



## Examination of sensory product characterization bias when check-all-that-apply (CATA) questions are used concurrently with hedonic assessments



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### ABSTRACT

The use of check-all-that-apply (CATA) questions for sensory product characterizations with consumers has been gaining acceptance. Hedonic scores have been reported to be unlikely to be biased by the concurrent elicitation of sensory data using CATA questions. However, it has not been established whether hedonic scores bias sensory characterizations. This research addressed this knowledge gap, using two empirical approaches. First, three studies ( $n = 344$  consumers) compared CATA product characterizations elicited with and without concurrent hedonic assessment. There were isolated incidences of weak bias, but overall, the evidence was transient and not suggesting major influences on sensory characterizations. Next, in seven studies ( $n = 719$  consumers) sensory characterizations elicited by consumer segments with different preference patterns were compared. Results suggested that sensory characterizations were unlikely to be biased. However, differences between the preference segments in how CATA questions were used to describe samples were identified, particularly for terms that lack a unique definition, are complex, intensity-related or have hedonic connotations. Therefore, if consumer segmentation is a key test objective, sensory characterizations should preferably be derived on a segment-by-segment basis. Further, if consumers participate in tests where sensory characteristics are of greater importance than hedonic assessments, results from this research suggest eliminating the latter.

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### Introduction

Sensory characterization is used to obtain qualitative and quantitative information about the sensory characteristics of products (Lawless & Heymann, 2010). Traditionally, sensory characterization is performed using descriptive analysis with assessors who are trained in attribute recognition and scaling (Lawless & Heymann, 2010; Meilgaard, Civille, & Carr, 1999). Meanwhile, consumers have been considered as largely unable to provide reliable information about the sensory characteristics of products and usually only been called upon to indicate liking/disliking (Stone & Sidel, 2004). However, this state of affairs is being challenged by evidence that consumers can provide accurate information about the sensory characteristics of products, which in many situations is similar to that provided by trained assessors (Ares, Bruzzone, & Giménez, 2011; Dooley, Lee, & Meullenet, 2010; Husson, Le Dien,

& Pagès, 2001; Moskowitz, 1996; Worch, Lê, & Punter, 2010). The use of consumers for sensory characterization is becoming more accepted within the sensory science community, and is being accompanied by the development of consumer-based methodologies and methodological research on the topic (Ares, 2014; Valentin, Chollet, Lelièvre, & Abdi, 2012; Varela & Ares, 2012, 2014). To become established such methodologies must be shown to provide valid and reliable alternatives for obtaining information about the sensory characteristics of products. The present research contributes to this goal and focuses on one of the simplest methodologies for sensory characterization: check-all-that-apply (CATA) questions (Varela & Ares, 2012). In this methodology respondents are presented with a list of words (or phrases) and are asked to select all the options they consider appropriate to describe each sample.

It is common to use CATA questions concurrently with hedonic assessment of samples to: (i) understand consumer preferences, including segmentation patterns and (ii) identify the sensory attributes driving liking/optimizing product formulation (Adams,

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Williams, Lancaster, & Foley, 2007; Ares, Barreiro, Deliza, Giménez, & Gámbaro, 2010; Dooley et al., 2010; Ng, Chaya, & Hort, 2013; Parente, Manzoni, & Ares, 2011; Plaehn, 2012). Although asking consumers about specific sensory characteristics can be a source of bias on hedonic scores (Earthy, MacFie, & Hedderley, 1997; Popper, Rosenstock, Schraidt, & Kroll, 2004; Prescott, Lee, & Kim, 2011), CATA questions have been found to be unlikely to bias hedonic scores across a range of product categories (Jaeger & Ares, 2014; Jaeger, Giacalone, et al., 2013). However, it remains unclear if the practice of concurrently eliciting sensory information and liking assessments can affect consumer-based sensory product characterizations. If in consumer tests, the use of CATA questions concurrently with hedonic assessments is to gain general acceptance, investigation of such pertinent questions is warranted. Therefore, the aim of the current research is to explore influences of concurrent hedonic elicitation on sensory characterization elicited using CATA questions.

There is some evidence to suggest that sensory characterization could be affected when hedonic scores are co-elicited. Survey research has shown that questions have the potential to alter a person's perception of a product (Strack, 1992). Answering a question causes a "priming effect" that makes some information more salient and relevant, even without the respondent's awareness (Schuman & Presser, 1981). For this reason, asking consumers to elicit hedonic scores could make the sensory characteristics they like/dislike about the product become more salient, which, in turn, could lead to an affective perceptual strategy making consumers focus their attention on the characteristics that are more relevant for explaining their preference patterns. If the aim of the study is to identify drivers of liking or directions for product reformulation, this perceptual shift may be acceptable. However, if the aim of the study is to obtain a sensory characterization of products, hedonic questions could be a relevant source of bias. In this sense, Earthy et al. (1997) reported that the order in which a hedonic question was included in the questionnaire affected consumers' ratings of sweetness, thickness and chocolate intensity of chocolate mousses. On the other hand, Mela (1989) reported that concurrent hedonic elicitation did not affect consumers' perceptions of saltiness and oiliness in crackers.

