and engage in more self-control behaviors in the morning (vs. in the evening) (Kouchaki and Smith 2014; Zor, Kim and Monga 2022).

Of particular relevance to the current work is how circadian rhythms assist people's interactions with the external world via arousal (Drust et al. 2005; Kleitman 1933, 1938). In pioneering circadian and sleep research, Kleitman (1933) noticed that the speed and accuracy of cognitive performance appeared to be dependent upon the diurnal rhythm in arousal. Specifically, an increase in arousal provokes a decrease in reaction time (Kleitman, Titelbaum and Feiveson 1938). Similarly, accuracy and performance in sports and other tasks, such as recalling the sequences of nine digits, tend to be better when arousal is low in the morning (Atkinson and Speirs 1998; Rana, Rishi, and Sinha 1996; Baddeley et al., 1970; Drust et al., 2005). In general, arousal is shaped by circadian rhythms and follows a consistent circadian pattern: it is usually lower in the morning, increasing logarithmically in a concave manner throughout the day (Gullo et al. 2019; Kleitman 1987; Thayer 1990). Circadian rhythms not only influence arousal but also how much external stimulation people want. Consider, for example, variety-seeking: people feel less arousal in the morning and, therefore, seek less external stimulation (through variety-seeking); as arousal increases over the day, so too does variety-seeking (Gullo et al. 2019). Given that complex sensory stimuli are more arousal-inducing compared to simple sensory stimuli (Berlyne 1967), we, therefore, expect that—as arousal increases over the day—so too will preference for complex sensory experiences. Formally:

> **H1:** Consumers' responses to complex sensory experiences are more favorable in the evening (vs. morning).

Moderation by Chronotype

H1 predicts systematic favorable responses to complex sensory experiences in the

evening (vs. morning), driven by circadian variation in arousal levels. Consumers respond less (more) favorably to complex sensory experiences in the morning (evening) because such experiences don't (do) match their low (high) arousal levels. In other words, people tend to match their internal stimulation levels with external stimulation. If that is the case, how do consumers' responses to complex sensory experiences vary across consumers with different circadian variations in arousal levels? To answer this question, we consider chronotype.

Chronotype refers to differences in circadian rhythms (sleep/wake and alertness patterns) across consumers (Natale and Cicogna 1996). Morning types are individuals who go to bed and wake up early, generally have higher levels of physiological arousal, feel more alert, and are full of energy in the morning. In contrast, evening types are individuals who go to bed and wake up late, generally have lower levels of physiological arousal, and feel less alert and energized in the morning (Baehr, Revelle and Eastman 2000; Natale and Cicogna 1996). Suppose consumers' responses to sensory complexity are driven by arousal. In that case, morning types should respond more favorably to complex sensory experiences in the morning, attenuating the proposed impact of time of day. On the other hand, evening types should respond less favorably to complex sensory experiences in the morning, enhancing the proposed impact of time of day. Formally:

H2: Chronotype will moderate the impact of time of day on consumers' responses to complex sensory experiences, such that the prediction in H1 will hold for evening (vs. morning) types.

Mediation by Arousal and Perceived Fit

H1-H2 are based on the notion that people tend to match their internal stimulation levels with external stimulation. Doing so requires that consumers are sensitive to their own arousal level and whether it matches the stimulation level of sensory complexity. To capture this, we draw upon perceived fit—the general subjective evaluation of individuals regarding how well

an object fits them (Shin, Hwang and Mattila, 2018; Walton and Cohen, 2007).

In general, perceived fit refers to consumers' perceptions of similarity, congruence, relevance, and match between a service/product offering and themselves (e.g., lifestyle, values, needs) (Kivetz and Simonson 2003; Lee et al. 2012; Shin, Hwang and Mattila 2018). Perceived fit leads to a variety of positive consumer responses: for example, the perceived fit between consumer lifestyles and a company's CSR activities increases support for the cause and company (Lee et al. 2012), and perceived fit with the service context enhances solo dining experiences (Shin, Hwang and Mattila 2018). Since perceived fit reflects compatibility with an object (Goodenow 1993; Walton and Cohen 2007), perceived fit in our context reflects the extent to which the sensory experience (i.e., external stimulation) aligns with the consumers' arousal levels (i.e., internal stimulation) (e.g., "How much do you feel like the sensory experience fits your current feelings?"). The higher the perceived fit, the greater the alignment between the internal and external stimulation levels.

Given that a complex sensory experience is high-arousal, consumers should perceive it as a higher fit when their own current internal feelings are also high-arousal—that is, in the evening rather than the morning. Accordingly, the effect of time of day on consumers' responses to complex sensory experiences will be sequentially mediated by arousal and perceived fit: arousal is lower (higher) in the morning (evening), which decreases (increases) the perceived fit of complex sensory experiences, leading to less (more) favorable responses. Moreover, as previously theorized, chronotype moderates the effect of time of day. Morning (vs. evening) types generally have higher levels of arousal in the morning and should, therefore, perceive the complex sensory experience as a good fit with their internal arousal levels, thereby attenuating the impact of time of day in H1. Formally:

H3: The effect of time of day on consumers' responses to complex sensory experiences is sequentially mediated by arousal and perceived fit: arousal is lower (higher) in the

morning (evening), which decreases (increases) the perceived fit of complex sensory experiences, leading to less (more) favorable responses.

H4: Chronotype will moderate the impact of time of day on consumers' responses to complex sensory experiences, such that the sequential mediation in H3 will hold for evening (vs. morning) types.

EMPIRICAL OVERVIEW

A set of five studies was conducted to test our theorizing (see Figure 1 for an organizing framework). Study 1 provides field evidence in a food service context for the effect of time of day on consumers' responses to complex sensory experiences (H1). Studies 2 and Study 3 provide additional evidence for the effect of time of day (H1) and reveal the role of arousal by directly measuring it and via moderation by chronotype (H2). Study 4 further bolsters our theorizing by assessing sequential mediation via arousal and perceived fit (H3). Lastly, study 5 assesses the full model—with moderation by chronotype and sequential mediation by arousal and perceived fit (H4). Together, these findings shed light on how, why, and when consumers' responses to complex sensory experiences will vary by time of day—providing guidance for service providers on the effective delivery of sensory experiences.

