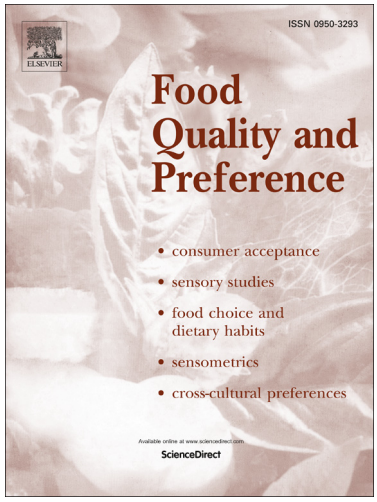

The Crunch Effect: Food Sound Salience as a Consumption Monitoring Cue

Ryan S. Elder, Gina S. Mohr

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The Crunch Effect: Food Sound Salience as a Consumption Monitoring Cue

Ryan S. Elder
Brigham Young University
rselder@byu.edu

Gina S. Mohr
Colorado State University
Gina.Mohr@colostate.edu

Authors contributed equally and are listed in alphabetical order.

Corresponding Author
Ryan S. Elder
690 TNRB
Brigham Young University
Provo, UT 84602

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Abstract

While a growing body of research explores the impact of normative and environmental extrinsic factors on food consumption quantity, less attention is given to the intrinsic cues, or sensory properties, of the food being consumed. Our research contributes to this growing literature by examining the effect of food sound salience (i.e., the sound that a food makes during mastication) on consumption quantity. Specifically, we show that increased attention to the sound the food makes, or food sound salience, may serve as a consumption monitoring cue leading to reduced consumption. Across three studies, we show a consistent negative relationship between the salience of a food's sound and food intake. Our research highlights the importance of intrinsic auditory food cues on consumption. Our findings are valuable to both researchers interested in understanding how sensory cues are connected to consumption and marketers utilizing sound in their communications to consumers.

1. Introduction

Few decisions are as recurrent in a consumer's daily life as those surrounding food consumption. The consequences of these decisions are serious, as overconsumption can lead to obesity (Hill et al., 2003; Levitsky & Pacanowski, 2011), increasing the risk of coronary heart disease, type II diabetes, and even breast cancer ("Adult Obesity Causes & Consequences," 2015). Both practitioners and researchers are eager to understand how consumers can better navigate these food consumption decisions. Indeed, a $60 billion weight-loss industry, including diet books, drugs, and weight-loss surgeries ("The U.S. Weight Loss Market," 2015), illuminates the magnitude of this consumer need.

Appropriately, researchers have increasingly explored the drivers of overconsumption and have emphasized the *extrinsic* factors that impact food consumption quantity, including norms, emotions, and external sensory cues (e.g., Bublitz, Peracchio, & Block, 2010; Cornil, Ordabayeva, Kaiser, Weber, & Chandon, 2014; Rozin, Trachtenberg, & Cohen, 2001; Wansink & Chandon, 2014). While the list of normative (Herman, Roth, & Polivy, 2003; McFerran, Dahl, Fitzsimons, & Morales, 2010) and emotional (Gardner, Wansink, Kim, & Park, 2014; Maier, Makwana, & Hare, 2015; Winterich & Haws, 2011) determinants of overconsumption is ever increasing, consumers still report their internal state of satiation, or feeling full, as a primary reason to stop consumption (Vartanian, Herman, & Wansink, 2008). However, in actuality, internal physiological cues are poorly utilized, especially within overweight and obese populations (Herman & Polivy, 2008; Schachter, Goldman, & Gordon, 1968). Thus, consumption researchers have shifted their focus from internal drivers of consumption quantity (i.e., hunger and satiation) to external sensory cues such as ambient sound, scent, and temperature.

The impact of *intrinsic* cues, or sensory properties of the food itself, on consumption has also received increased attention. Extant research in this area has characterized the impact of food taste (Pliner & Mann, 2004), smell (Krishna, Morrin, & Sayin, 2014) and visual properties (Kahn & Wansink, 2004) on consumption. To expand to this research stream, we explore how the intrinsic auditory cues elicited during consumption impact consumption quantity. Across three studies, we show that increased attention to the sound the food makes, or food sound salience, leads to reduced consumption. Our research adds to the literature showcasing the impact of sound on flavor perception and consumption (Christensen & Vickers, 1981; Dematte et al., 2014; de Liz Pocztaruk et al., 2011; Spence, 2012, Spence & Shankar, 2010; Woods et al., 2011).

We choose to focus on food sound salience as sound has traditionally been the "forgotten" flavor sense (Spence, 2015), leading to its underutilization in flavor perception. Despite the recent literature establishing sound as an integral component of flavor (Dematte et al., 2014; Spence, 2012, 2015), data from our pilot study suggest that consumers still consider sound an unimportant attribute in their consumption decisions. Food sound salience can have a unique impact on food regulation as it can be manipulated by the individual at the time of consumption by either paying increased attention to the sound, or by regulating the sound during mastication. This attention to sound can be consumer initiated, or even directed by food packaging or advertising cues. Therefore, establishing a link between intrinsic sound and consumption quantity is valuable for both sensory science researchers interested in understanding how sensory cues are connected to consumption, and practitioners who emphasize sound in their communications to consumers.