Concurrently collection of sensory and hedonic data could also affect the perceptual strategy used by consumers for evaluating samples. Asking consumers to rate their liking of products could induce an affective mindset, which promotes a synthetic perceptual strategy instead of an analytical evaluation of products (Prescott, Johnstone, & Francis, 2004). Affective evaluation of products has been reported to improve consumers' discriminative ability in discrimination tests due to increased attention and involvement with the task (Boutrolle, Delarue, Köster, Aranz, & Danzart, 2009; Chae, Lee, & Lee, 2010; Frandsen, Dijksterhuis, Brockhoff, Nielsen, & Martens, 2007; Kim, Chae, van Hout, & Lee, 2014). However, it is not clear if affective strategies increase consumers' ability to detect differences in the sensory characteristics of the samples when they complete descriptive tasks.

Heterogeneity in liking/disliking for the tested products is another possible source of sensory characterization bias in consumer tests that concurrently elicits sensory CATA data and hedonic scores. Heterogeneity among consumers in perception of food products has been long recognized and segments that differ in the way in which they perceive products (e.g. Prutkin et al., 2000) and/or in the relative importance they attach to the sensory characteristics of products (e.g. Carroll, 1972; Harwood, Ziegler, & Hayes, 2012) have been described. Considering that novel methodologies for sensory characterization do not involve training in attribute recognition or quantification (Valentini et al., 2012), consumer segments with distinct preference patterns could differ in how they describe products, i.e., generate different CATA product profiles.

To achieve the aim of this research and evaluate the likelihood of sensory product characterization bias with CATA questions when consumers concurrently elicit hedonic scores, a two-prong research strategy was implemented. In Part 1 the influence of concurrent hedonic elicitation on sensory product characterizations using CATA question was studied by comparing sensory spaces obtained using CATA questions with and without concurrent elicitation of hedonic scores ('CATA only' vs 'Hedonic & CATA'). Three studies, in which 344 consumers took part, were conducted. In Part 2 focus was directed to the influence of heterogeneous preference patterns on sensory characterizations and product spaces. In seven studies, the sensory product characterizations provided by consumers with different preference patterns were compared in terms of discrimination among samples and with respect to sample and term configurations.

## Materials and methods

### *Part 1: Comparison of sensory spaces obtained using CATA questions with and without concurrent elicitation of hedonic scores ('CATA only' vs. 'Hedonic & CATA')*

The three studies in Part 1 of this research (Study 1–3) presented food and beverage samples to consumers and compared CATA responses elicited with or without concurrent hedonic evaluation.

#### *Part 1: Participants*

A total of 344 consumers participated in Studies 1–3. The number of consumers in each study ranged from 113 to 117. Participants were registered on a database maintained by a professional recruitment agency and were screened in accordance with eligibility criteria for each of the studies. Participants gave voluntary consent to participants and were compensated in cash.

All participants lived in the Auckland region (New Zealand) and were overwhelmingly of Caucasian ethnicity. The ages of participants were 19–64 years old and the percentage of female participants ranged from 50% to 65%. Participants represented households in diverse socio-economic strata, however, none of the consumer samples were representative of the general New Zealand population.

#### *Part 1: Samples*

In Study 1, five lite bread samples from the Arnott's™ Cruskits range (Rice, Rye, Light and Corn) were used. Corn Cruskits were presented twice, either fresh or 'stale'. The 'stale' sample was produced by spraying fresh Cruskits twice on each side with filtered water 1 h prior to presentation to participants.

In Study 2, samples of kiwifruit (*Actinidia chinensis* and *Actinidia deliciosa*) were used (two commercial varieties and one pre-commercial selection). One cultivar was presented twice, sorted by size ('large' or 'small'). All fruit was harvested at commercial maturity and stored in a commercial pack house prior to the study. Eating ripe samples of half fruit were presented to participants.

In Study 3, samples of juice were made from blackcurrant berries (*Ribes nigrum*). Whole blackcurrant fruit from commercial and pre-commercial selections were sourced from the same research orchard. Fruit from each cultivar were pressed into juice using a 20 × 17 cm basket fruit press (Ferrari #11075, Italy) and blast frozen. One day prior to consumer testing, juices were thawed and stored at 4 °C. On the day of testing, the Brix level of each sample was adjusted to 9.4 g/100 g sugar by addition of sucrose before making a 1:14 dilution with filtered water. A commercially available concentrate (Barker's™ Blackcurrant Juice) was included for comparative purposes.

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