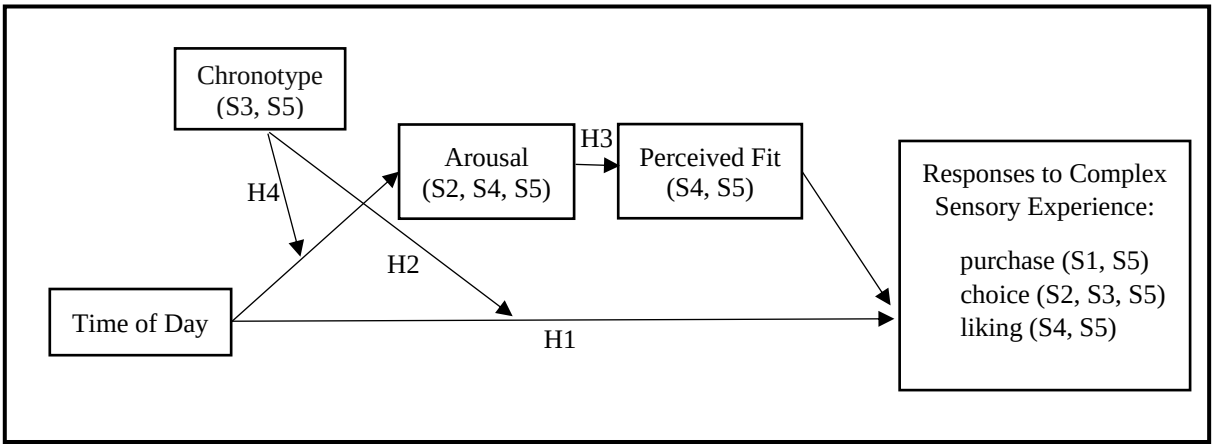

Figure 1: Conceptual Model

STUDY 1: ACTUAL PURCHASE BEHAVIOR IN THE FIELD

The purpose of Study 1 is to provide an initial test of the effect of time of day on consumer responses to complex sensory experiences. We do so in a field study with the cooperation of a service provider in Houston, USA. Consistent with H1, we expect consumers to purchase less complex sensory experiences in the morning but more complex sensory experiences in the evening.

Procedure and Data Description

We tracked consumers' online ordering behavior in a bubble tea shop in the United States over six months, resulting in 1269 transactions. We focused on online orders because each transaction clearly included the drink information, time of day, and the number of toppings (In-store orders are more difficult to track because consumers add their own toppings.). Consumer choice of flavors and toppings served as a measure of consumer preference for sensory complexity. For example, consumers could order less complex drinks (e.g., a classic green tea without any toppings) or more complex drinks (e.g., a mango peach green tea with tapioca, red beans, and pudding). The sensory complexity measure was calculated by summing the explicit flavors and toppings (e.g., a mango peach green tea with tapioca and pudding toppings has 1 base flavor (i.e., green tea), 2 flavors (i.e., mango and peach) and 2 toppings (i.e., tapioca and pudding) for a complexity score of 5). When the number of explicit flavors was unclear, we consulted the owner.

Results

For analysis purposes, we transformed time of day into an hourly interval variable (e.g., 13:15 = 13); Figure 2 shows the relationship between time of day and sensory complexity. A regression analysis of the sensory complexity of consumers' preferences revealed a significant positive effect of time of day ($B = .216$, $t = 9.32$, $p < 0.001$), such that consumers ordered increasingly complex drinks as the day progressed. For robustness, we also

transformed time of day into a continuous variable (e.g., 13:15 = 13.25). Again, a regression analysis revealed a significant positive effect of time of day ($B = .211$, $t = 9.06$, $p < 0.001$). Because some of the explicit flavors were difficult to identify (e.g., mixed fruit tea), we also utilized toppings as the sensory complexity measure and found a similar pattern of results using either transformation (respectively, $B_{\text{hourly interval}} = .206$, $t = 9.71$, $p < 0.001$; $B_{\text{continuous}} = .202$, $t = 9.44$, $p < 0.001$).

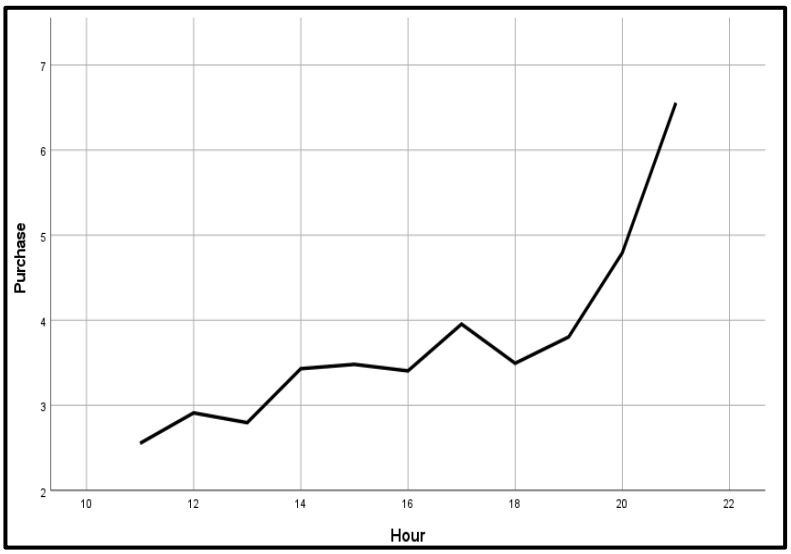

Figure 2: Purchase of Complex Sensory Experiences Varies by Time of Day (Study 1)

Discussion

Study 1 provides preliminary support for H1: consumers' responses to complex sensory experiences tend to become increasingly favorable over the course of the day. These results were robust to varying operationalizations of time of day and sensory complexity; however, one might argue the drinks exhibited differences in sensory complexity and health perceptions due to the different flavors and toppings added. Due to diminished self-control, customers may perceive complex tasting experiences as more hedonic and tempting as the day progresses. (We further discuss and address this alternative explanation in Study 3).