1.1 Literature Review

1.1.2 Sensory Cues and Consumption

Through a variety of mechanisms, extrinsic sensory cues affect consumption quantity. Pleasant (unpleasant) aromas that are congruent (incongruent) with the food increase (decrease) consumption (Fedoroff, Polivy, & Herman, 1997; 2003; Wadhwa, Shiv, & Nowlis, 2008). Visual cues, such as lighting, impact how long a consumer spends in a restaurant, and consequently how much food is ordered (Lyman, 1989; Stroebele & De Castro, 2004). Sound (via background music) has been shown to affect food consumption by changing the perceived passage of time (Caldwell & Hibbert, 2002; Guéguen et al. 2004, 2008), impacting consumers' moods (Alpert & Alpert, 1990), distracting consumers (Bellisle & Dalix, 2001; Stafford, Fernandes, & Agobiani, 2011; Wansink, 1992), and biasing consumers' behaviors by activating attributes consistent with the sounds (North & Hargreaves, 1997, North, Hargreaves, & McKendrick, 1999).

Food consumption quantity is not only subject to the extrinsic sensory cues present in the surrounding environment, but also the intrinsic sensory cues experienced from the food stimulus itself. The most obvious intrinsic sensory cue, taste, has been conceptualized in existing research as palatability, or the experienced pleasure of eating. Perhaps unsurprisingly, palatable foods are consumed in greater quantities than unpalatable foods (Bobroff & Kissileff, 1986).

Additional research on intrinsic sensory cues and food has focused on a subset of the sensory modalities and has largely explored evaluations rather than consumption quantity. Food visibility (Deng & Srinivasan, 2013; Scheibehenne, Todd, & Wansink, 2010), color (Dubose,

Cardello, & Maller, 1980; Geier, Wansink, & Rozin, 2012; Hoegg & Alba, 2007), or presentation (Reisfelt, Gabrielsen, Aaslyng, Bjerre, & Møller, 2009) all impact evaluations. More recently, texture (Biswas, Szocs, Krishna, & Lehmann, 2014) and aromas (Krishna, Morrin, & Sayin, 2014) associated with food have also been shown to be important factors affecting consumption evaluations.

The role of intrinsic sound in food consumption has recently received increased attention, primarily in relation to evaluations of the food and not the quantity consumed (see Spence, 2015; Zampini & Spence, 2004, 2010). Crispness, in particular, is the auditory descriptor that is most strongly associated with the pleasantness of a food (Vickers, 1982), although research suggests that crispness is not solely determined through auditory cues (Christensen & Vickers, 1981). More recent work in this area confirmed that crispness of a food impacts food quality (Zampini & Spence, 2004). Specifically, by selectively manipulating the frequency and amplitude of the sound feedback produced when eating a potato chip, Zampini and Spence (2004) demonstrate a direct link between sound and perceptions of product freshness.

While these studies highlight the important role that sound plays in food evaluations, what remains unclear is the effect of food sound on the quantity of food consumed. In the current research we address this gap by directly testing the relationship between food sound salience and the quantity of food consumed. We explore factors that are expected to directly affect consumption quantity, and can be manipulated by consumers themselves (Wansink & Chandon, 2014).

1.1.3 Consumption Monitoring

An important determinant of food regulation is whether consumers are provided with the opportunity to monitor their consumption. Sensory cues that have been shown to enhance consumption monitoring have been visual in nature. For example, Geier, Wansink, & Rozin (2012) show that "pause points" can be created by enhancing the salience of the visual aspects associated with a snack item (i.e., red potato chips in a container of regular potato chips), which, in turn, encourage monitoring and decrease consumption. In another study, the consumption of chicken wings decreased by 27% when the remaining bones of the eaten chicken wings were left on the table compared to when the waitress took them away (Wansink & Payne, 2007). Thus, drawing attention to the consumed food led to a decrease in consumption (Wansink, 2006; Wansink & Chandon, 2014).

Just as the sight of consumed food helps consumers monitor their food intake, we predict that drawing attention to the sound of the food may also serve as a consumption monitoring cue. Formally, we hypothesize that increasing (vs. decreasing) food sound salience will lead to less food consumption. The sound that a crunchy food makes when it is consumed provides an intrinsic cue of consumption such that when the consumer no longer hears the sound of the food, an auditory pause in the consumption experience is created. Alternatively, when the crunch of the food is not salient, and the natural pause points created by the sound are not available, the ability to monitor consumption is impaired. In this research we establish the importance of food monitoring via intrinsic sensory cues by focusing on the role of intrinsic food sound on consumption quantity.

We present a pilot study and three additional lab studies to test these relationships. The pilot study establishes consumers' lay beliefs about the role that each sensory modality plays in their food consumption experience. Study 1 tests the relationship between food sound salience

and food consumption quantity. In study 2, we explore an alternate means of isolating intrinsic food sound to test its effect on consumption quantity. Finally, study 3 showcases the managerial implications of our findings and conceptually replicates the prior studies by manipulating food sound salience through advertising.