STUDY 2: PREFERENCE/CHOICE FOR A MULTISENSORY EXPERIENCE

The objective of Study 2 is to provide additional evidence for the effect of time of day on consumers' responses to sensory complexity (H1) while providing preliminary evidence for the role of arousal. As an emerging trend in the restaurant industry, many restaurants use state-of-the-art sensory technology, projection mapping, and sounds to deliver complex sensory dining experiences (Bogunovich 2017; Achille 2017). For example, Ultraviolet by Paul Pairet in Shanghai unites food with multi-sensory technology to create a fully immersive dining experience that combines a 20-course meal with lights, sounds, and scents (see more examples in the Web Appendix). According to the definition of sensory complexity, such dining experiences provide good examples of complex sensory experiences. Therefore, we conducted Study 2 within the context of choosing whether to dine at a restaurant offering a complex multisensory service experience.

Participants and Procedure

To examine the impact of time of day, 126 U.S. participants were recruited from Prolific and completed the study in the morning (5 a.m. to 11 a.m.) or the evening (5 p.m. to 11 p.m.) (following Gullo et al. 2019). Participants who completed the survey outside the time frame (i.e., their local times didn't fall into 5 a.m. to 11 a.m. or 5 p.m. to 11 p.m. slots) or who failed attention checks were excluded, leaving 112 participants.

To assess arousal, participants were asked to report how they feel right now ("Please rate how you are feeling right now": aroused, excited, active, elated; 1 = not at all, 7 = very much; $\alpha = .92$; adapted from Fedorikhin and Patrick 2010). Participants then imagined they needed to choose a restaurant for breakfast/brunch (in the morning condition) or dinner (in the evening condition). Participants then saw two restaurant options, where one restaurant provided a more complex multisensory dining service (see Web Appendix). Choice was coded as 1 if participants chose the complex option, otherwise 0. As a manipulation check,

participants rated the complexity of the dining experience ("In general, dining at this restaurant will be a complex experience; 1 = strongly disagree, 7 = strongly agree". Lastly, participants reported their local time and time zone and provided background information (e.g., demographics).

Results

Manipulation Check. As intended, participants perceived the multisensory restaurant dining experience to be more complex than the regular restaurant ($M_{multisensory} = 5.54$, $M_{regular} = 4.06$, $t(111) = 6.88$, $p < .001$).

Consumer Response. Choice of the multisensory restaurant varied by time of day ($\chi^2(1) = 7.84$, $p = .005$), with a higher proportion of participants choosing the complex sensory experience in the evening than in the morning (56.5% vs. 30%; $Z = -2.80$, $p = .005$), supporting H1.

Mediation Analysis. Consistent with our theorizing, an analysis of self-reported arousal revealed that participants were less aroused in the morning than in the evening ($M_{morning} = 3.91$, $M_{evening} = 4.65$, $t(110) = -2.18$, $p = .032$). To assess mediation, a bootstrapping analysis was conducted (PROCESS model 4, 5000 samples; Hayes 2013) with choice as the dependent variable, time of day as the independent variable, and arousal as the mediator. The indirect effect via arousal was supported (effect = .21, SE = .15, 95% CI = [.0077, .5647]), providing preliminary support for the role of arousal.

Discussion

Consumers are more likely to choose a multisensory experience in the evening (vs. morning), driven by increasing arousal levels. These findings support H1 and corroborate field Study 1 with greater experimental control. These findings also provide evidence for the underlying arousal mechanism. However, one might argue that the time-of-day variation in consumers' responses to sensory complexity can be explained by social norms or self-control,

which will be addressed in study 3.

STUDY 3: TESTING THE UNDERLYING AROUSAL MECHANISM VIA MODERATION BY CHRONOTYPE

The objective of Study 3 is to examine the moderating role of chronotype (i.e., testing H2). Specifically, we expect that the effect of time of day in H1 (which arises due to increasing arousal over the course of the day) will hold for evening types but be attenuated for morning types (who experience higher arousal levels in the morning). If supported, this prediction would bolster our evidence for an underlying arousal mechanism (via moderation of process) and also address and rule out several alternative explanations as follows.

First, consider alternative explanations based on other factors that might alter responses by time of day but are unaffected by chronotype. For example, social norms could favor more complex sensory experiences in the evening because it seems more acceptable to indulge and have fun in the evening (i.e., after work) (Heath, Tynan and Ennew 2015; Parker et al. 2020)—but social norms are unlikely to be affected by chronotype. Hence, an alternative explanation, like social norms, can be ruled out if H1 holds for evening types but attenuates for morning types.

Second, complex sensory experiences may be perceived as more hedonic (Hirschman and Holbrook, 1982; Wiedmann et al., 2013) and, therefore, tempting as the day progresses due to diminished self-control. Prior research indicates that morning-type people have stronger self-control in the morning, whereas evening-type people tend to exert more self-control in the evening (Curtis, Burkley and Burkley 2014). If the proposed time-of-day effect is driven by self-control, morning types should respond less favorably to complex sensory experiences in the morning, enhancing the proposed effect of time of day, whereas evening types should respond more favorably to complex sensory experiences in the morning, attenuating the proposed effect of time of day. However, following H2, we expect the opposite pattern – that

H1 holds for evening types who experience increased arousal as the day progresses but is attenuated for morning types whose arousal levels are higher in the morning.

Participants and Procedure

Similar to Study 2, 198 U.S. participants were recruited from Mturk and completed the study in the morning (5 a.m. to 11 a.m.) or the evening (5 p.m. to 11 p.m.) (following Gullo et al. 2019). Participants who completed the survey outside the time frame were excluded, resulting in a final sample of 167 participants.

As a measure of responses to complex sensory experiences, participants were asked to choose among three different flavors of sparkling water: unflavored (control), orange-flavored (simple), and orange & mango-flavored (complex)[2].

Next, chronotype was measured using two items (r = .73) that directly reflect self-categorization to chronotype groups (Jankowski 2015) and are commonly used in different self-reported chronotype questionnaires (e.g., Composite Scale of Morningness (CSM), originally developed by Smith, Reilly and Midkiff 1989; Morningness-Eveningness Questionnaire (MEQ), originally developed by Horne and Ostberg 1976; Diurnal Type Scale (DTS), originally developed by Torsvall and Åkerstedt 1980; Basic Language Morningness (BALM), improved by Brown 1993). The first item asked: "One hears about 'morning' and 'evening' types of people. Which ONE of these types do you consider yourself to be?" (1 = definitely an evening type, 4 = definitely a morning type). The second item asked: "Please indicate the extent you are a morning or evening active individual" (1 = pronounced evening active (morning tired and evening alert), 4 = pronounced morning active (morning alert and evening tired). Responses were coded such that higher scores reflected morning type. Lastly, participants reported their time zone, local time, and background measures (e.g.,

[2] A pilot test confirmed that sparkling waters are commonly consumed throughout the day (differ from the scale midpoint 4: $M_{morning} = 4.68$, $t(89) = 4.08$, $p < .001$; $M_{midday} = 5.09$, $t(22) = 2.67$, $p = .014$; $M_{evening} = 5.33$, $t(70) = 8.83$, $p < .001$).

demographics).

Results

Consumer Response. A multinomial logistic regression of choice as a function of the time of day and chronotype revealed a main effect of time of day ($\chi^2(2) = 8.31$, $p = .016$), qualified by its interaction with chronotype ($\chi^2(2) = 6.39$, $p = .041$); the main effect of chronotype was NS ($\chi^2(2) = 1.629$, $p = .443$). Recoding choice as 1 if participants selected the complex option, otherwise 0, a floodlight analysis (Spiller et al., 2013) revealed that the impact of time of day was significant for all values of chronotype below the Johnson-Neyman point of 2.41 (effect = .75, $z = 1.96$, $p = .05$)[3]. As Figure 3 illustrates, evening-type participants were less likely to choose the complex option in the morning than in the evening (per H1) whereas morning-type participants were not. These results support H2 and are consistent with an account based on arousal.

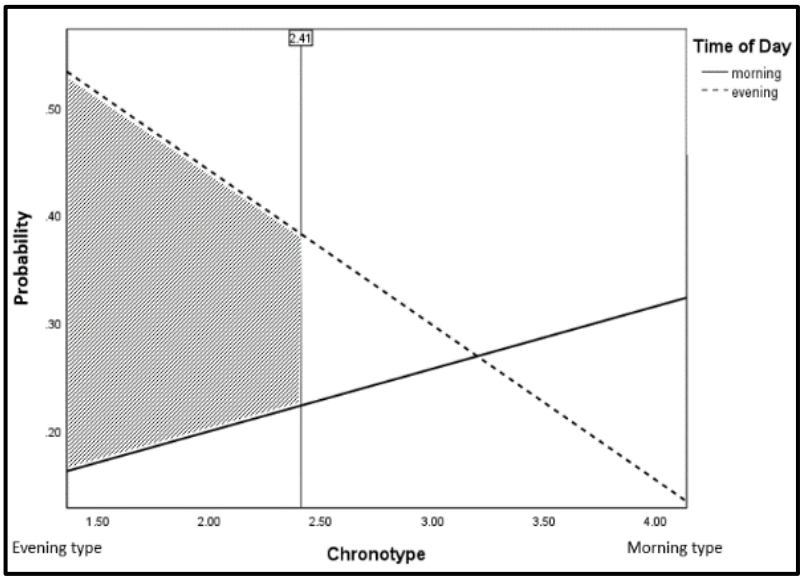

Figure 3: Choice of Complex Sensory Experiences Varies by Time of Day and Chronotype (Study 3)

Discussion

Study 3 finds that consumers are more likely to choose a complex sensory experience in the evening than in the morning, a pattern that emerges for evening types but is attenuated for

[3] For completeness, separate floodlight analyses contrasting the complex option against the control and against the simple option yield similar results (see Web Appendix).

morning types (who tend to experience greater arousal in the morning). This pattern also helps rule out an alternative account based on self-control (which would predict the opposite pattern for chronotype) and alternative accounts based on other factors (e.g., social norms) that might influence consumers' responses by time of day but are unaffected by chronotype.

STUDY 4: A SEQUENTIAL MEDIATION

The objective of Study 4 is to shed further light on the underlying mechanism by assessing sequential mediation via arousal and perceived fit (i.e., testing H3). We expect consumers to have lower (higher) arousal levels in the morning (evening), so they perceive a lower (higher) fit of complex sensory experiences with their current feelings, leading to less (more) favorable responses. As a secondary objective, we assess consumer responses to advertising of multi-sensory experiences (to assess robustness to a promotional context).

Participants and Procedure

A total of 152 U.S. participants were recruited from Prolific and completed the study in the morning (5 a.m. to 11 a.m.) or the evening (5 p.m. to 11 p.m.) (following Gullo et al. 2019). Participants who completed the survey outside the time frame or indicated they were on a nocturnal schedule (e.g., night/irregular shifts) or who failed attention checks were excluded, leaving 129 participants in the final sample.

First, arousal was measured by asking participants to report how they feel right now ("Please rate how you are feeling right now": aroused, excited, active, elated; 1 = not at all, 7 = very much; $\alpha = .85$; adapted from Fedorikhin and Patrick 2010). Participants then imagined they were on vacation and searching for a spa service. Participants saw a full-service spa promoting their new spa experience, advertised as a complex multisensory experience (see Web Appendix). To assess their response to the complex sensory experience, participants were asked to indicate how much they liked the advertised spa experience. To assess perceived fit, participants were asked, "How much do you feel like the advertised spa

experience fits your current feelings?" (1 = not at all, 7 = very much) (drawn from Shing, Hwang and Mattila 2018)[4]. To ensure that the advertised spa experience is perceived as a complex multisensory experience, participants were asked to rate the complexity of the spa experience ("In general, this advertised spa treatment is a complex experience."; 1 = strongly disagree, 7 = strongly agree). Lastly, participants reported their local time and time zone and provided background information (e.g., demographics).