2. Pilot Study

2.1 Materials and Methods

2.1.1 Participants

Two hundred twenty-three undergraduates (63% male) at a western university participated in this study for course credit.

2.1.2 Stimuli

In an online survey format, a hypothetical eating scenario was presented to all study participants. Participants were told that, “We would like you to think of a typical, but specific sandwich that you will eat. Please imagine that you are eating alone.” Following this prompt, participants evaluated what they imagined on dimensions relating to food quality and consumption quantity.

2.1.3 Design and Procedure

The design for the pilot study was a one factor within subjects design. Participants answered all questions for each of the five senses. Study participants accessed the study online while seated at individual computer terminals. On the first screen of the study, participants were provided with the description of the eating scenario to which they would provide their reactions. After reading the scenario, participants were asked: "When determining what you are going to eat, how important are the following food-related sensory cues?" (1 = not at all important; 7 = extremely important); "When determining when to stop eating, how important are the following food-related sensory cues?" (1 = not at all important; 7 = extremely important); "In a typical meal, how QUICKLY do you get BORED of the following sensory experiences when eating?" (1 = not at all quickly; 7 = extremely quickly); "How important is each food-related sensory experience in determining how much you enjoy your meal?" (1 = not all important; 7 = extremely important). For each of these questions, respondents provided a rating for vision, taste, smell, sound, and touch.

2.1.4 Data Analysis

Paired-samples t-tests were conducted to examine differences between participants' ratings for each sensory modality.

2.2 Results

2.2.1 Sensory Modality Importance

Analysis revealed that sound was expressed to be less important, compared to vision, taste, smell, and texture, in determining when participants decide to start eating, stop eating, and how much participants would enjoy the meal (all comparisons with sound Bonferonni corrected, $p < .05$; see table 1 for means). Participants also stated that they become bored of the sound of eating food more quickly than they do of the other sensory modalities (Bonferonni corrected, all $p < .05$).

Insert Table 1 About Here

2.3 Discussion

These findings offer support for the notion that, like food scientists, consumers place little importance on the role of sound in the eating experience. These data suggest that consumers do not believe that a food's sound has an effect on: 1) the quantity of food consumed; or 2) their enjoyment of the meal. In addition, sound can be directly manipulated by the consumer, making food sound salience an important construct to explore from both sensory science and managerial perspectives. In the studies that follow, we explore the main effect of intrinsic food sound salience on consumption quantity and test the prediction that making auditory cues associated with food consumption more salient, may limit the quantity of food consumed.

3. Study 1

3.1 Materials and Methods

3.1.1 Participants

One hundred eighty-two undergraduates (69% male) participated in the experiment.

3.1.2 Stimuli

The food stimuli used in this study were eight mini Famous Amos cookies (2 servings; 300 calories). The food was presented in a white plastic bowl at the top left of the participant's desk. At the beginning of the study, the bowl was covered by a plain white piece of paper. The independent variable, food sound salience, was manipulated in three experimental conditions. To determine whether the intensity of food sound differentially impacted consumption over and above focusing on intrinsic food sound, two food sound salience conditions were created—loud, and quiet. In the loud food sound salience condition the food sampling instructions provided to study participants read, "we would like you to eat the snack food as loudly as you can." In the quiet food sound salience condition the instructions stated that, "we would like you to eat the snack food as quietly as you can." In the control condition, instructions stated that, "we would like you to eat the snack food as you ordinarily would."

3.1.3 Design and Procedure

The design for study 1 was a one factor between subjects design with three levels of food sound salience (quiet, loud, control). Participants were seated at individual carrels and were instructed to put on headphones to reduce distractions. The study was administered using an online survey instrument, and the first screen introduced participants to the study. Participants were told that, "In this study we are interested in how consumers eat and evaluate various snack foods. You have been provided with a bowl of food. Do not uncover or begin sampling until instructed to do so. On the following screen you will be given very specific instructions on how to sample the food that has been given to you. In addition, given the nature of this study, we ask that you please put on the headphones so that you are not distracted by other research participants. Please proceed when you are ready."

Participants were then randomly assigned to one of the three experimental conditions described above and told that, "We ask that you try at least one, though you are welcome to eat as many as you would like. When you are ready to sample the food please proceed to the next screen of this survey."

Participants were instructed to inform the research assistant when they completed the taste test. At that moment, the bowl of uneaten cookies was removed from the carrel. The remaining cookies were later counted to determine the total number of cookies consumed.

On the following screens, participants then rated their evaluations of taste [How would you rate the overall taste of the snack food? (1 = very poor taste, 9 = very good taste)]; quality [How would you rate the overall quality of the snack food? (1 = very poor quality, 9 = very good quality)], deliciousness [How would you rate the overall deliciousness of the snack food? (1 = not at all delicious, 9 = very delicious)]; enjoyment [How much did you enjoy eating the snack food? (1 = not at all, 9 = very much)], and whether they would like to eat more of the snack if

they had it again tomorrow [How much would you like to eat more of the snack food you had today again tomorrow? (1 = not at all, 9 = very much)].