Results

As intended, a simple comparison with the scale mid-point revealed that participants perceived the advertised spa treatment as a complex experience ($M = 5.1$, $t(128) = 7.94$, $p < .001$).

Consumer Response. ANOVA of liking revealed a main effect of time of day ($M_{morning} = 3.09$ vs. $M_{evening} = 3.67$; $F(1, 127) = 4.21$, $p = .042$): consumers indicated a greater liking for the ad featuring a complex sensory experience in the evening (vs. morning). This result supports H1.

Mediation Analysis. To test H3, a bootstrapping analysis was conducted (PROCESS model 6, 5000 samples; Hayes 2013) with time of day as the independent variable, arousal and perceived fit as sequential mediators, and liking as the dependent variable. The results provide support for the proposed sequential mediation chain: time of day→arousal→perceived fit→liking (effect = .18, SE = .10, 95% CI = [.0268, .4244]). (The reverse sequential mediation chain was not supported; effect = -.01, SE = .02, 95% CI = [-.0571, .0213].) As expected, (i) participants had lower (higher) arousal levels in the morning (vs. evening) ($B = .54$, $t(127) = 2.5$, $p = .014$); (ii) arousal level increased the

[4] The construct of perceived fit focuses on the consumers' subjective judgment of how well the complex sensory experience aligns with their internal arousal levels. Hence, rather than measure specific feelings (as we do with arousal), the perceived fit measure focuses on the extent of fit between the internal feeling state and external stimulation (i.e., advertised experience). Single-item measures for perceived fit are commonly used in previous research (Bergkvist and Rossiter 2007; Edwards and Billsberry 2010; Shin, Hwang and Mattila 2018).

perceived fit of the complex spa experience (B = .48, t (126) = 4.2, p < .001), and (iii) perceived fit had a positive impact on liking of the complex experience (B = .70, t (125) = 11.2, p < . 001). These results support H3.

Discussion

Study 4 provides evidence for our theorizing that time-of-day effects are sequentially mediated by arousal and perceived fit (i.e., H3). The match between the level of internal arousal and external stimulation induced by complex sensory experiences increases the perceived fit, leading to a more favorable ad response in the evening (vs. morning).

STUDY 5: FULL MODEL TEST

The objective of Study 5 is to test the full model (H1—H4) with time of day as the independent variable, chronotype as the moderator, arousal and perceived fit as sequential mediators, and consumers' responses to complex sensory experiences (including liking, purchase intention, and choice) as the dependent variables.

Participants and Procedure

A total of 200 U.S. participants[5] were recruited from Prolific and completed the study in the morning (5 a.m. to 11 a.m.) or the evening (5 p.m. to 11 p.m.) (following Gullo et al. 2019). First, arousal was measured by asking participants to report how they feel right now ("Please rate how you are feeling right now": aroused, excited, active, elated; 1 = not at all, 7 = very much; α = .89; adapted from Fedorikhin and Patrick 2010). In addition, participants were also asked to report their local time and indicate whether it was morning, evening, or hard to tell (to address the concern that participants might not define morning and evening as intended by the study design). Participants then imagined they were on vacation and searching for a spa service. As in Study 4, participants saw a full-service spa promoting their new spa experience as a complex multisensory experience. Participants were asked to

[5] No participants completed the survey outside the time frame.

indicate how much they liked the advertised spa experience, their purchase intention (1 = not at all probable; not at all likely, 7 = very probable; very likely; r = .97), and their choice ("I would try this advertised spa experience right now"; 1 = yes, 2 = no). The perceived fit and complexity of the spa experience were measured using the same items as in Study 4. Chronotype was measured using the same two items (r = .77) as in Study 3, and responses were coded such that higher scores reflected morning type. Lastly, participants reported their time zone and provided background information (e.g., demographics).

Results

Participants who completed the study between 5 a.m. and 11 a.m. indicated that they were in the morning (N = 100) while participants who completed the study between 5 p.m. and 11 p.m. indicated that they were in the evening (N = 100). A simple comparison with the scale mid-point revealed that participants perceived the advertised spa treatment as a complex experience (M = 5.08, t (199) = 10.10, p < .001), as intended.

Consumer Responses. Analysis of ad liking as a function of time of day, chronotype, and their interaction revealed a main effect of time of day (B = 1.49, t (196) = 2.09, p = .04), qualified by a marginal interaction with chronotype (B = -.47, t (196) = -1.69, p = .09); the main effect of chronotype was not significant (B = .23, t (196) = 1.24, p = .22). A floodlight analysis (Spiller et al. 2013) revealed that the effect of time of day was significant for all values of chronotype below the Johnson-Neyman point of 2.02 (effect = .55, t = 1.97, p = .05). As Figure 4 illustrates, evening-type participants liked the complex spa experience more in the evening than in the morning whereas morning-type participants did not.