We also asked participants to indicate how intense their sensory experiences (vision, taste, smell, sound, and touch) were with the snack food on 7-point scales (1 = not at all intense, 7 = extremely intense).

3.1.4 Data Analysis

Our dependent variables were food sound intensity and food consumption quantity. The quantity of food consumed was measured by creating a difference score between the original number of cookies provided to study participants (eight) and the number of cookies remaining. We conducted two separate ANOVAs with food sound salience as the independent variable and sound intensity and quantity consumed as the dependent variables. Post-hoc mean comparisons tested for statistical differences among the experimental conditions.

Additional dependent measures were ratings of taste, quality, deliciousness, enjoyment, and whether participants would like to eat more of the snack if they had it again tomorrow. In this or the subsequent studies, there was no effect of experimental condition on ratings of taste, quality, deliciousness, enjoyment, or whether they would like to eat more of the snack if they had it again tomorrow ($p > .1$). We will not discuss these measures further.

3.2 Results

3.2.1 Sound Intensity

One participant did not follow instructions to eat at least one cookie and was removed from our analyses. An ANOVA showed differences in sound intensity ($F(2, 178) = 3.28$, $p < .05$), with participants in the loud food sound salience condition rating the eating experience to be more intense ($M_{loud} = 5.28$) than participants in the control condition ($M_{control} = 4.53$; $t(178) = 2.49$, $p < .05$), but not the quiet food sound salience condition ($M_{quiet} = 4.75$; $t(178) = 1.76$, $p = .079$).

3.2.2 Consumption Quantity

When analyzing food sound salience as a three level factor (control, quiet, loud), we find a marginally significant main effect on consumption quantity ($F(2, 178) = 2.66$, $p = .097$). The means and follow up contrasts (Tukey HSD corrected) reveal only directional differences between means. Specifically, loud food sound salience (eating loudly) led to less consumption than the control condition ($M_{loud} = 2.65$, $M_{control} = 3.38$; $p = .09$, one-tailed). Quiet food sound salience (eating quietly) also led to less consumption than the control condition ($M_{quiet} = 2.59$; $t(178) = 1.96$, $p = .06$, one-tailed) (Figure 1). These differences, however, were not significant. There was no difference in consumption between the quiet and loud food sound salience conditions ($p > .7$).

Our primary analysis of interest was examining the impact of food sound salience on consumption quantity. We collapsed across quiet and loud conditions and tested the effect of the combined food sound salience conditions, compared to the control, on consumption quantity in an ANOVA. Our analysis revealed a significant effect, with the food sound salience condition

leading to less consumption than the control condition ($M_{food\ sound\ salience} = 2.61$, $M_{control} = 3.38$; $F(1, 179) = 4.73$, $p < .05$).

Insert Figure 1 about here

3.3 Discussion

We showed that both quiet and lout food sound intensity similarly manipulated food sound salience. Thus, operationally, manipulations of attention to the sound the food makes should impact food sound salience. Additionally, it is probable that food sound salience increased the focus (i.e., mindfulness) on the eating experience. Thus, the predicted effect of food sound salience on quantity consumed might be a function of making other sensory cues more salient as well. Therefore, the primary aim of study 2 is to directly manipulate food sound salience without incurring an additional effect of mindfulness on the eating situation. Specifically, in study 2 we isolate the salience of the intrinsic food sound without drawing attention to other sensory cues. We predict that high, compared to low, food sound salience will result in lower food consumption quantity.

4. Study 2

4.1 Materials and Methods

4.1.1 Participants

Seventy-one undergraduates (67% male) completed this study for course credit.

4.1.2 Stimuli

The food stimuli used in this study were Snyder's mini pretzels. Each participant was provided with a plain white bowl of 10 pretzels (.5 servings; 55 calories). At the beginning of the study, the bowl was covered by a plain white piece of paper. Food sound salience served as the independent variable in study 2 and was manipulated by adjusting the volume level of white noise played through headphones. In the low food sound salience condition, participants heard a loud ambient sound in the headphones, masking the natural sound produced by mastication, thereby making the food sound less salient. In contrast, in the high food sound salience condition, participants heard a quiet ambient sound, allowing participants to hear the natural sound of mastication, thus making the food sound more salient. We tested the effectiveness of our manipulation in a separate pretest[1].

[1] In order ensure the effectiveness of our manipulation, we pretested the two sound levels. In the pretest, 83 undergraduates consumed pita chips while wearing headphones playing white noise (-29.5 dbFS for high food sound salience, 14.5 dbFS for low food sound salience). Participants were asked to report how much the headphones prevented them from hearing the food sound, how well they could hear the food crunching, and how loud the sound of the food was when they ate it (α = .89). As expected, when the ambient noise in the headphones was loud, the food sound salience was lower than when the ambient noise was quiet (M_{loud} = 3.97, M_{quiet} = 4.32; $F(1, 81) = 5.26$, $p < .05$).