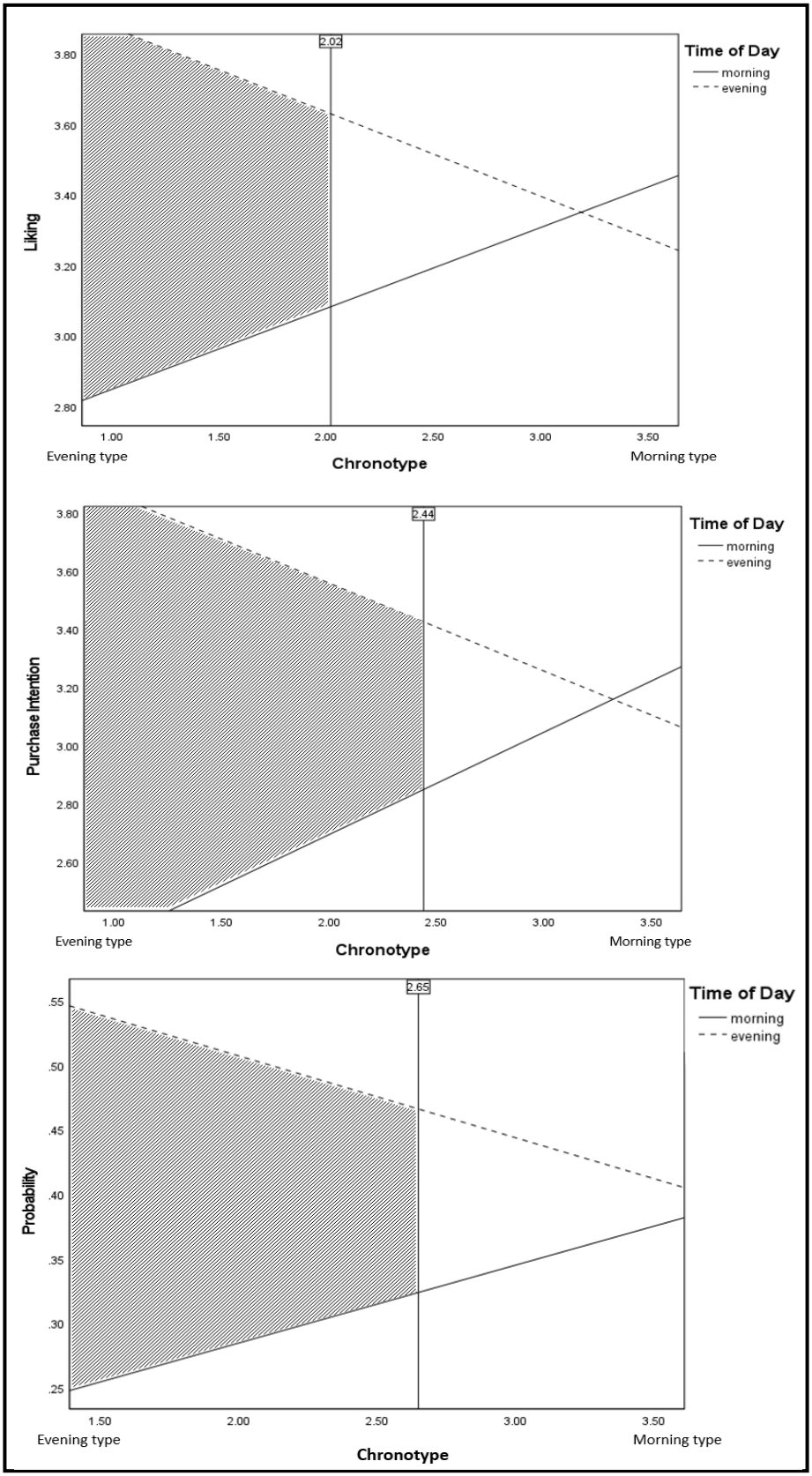

Figure 4: Consumer Responses to Complex Sensory Experiences Vary by Time of Day and Chronotype (Study 5)

A similar pattern emerges for purchase intention and choice. For purchase intention, the analysis revealed a main effect of time of day (B = 2.17, t (196) = 2.68, p = .008), a marginal

effect of chronotype (B = .35, t (196) = 1.68, p = .09), qualified by their interaction (B = -.65, t (196) = -2.08, p = .04)). In a floodlight analysis, the effect of time of day was significant for all values of chronotype below the Johnson-Neyman point of 2.44 (effect= .57, t = 1.97, p = .05). Likewise, recoding choice as 1 if participants would like to try the complex spa experience, otherwise 0, an analysis of choice revealed a main effect of time of day (B = 2.03, z (196) = 2.36, p = .02), qualified by its marginal interaction with chronotype (B = -.54, z (196) = -1.64, p = .10). In a floodlight analysis, the effect of time of day was significant for all values of chronotype below the Johnson-Neyman point of 2.65 for (effect = .61, t = 1.96, p = .05).

Moderated Sequential Mediation Analysis. A bootstrapping analysis was conducted using PROCESS model 86 (Hayes 2013) with time of day as the independent variable, chronotype as the moderator, arousal and perceived fit as the mediators, and liking as the dependent variable. Specifically, the interaction between time of day and chronotype on arousal was significant (B = -.72, t (196) = -3.63, p < .001) with the effect of time of day emerging for all values of chronotype below the Johnson-Neyman point of 2.26 (effect = .37, t = 1.97, p = .05). As shown in figure 5, participants who were evening types had higher arousal levels in the evening than in the morning but this time-of-day difference is attenuated as the value of chronotype shifts toward morning. Also, as theorized, arousal significantly influenced the perceived fit of the complex experience (B = .55, t (197) = 7.47, p < .001), and perceived fit had a positive impact on the liking of the complex experience (B = .85, t (194) = 13.29, p < .001). These results support the proposed moderated sequential mediation (index of moderated mediation = -.34, SE = .11, 95% CI = [-.5892, -.1445]).

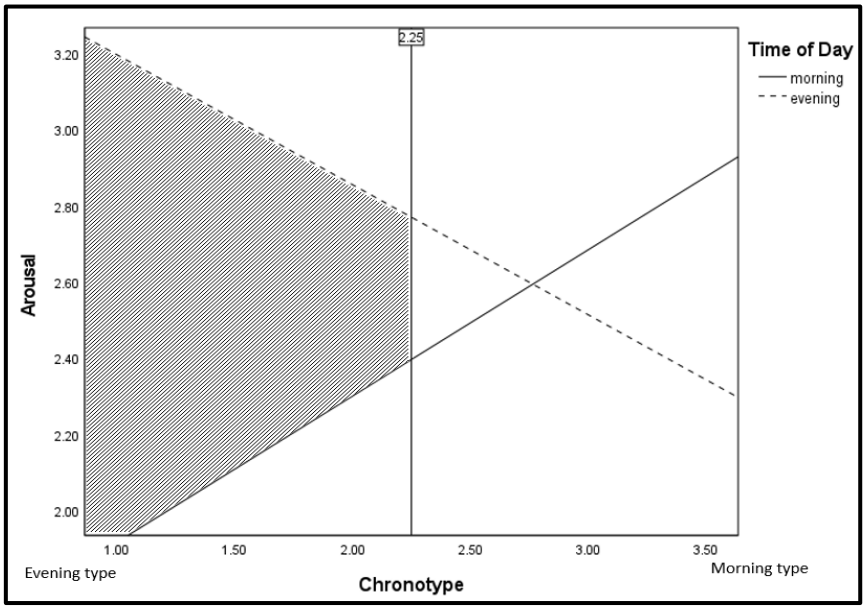

Figure 5: Arousal Varies by Time of Day and Chronotype (Study 5)