4.1.3 Design and Procedure

The design for study 2 was a one factor between subjects design with two levels of food sound salience (high, low). Participants were seated at individual carrels with a covered bowl of pretzels and told to put on headphones to reduce distractions. The headphones were used to manipulate food sound salience. Similar to the procedure in study 1, the study was conducted using an online survey platform. At the beginning of the survey, participants rated their current state on several dimensions (happy, hungry, alert, tired). We were interested in how hungry participants were but wanted to disguise it among the other measures. Specifically, participants answered: "How hungry are you right now?" (1 = not at all hungry; 7 = very hungry). After these measures, participants advanced to a screen that automatically played either loud, or quiet, white noise into the headphones. The white noise was manipulated accordingly for each of the sound salience conditions. Participants were provided with the following instructions: "Eat at least one of the snack items. You may eat as many as you like after the first one. When you are finished sampling, please proceed to the next page." Participants were instructed to cover and return the uneaten pretzels to the corner of the desk and proceed to the next screen on the computer.

Similar to study 1, the primary measures of interest were ratings of taste, quality, deliciousness, and enjoyment of eating the snack food and how much they would like to eat more of the snack if they had it again tomorrow. As a manipulation check, participants were asked to rate: "How loud was the sound in the headphones?" (1 = very quiet; 7 = very loud)

4.1.4 Data Analysis

An ANOVA was conducted to test the relationship between our independent variable, sound salience, and our dependent variable, consumption quantity. Similar to study 1, food consumption quantity was measured by calculating the difference between the original number of pretzels (ten) and the remaining number of pretzels. Prior to our analysis, we removed the four outliers present (75% male, all were in the high food sound salience condition as there were no outliers indicated in the low food sound salience condition). We defined an outlier as 1.5 IQR above or below the first and third quartiles (Tukey, 1977, Van den Bergh, Dewitte, & Warlop, 2008). An analysis using two standard deviations above and below the mean resulted in the same outliers. Removing the outliers did not change the pattern of results. Remaining were 67 participants (67.2% male; 32 in high food sound salience, 35 in low food sound salience). A manipulation check confirmed that participants in the low food sound salience condition rated the sound in the headphones to be louder than participants in the high food sound salience condition ($M_{low} = 5.74$, $M_{high} = 2.50$; $F(1, 65) = 126.00$, $p < .001$).

4.2 Results

4.2.1 Consumption Quantity

We conducted an ANOVA with food sound salience as the independent variable, hunger as a covariate, and pretzels consumed as the dependent variable. Our analysis revealed hunger to be a significant covariate ($p = .05$). More importantly, we found that participants in the high food

sound salience condition consumed fewer pretzels than those participants in the low food sound salience condition ($M_{low} = 2.75$, $M_{high} = 4.11$; $F(1, 64) = 5.27$, $p < .05$) (Figure 2).

Insert Figure 2 about here

4.3 Discussion

The findings from study 2 show that manipulating food sound salience can impact consumption quantity, with higher (vs. lower) food sound salience leading to less consumption. In study 3, we explore the managerial implications for food sound salience. Specifically, we manipulate food sound salience through product description, such as those used in labeling or advertising.

5. Study 3

5.1 Materials and Methods

5.1.1 Participants

One hundred fifty-six undergraduates (59.6% male) participated in the study for course credit.

5.1.2 Stimuli

The food stimuli used in this study were eight Toll House Pita Chips: Mediterranean Herb (1.33 servings; 93 calories). The food was presented to participants as in the prior studies, in a plain white bowl covered by a white piece of paper. We operationalize food sound salience in two experimental conditions by manipulating the description of the food by either emphasizing the food's sound, compared to its taste (modified from Elder & Krishna, 2010). In the food sound salience condition, the product description read, "Our pita crackers deliver the crunch you crave. You'll love the crispy sound of each bite. Our new pita crackers are the perfect crunchy choice for all your snacking." In the taste salience condition, the product description read, "Our pita crackers deliver the taste you crave. You'll love the delicious flavor of each bite. Our new pita crackers are the perfect tasty choice for all your snacking."

5.1.3 Design and Procedure

The design for study 3 was a one factor between subjects design with two levels of advertisement sense (taste, sound). Study participants were seated at individual carrels. The study instructions were provided in an online survey. After being introduced to the study on the first screen, and reporting their hunger level among other items as in study 2, participants were randomly assigned to one of the two experimental conditions when they advanced to the next screen. Each participant was instructed to read an excerpt from the packaging for the snack food. After reading this, participants were told to eat at least one of the snack items. Participants rated their evaluations of the snack food as in the prior studies, as well as the extent to which they paid attention to individual sensory experiences while eating the pita chips, and which sensory experience the advertisement focused on. This last measure served as our manipulation check.

Participants were specifically asked, "What was the main sensory experience used in the packaging description for the pita crackers?" Responses included each of the five senses: "The look/taste/sound/smell/feel of the pita crackers."

5.1.4 Data Analysis

Our dependent variable was the number of pita chips consumed and calculated by subtracting the remaining pita chips in the bowl from the original quantity provided (eight). An ANOVA was conducted with sound salience condition as the independent variable and quantity of pita chips consumed as the dependent variable.

Of the 156 participants, 5 were removed due to experimenter error (failure to record the number of pita chips consumed). Twenty-eight participants failed the manipulation check of correctly identifying the sensory experience portrayed in the advertisement (i.e., taste of the pita crackers in the taste condition, sound of the pita crackers in the sound condition). Thus, our resulting sample was 123 undergraduate participants (61.8% male, 58 in sound condition, 65 in taste condition).

The advertisement manipulation was largely successful in impacting attention to sensory experiences. Participants in the taste salience condition reported paying significantly more attention to taste than participants in the food sound salience condition ($M_{sound} = 6.14$, $M_{taste} = 6.48$; $F(1, 122) = 5.13$, $p < .05$). Participants in the food sound salience condition reported paying directionally more attention to sound than participants in the taste salience condition ($M_{sound} = 5.12$, $M_{taste} = 4.68$; $F(1, 122) = 2.24$, $p = .14$).

5.2 Results

5.2.1 Consumption Quantity

We conducted an ANOVA with food sound salience as the independent variable, hunger as a covariate, and consumptions quantity as a dependent variable revealed hunger to be a significant covariate ($p = .04$). Importantly, participants ate significantly fewer pita chips in the food sound salience condition than in the taste salience condition ($M_{sound} = 4.79$, $M_{taste} = 5.86$; $F(1, 120) = 4.21$, $p < .05$) (Figure 3). There were no significant differences between conditions on evaluations.

Insert Figure 3 about here

5.3 Discussion

5.3.1 Summary

Across three studies, in which we operationalize food sound salience through different methods, we show a consistent negative relationship between the salience of a food's sound and food intake. In study 1, participants consumed less compared to a control condition when the food sound was salient. In study 2, we manipulated food sound salience through ambient sound delivered via headphones. We again showed that making the food sound more salient decreased consumption quantity. Finally, in study 3 we showed that marketing communications that make a food's sound salient, compared to its taste, lead to a decrease in food intake. Our findings

demonstrate a direct link between sound and consumption quantity and provide important insights to practitioners and researchers who seek to better understand the various factors that can curb over-consumption. Below we provide direction for future research as well as outline practical insights from our findings.

5.3.2 Limitations and Future Research

Although intrinsic food sound may be an important product factor, the study of sound as it relates to consumption quantity has been limited to its role as an extrinsic cue. For example, extrinsic sounds (i.e., background music) have been shown to affect consumption quantity by influencing the speed at which patrons eat (Milliman, 1986) or by enhancing the mood of the consumer (Guéguen et al., 2008). Sound as an intrinsic cue in the food consumption experience, however, has been limited to its effect on perceptions of a product's quality (i.e., freshness; Zampini & Spence, 2004). Our research addresses this gap by directly examining the role of intrinsic food sound on consumption quantity.

Our focus on the relationship between intrinsic food sound and consumption quantity will be of interest to food scientists who have, in earlier work, focused on the association between auditory cues and the detection of a food's crispness or crunchiness (Christensen and Vickers 1981; Wood et al., 2011) and the association between crispness and food quality (Zampini and Spence 2004). Interestingly, Christensen and Vickers (1981) use a similar masking technique that we use in study 2 (i.e., headphones to produce ambient sound) to show that auditory cues associated with biting are not necessary for the detection of food crispness. Subsequent research

also explored the impact of background noise on food crunchiness, liking, and other sensory properties, showing that the louder background sound increases perceived crispness (Woods et al., 2010). Although we show that a louder background sound leads to lower food sound salience (study 2), it is possible that the background sound in our studies could have impacted perceived crunchiness, but we did not explore this measure as it was not central to our theorizing. There is, however, considerable room for future research to explore how sensory properties of the food such as crispness and crunchiness impact overall consumption. We focus on food sound salience, in general, and not on these specific sensory properties. Our research should help build a theoretical foundation for future research, including what other sensory factors, and perhaps individual factors, moderate the relationships found in our studies and earlier work in this domain.

Given the exploratory nature of the research, we did not fully explicate the process by which food sound salience affects consumption quantity. One possibility is that food sound serves as a sensory consumption monitoring cue, similar to visual cues (e.g., red potato chips, visibility of the food in a package). Another possibility is that consumers simply get bored with the consumption experience when food sound is made salient. Beyond establishing the process for the present phenomenon, the ability of sensory cues beyond vision to serve as consumption monitoring cues is a promising avenue for future research.

Across our studies we show that increases in food sound salience decrease consumption quantity. However, there may also be scenarios where food sound salience leads to increased consumption. Deng and Srinivasan (2013) show that the visual salience of food through transparent packaging may increase consumption when the food is attractive (e.g., Froot Loops), but that the same transparency may decrease consumption when the food is large (e.g., cookies),

as consumers use the visual cue for consumption monitoring. In a similar manner, there may be instances where food sound salience would increase consumption, such as the unique, positively valenced crackling sound of Pop Rocks. Future research can explore additional boundary conditions regarding when food sound salience negatively or positively impacts consumption quantity.