A similar pattern of results emerges when using purchase intention (index of moderated mediation = -.38, SE = .12, 95% CI = [-.6506, -.1641]) and choice (index of moderated mediation = -.47, SE = .18, 95% CI = [-.8920, -.2016]) as dependent variables. Specifically, the proposed sequential mediation (time of day→arousal→perceived fit→consumer responses) held for evening types (liking: effect = .43, SE = .14, 95% CI = [.1844, .7353]; purchase intention: effect = .49, SE = .16, 95% CI = [.2081, .8482]; choice: effect = .60, SE = .23, 95% CI = [.2513, 1.1493]) but is not supported for morning types (liking: effect = -.20, SE = .13, 95% CI = [-.4805, .0309]; purchase intention: effect = -.22, SE = .14, 95% CI = [-.5241, .0353]; choice: effect = -.28, SE = .19, 95% CI = [-.7016, .0395]) (see Table 1 in Web Appendix for more details). In addition, note that the alternative moderated sequential mediation chain (time of day→perceived fit→arousal→consumer responses) did not receive support (liking: index of moderated mediation = -.0009, SE = .02, 95% CI = [-.0524, .0445]; purchase intention: index of moderated mediation = -.02, SE = .03, 95% CI = [-.0215, .0825]; choice: index of moderated mediation = .04, SE = .05, 95% CI = [-.0366, .1653]). Together, these results support H4 and the nomological network illustrated in Figure 1.

GENERAL DISCUSSION

This research examines the influence of time of day on consumer reactions to complex sensory experiences. Drawing on the Theory of Arousal (Berlyne 1967), we theorize that consumers tend to feel less (more) internally stimulated in the morning (evening) and, therefore, perceive complex sensory experiences (which are highly arousing) as lower (higher) in fit with their current feelings of internal stimulation, and this perceived fit, in turn, affects their responses to complex sensory experiences. Building upon this theorizing via moderation of process, we identify chronotype as a theoretically (and pragmatically) relevant moderator: people who feel more aroused in the morning (i.e., morning types) respond more favorably to complex sensory experiences in the morning whereas people who feel less aroused (i.e., evening types) respond less favorably to complex sensory experiences in the morning.

Theoretical Implications

This research makes several theoretical contributions. First, this research enhances our understanding of the biological drivers of behavior. Prior research shows that time of day and arousal influence people's performance (e.g., memory tests, sports, reaction times) (Atkinson and Speirs 1998; Baddeley et al., 1970; Kleitman, Titelbaum and Feiveson 1938), information processing (Sanbonmatsu and Kardes 1988), strategic reasoning (Dickinson and McElroy 2012), and variety seeking (Gullo et al. 2019; Huang et al. 2019). This research extends the influence of time of day on consumers' responses to complex sensory experiences. In doing so, this research also adds to the sensory marketing literature by shedding light on the drivers of consumers' responses to sensory complexity. Prior research mainly focuses on the influence of sensory complexity on hedonic responses (Chmiel and Schubert 2017; Giacalone et al. 2014; Lévy, MacRae and Köster 2006), perception of satiation (Larsen et al. 2016; Tang et al. 2016), and factors that influence perceived

complexity (Schlich et al. 2015; Weijzen et al. 2008). Most of these studies examine sensory complexity by focusing on the stimulus itself (Larsen et al. 2016; Lévy, MacRae and Köster 2006; Palczak et al. 2019), exposure time (Lévy, MacRae and Köster 2006) or individual differences in optimal arousal level (Giacalone et al. 2014; Lévy, MacRae and Köster 2006). Little is known about how responses to sensory complexity vary over the course of the day. Taking a novel perspective from the biological basis of behavior, this research addresses this gap by examining the influence of time of day. While the notion of optimal arousal and cognitive depletion may suggest that consumers' responses either remain consistent or become less positive over the course of the day (as discussed previously), the current research identifies the novel phenomenon that consumers' responses to complex sensory experiences become increasingly favorable throughout the day.

Second, this research further elucidates the underlying mechanism by theorizing and providing evidence for sequential mediation by arousal and perceived fit. Gullo et al. (2019) proposed a matching effect on variety-seeking (i.e., people feel less arousal in the morning and seek less external stimulation through variety-seeking to match the felt internal stimulation level)—but their work did not examine the underlying mechanism behind the matching effect. The current research builds upon their work by demonstrating how and when such a matching process plays a role in complex sensory experiences. Specifically, we find that consumers tend to feel less (more) arousal in the morning (evening) and, therefore perceive complex sensory experiences (which are highly arousing) as lower (higher) in fit with their current feelings of internal stimulation. This perceived fit, in turn, affects their responses to complex sensory experiences. In further support of this theorizing, we also examine moderation of process via chronotype: the effect of time of day on consumer responses to complex sensory experiences is altered by individual factors like chronotype (e.g., different sleep/wake and alertness patterns across individuals) that change felt internal

stimulation levels.

Practical Implications

This research provides several important managerial implications. Consumers prefer complex sensory experiences and are more likely to engage in such experiences in the evening (vs. morning). Therefore, service providers should vary their offerings of simple and complex experiences over the day. For instance, restaurants might want to provide more breakfast menu options with simple flavors (e.g., plain yogurt) but more dinner menu options with complex flavors (e.g., sweet and sour chicken wings). Likewise, experiential service providers could provide more time slots for complex services or activities in the evening (e.g., multisensory dining services, multisensory spa services, immersive experiences, 4D movies, VR/AR service/experiences). Considering that the demand for complex sensory experiences may be low in the morning, service providers might want to offer discounts for their complex sensory services or activities in the morning.