We chose to focus on a food's sound, compared to its other sensory characteristics, primarily because intrinsic food sound has yet to be explored as a potential consumption monitoring cue. Additionally, sound occupies a unique space as it is not considered to be as important as other sensory modalities in the food consumption experience (i.e., our pilot study; Spence, 2015). While in study 3 we show that describing a product in terms of sound versus taste led to a decrease in consumption, given the low importance consumers place on sound, it is possible that manipulating the salience of other sensory experiences will lead to an even greater decrease in consumption when compared to sound. Future research could explore this possibility.

5.3.3 Managerial and Public Welfare Implications

Our findings provide important insight to both researchers and practitioners interested in understanding how sensory factors may influence food consumption. First, we demonstrate that food sound salience can be manipulated by the consumer, the environment, or through marketing communications to affect food consumption quantity. To our knowledge, this relationship has not been examined in existing research despite the importance that food sound has in the consumer environment. Products such as Doritos, Pringles, and Corn Nuts continually use intrinsic sound as a marketable attribute of their products. Manufacturers of Magnum ice cream bars received criticism from consumers when they reformulated their product to reduce the

extent to which the chocolate coating was slipping off the ice cream bar. They later learned that this "problem" was actually enjoyed by consumers because the chocolate's brittle quality produced the iconic "crackling sound," that was so integral to the eating experience (Spence, 2015). Consequently, manufacturers returned to their original formulation in order to preserve the sound intensity of the ice cream bar. Food sounds matter to consumers, and our research presents previously unknown downstream consequences of highlighting these sounds in marketing communications.

Our findings also illuminate the importance of understanding sensory cues as influential factors in food consumption. While existing research places little importance of the role of intrinsic sound in the consumer food environment, we demonstrate that the salience of a food's sound can in fact significantly impact the quantity of food a person eats. Our basic finding is both generalizable and robust, with our studies testing the effect across different products (both healthy and unhealthy snack foods) and contexts.

Next, our research also contributes to a growing effort by researchers across disciplines to understand the drivers of overconsumption, which is cited to be an important contributing factor to rising obesity rates. The World Health Organization cites that the prevalence of obesity more than doubled between 1980 and 2014 worldwide (Obesity and Overweight, World Health Organization). Therefore, identifying the possible mechanisms that curb consumption is a critical step in addressing this important public health problem.

A growing trend among food wellbeing researchers is to suggest practical tools and small lifestyle modifications that "nudge" consumers to eat less (i.e., Wansink 2014). Our research demonstrates that consumers can leverage food sound salience in two ways to help curb consumption quantity. First, we show that food consumption quantity decreases when consumers

focus on the sound that the food makes (making it either quieter or louder) compared to when there is no focus on sound. Second, we show that food consumption quantity decreases when the sound of the food is more intense, compared to a condition in which it is masked. Consumers who are distracted, or who are in the presence of environmental cues that mask intrinsic food sound, may inadvertently suppress an important consumption monitoring cue. An interesting area of future research is to explore intrinsic food sound salience as a consumption monitoring cue in both of these contexts.

Finally, the notion that consumers have control over food sound salience has broader implications that would be worth exploring in future studies. In particular, social settings or environments that motivate consumers to attend to the sound of the food may subsequently lead to a decrease in consumption. For example, in a setting where social norms would favor quiet consumption (i.e., a meeting, or conversation with another person), an individual may modulate the sound of the food to be quiet, thus enhancing the salience on the food sound, and consequently leading to lower consumption. Thus, understanding the construct of food sound salience has implications not only for sensory scientists and practitioners, but also for consumer well-being.

Tables

	Sensory Experience				
Question	Sound	Vision	Taste	Smell	Texture
Importance to Start Eating	3.26^{a} (.101)	5.57^{b} (.077)	6.49^{c} (.057)	5.66^{b} (.074)	5.13^{d} (.096)
Importance to Stop Eating	3.14^{a} (.104)	5.28^{b} (.101)	5.82^{c} (.089)	4.79^{d} (.109)	4.82^{d} (.111)
Importance to Meal Enjoyment	3.17^{a} (.110)	5.34^{b} (.094)	6.77^{c} (.039)	5.73^{d} (.071)	5.21^{b} (.095)
How Quickly Bored of Sensory Experience	4.50^{a} (.124)	3.70^{b} (.112)	2.28^{c} (.099)	3.32^{b} (.103)	3.47^{b} (.109)

Table 1. Means from Pilot Study

Note: Numbers in parentheses represent the standard error of the means. Means that have no superscript in common are significantly different from each other (Bonferroni corrected; $p<0.05$).

Figures

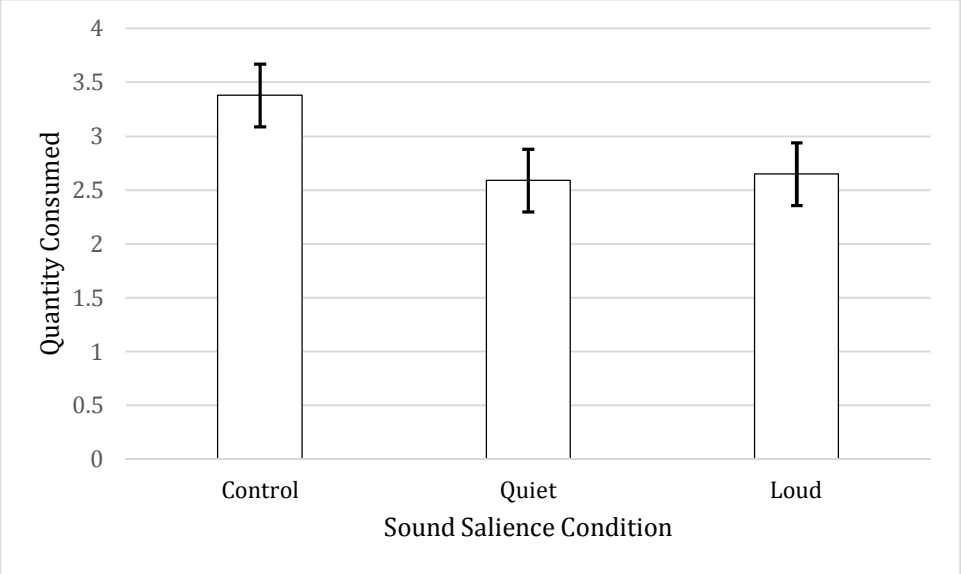

Figure 1. Mean consumption quantity dependent on sound salience condition. Error bars represent standard errors of the mean (Study 1).

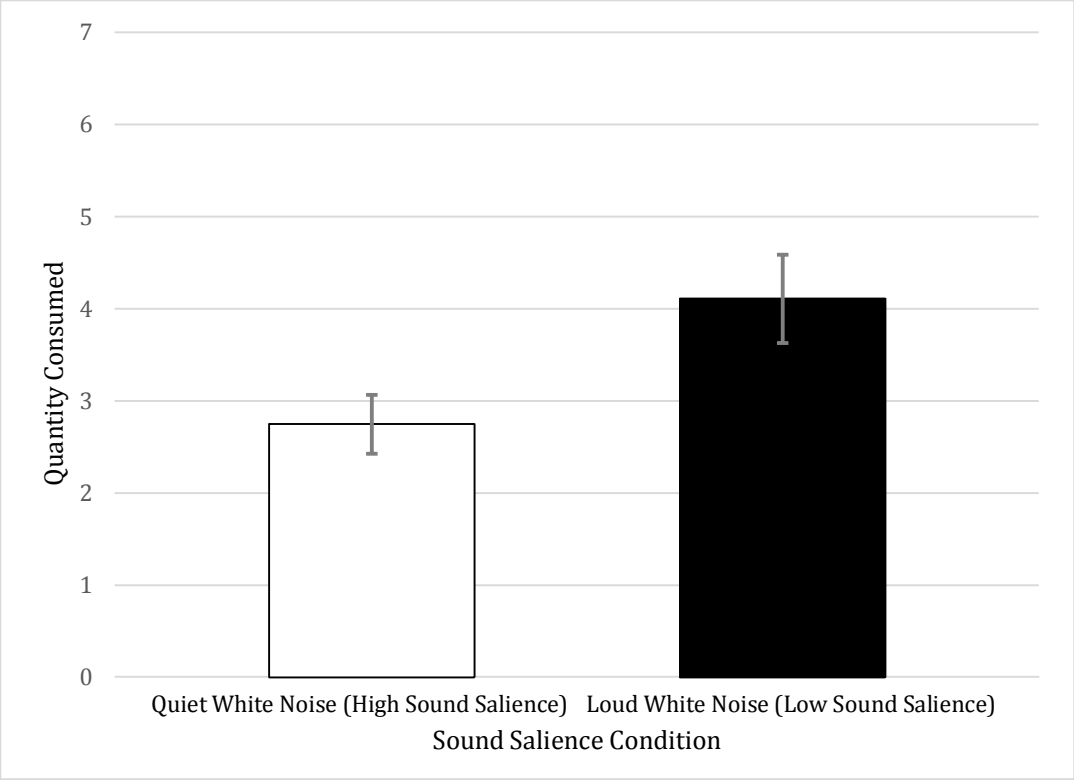

Figure 2. Mean consumption quantity dependent on sound salience condition. Error bars represent standard errors of the mean (Study 2).

Figure 3. Mean consumption quantity dependent on sound salience condition. Error bars represent standard errors of the mean (Study 3).

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The Crunch Effect: Food Sound Salience as a Consumption Monitoring Cue

Highlights

- The impact of intrinsic auditory cues on consumption quantity is explored.
- Food sound salience leads to a decrease in consumption quantity.
- Marketers can manipulate food sound salience, thereby impacting consumption.