In addition, our findings provide guidance for marketing communications. Consumers generally prefer simple sensory experiences in the morning but more complex ones in the evening. Service providers should develop marketing communications that leverage time-of-day-based effects. For offerings that are naturally high (low) in sensory complexity, advertising may be more effective in the evening (morning) than in the morning (evening). Similarly, ads that appeal to sensory complexity should be more effective in the evening than in the morning. For example, to promote spa services in the morning, marketers might want to emphasize the core of the experience – simple relaxation. But when advertising spa services in the evening, they might want to emphasize the multisensory experience– immerse yourself in a complex sensory environment with vibrating beds, VR goggles, and stereo surround music.

Consumers also systematically differ as a function of chronotype in their reaction to

complex sensory experiences over the course of the day. Evening-type (vs. morning-type) consumers are more likely to be influenced by time of day in response to complex sensory experiences. Hence, service providers targeting evening consumers should consider adjusting the sensory complexity of their product or service offerings and their marketing communications to leverage time-of-day differences. For example, extensive research suggests that young people are more likely to be evening types due to circadian disruption by social and environmental factors (e.g., partying, staying up late to study) (Arora and Taheri 2014; Harvey et al. 2018; Karan et al. 2021). Hence, service providers and marketers targeting students, such as travel agencies and restaurants in campus locales, might consider varying their offerings in terms of sensory complexity and advertising over the day. In addition, businesses using mobile apps that can track users' biological data (e.g., sleep and wake-up time, heart rate) can easily detect users with different chronotypes and provide adjusted products or service offerings over time of day to evening-type users.

In contrast, service providers targeting morning-type consumers might not benefit from time-of-the-day adjustments. Older adults (Carrier et al. 1999; Czeisler et al. 1992; Monk 2005), athletes and fitness enthusiasts (Kunorozva et al. 2012; Roden, Rudner and Rae 2017; Silva et al. 2012), and individuals in rural communities (Carvalho, Hidalgo and Levandovski 2014) tend to display morning-type tendencies. Service providers targeting these groups of people may not benefit from varying the sensory complexity of their offerings and communication strategies over the course of the day.

Finally, the selection of communication channels is important. Evening types prefer using new media and technology to get information, while morning types prefer traditional media (Nimrod 2015). Hence, it may also be more effective for marketers to develop communications that leverage time-of-day-based effects on social media instead of traditional media, such as newspapers and television.

Limitations and Future Research

This research is not without its limitations, which also point to promising avenues for future research. First, we use time of day to define "morning" and "evening" in this research, which may not always be consistent with circadian rhythms. Indeed, circadian rhythms and arousal can be adjusted by external cues such as sunlight (Bass 2012), which begs the question: how might sunlight and weather influence consumers' responses to sensory complexity over time of day? For example, lack of sunlight (e.g., cloudiness) makes people feel tired and less aroused (Denissen et al. 2008; Gullo et al. 2019), which could negatively influence consumers' responses to sensory complexity and potentially attenuate time-of-day effects. Future research should also consider other factors, such as food intake and stress, that can affect circadian rhythms (Meléndez-Fernández et al. 2023; Ota et al. 2021).

Second, our research largely focused on morning and evening comparisons, and future research might examine more closely consumers' reactions to complex sensory experiences during the midday. While previous research suggests that an individual's arousal increases in a concave manner throughout the day (Gullo et al. 2019; Kleitman 1987; Thayer 1990), Study 1 finds that consumption of complex sensory experiences increased as the day progressed in a more convex pattern. We lack data regarding arousal levels and sleep/wake patterns in this field study, but one possibility is that consumption in the midday period is less affected by circadian rhythms but instead driven more by the association of the midday with rest and napping (Foscolou et al. 2019; Mantua and Spencer 2017; Zijlstra 2008).

Third, sensory complexity is distinct from variety, and it would be interesting to examine the relationship between complexity and variety in future research. For example, would consumers' variety-seeking behaviors change due to the sensory complexity of the environment? The sensory complexity of the environment may have already fulfilled consumers' need for external stimulation to match their internal arousal levels; if so, then

environmental sensory complexity could reduce variety-seeking behaviors.

Fourth, our research examined multi-sensory experiences in which the sensory elements were somewhat congruent, and future research is encouraged to investigate how consumers react to incongruent sensory elements (van Bergen et al. 2022; Fondberg et al. 2018). For example, consumers prefer the experience of tasting complex flavored drinks in the evening, but would they prefer mixed flavors that are congruent (e.g., multiple berry flavors) or incongruent (e.g., pineapple & cinnamon)? Incongruent sensory elements may be more arousing than congruent elements, leading to a preference for incongruent over congruent sensory complexity in the evening.

Lastly, the present research compared consumer reactions to sensory complexity between participants (i.e., comparing morning and evening groups). It would be interesting to track consumer preferences for sensory complexity within participants over the course of the day. Indeed, variation in sensory complexity is evident in a wide number of domains (including art, music, and other entertainment) – which opens up many interesting questions regarding how consumers react to complex sensory experiences over the course of a day.

FOOTNOTES

1. Should the consumer choose to mix the various single-flavor yogurts from the multi-pack and consume that mixture, then we would refer to it as sensory complexity. The key is whether the multiple sensory elements coexist within the stimulus and are experienced simultaneously.

2. A pilot test confirmed that sparkling waters are commonly consumed throughout the day (differ from the scale midpoint 4: $M_{morning} = 4.68$, $t(89) = 4.08$, $p < .001$; $M_{midday} = 5.09$, $t(22) = 2.67$, $p = .014$; $M_{evening} = 5.33$, $t(70) = 8.83$, $p < .001$).

3. For completeness, separate floodlight analyses contrasting the complex option against the control and against the simple option yield similar results (see Web Appendix).

4. The construct of perceived fit focuses on the consumers' subjective judgment of how well the complex sensory experience aligns with their internal arousal levels. Hence, rather than measure specific feelings (as we do with arousal), the perceived fit measure focuses on the extent of fit between the internal feeling state and external stimulation (i.e., advertised experience). Single-item measures for perceived fit are commonly used in previous research (Bergkvist and Rossiter 2007; Edwards and Billsberry 2010; Shin, Hwang and Mattila 2018).

5. No participants completed the survey outside the time frame.

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