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Application of hedonic dynamics using multiple-sip temporal-liking and facial expression for evaluation of a new beverage

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ABSTRACT

Drinking and eating are not a matter of a single sip or bite. Dynamic data gathered from multiple sip or bite, seem to be more reliable than simple sip/bite evaluation. However, methodologies and analyses based on multiple sips/bites have received little attention until recently. The present study tested an innovative approach to measure the temporal changes in acceptance. It combines multiple-sip temporal-liking measurements (MSTL) with implicit taste reactivity using facial pattern expressions at different time points, for evaluation of a new beverage. Seventy-three consumers (35 females and 38 males) evaluated acceptance during 60 s, drinking three sips, with each sip every 20 s. The consumers' faces were filmed by a camera during the test session in order to analyze facial affective reactions. The results of the present paper show that MSTL modality allows seeing temporal changes in the acceptance of the beverage. Parameters analyzed maximum intensity (I_{max}) and area under the curve (AUC) in self-reported response curves presented variation through successive sips. The self-rated liking increased from the first sip to the third. In the same way facial expressions also showed a change over time during successive sips. In this case, the basic emotion of disgust, unpleasantness-related Action Units (AUs; AU 26 and AU 15) and negative valence showed a decrease from the first sip to the third one. It was observed that negative facial reactions are greater than the positive facial reactions in intensity.

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1. Introduction

In this paper temporal aspects of consumer acceptance during consumption are examined. Temporal consumer acceptance is an issue that has recently gained interest (Delarue & Blumenthal, 2015). There are different ways to measure consumers' hedonic response to food in a dynamic perspective during a one bite/sip consumption event that have been suggested. Hedonic Time-Intensity (TI) and Multi-Attribute Time-Intensity methods have been used to provide information about the onset and decay of the hedonic attributes, its duration and its maximal intensity (e.g., Delarue & Loescher, 2004; Kuesten, Bi, & Feng, 2013; Methven et al., 2010). The Temporal Dominance of Sensations (TDS), Temporal Dominance of Emotions (TDE) and Temporal Drivers of Liking (TDL) approaches, consist of identifying dominant

sensations/emotions which are responsible for the liking or disliking of a product, until the perception ends (e.g., Jager et al., 2014; Sudre, Pineau, Loret, & Martin, 2012; Thomas, Visalli, Cordelle, & Schlich, 2015).

Sudre et al. (2012) adapted TDS approach to investigate the temporal aspects of hedonic assessment, replacing the attributes by a 7-point liking scale. Consumers recorded temporal changes in their liking by clicking on a button corresponding to the above 7-point liking scale. With this procedure, consumers were not asked to constantly manipulate a cursor as for Time-Intensity, but just to focus on their liking change. However, the consumer decision to change the liking level during test is more an interval measure than a continuous quantification. Thomas et al. (2015) applied TDS to measure temporal liking, but they introduced a change in order to encourage the subjects to re-evaluate their liking. The blackened box corresponding to their liking score is turned back to white after 3 s. Subjects were instructed to re-evaluate their liking at these moments, and clicking the same box as before if they do not perceive any change in liking. The modification to the TDS scale brings it closer to the Time-Intensity register.

These approaches take into account one sip of the product. However, consuming a beverage is not a matter of a single sip as it implies dynamic physical, sensory, physiological and psychological phenomena with time (Delarue & Blumenthal, 2015; Galmarini, Symoneaux, Visalli, Zamora, & Schlich, 2015; Sudre et al., 2012). In order to get a more realistic description of the products' sensory and hedonic experience, dynamic changes over several sips in perception and acceptance of the drink should be considered. In this sense, previous studies have reported that small differences in the sensory profiles of products only become noticeable after repeated tasting; and changes in acceptance may be associated with small variations in the sensory properties over time (Köster, 2009; Köster, Couronne, Léon, Lévy, & Marcelino, 2002; Stein, Nagai, Nakagawa, & Beauchamp, 2003; Zandstra, Weegels, Van Spronsen, & Klerk, 2004). For instance, the use of multiple-sip Temporal Dominance of Sensations have been able to identify differences among sweeteners which had not been detected using classic sensory measurements averaged across time (Zorn, Alcaire, Vidal, Giménez, & Ares, 2014). To our best knowledge, no previous studies have applied multiple-sip methodology to the temporal liking assessment of beverages.

The focus of the present study was to test an improved method of TI, called multiple-sip temporal-liking (MSTL), based on scoring liking at predefined time-points during several sips (using computerized time-intensity method) to evaluate a new healthy beverage.

In recent years, there has been a growing interest in developing new functional beverages with special characteristics and health properties. Fortification of drinks offers a convenient alternative to contribute to a better nutritional quality of the population and a better balance in the daily diet. In particular, fortified drinks elaborated with wine polyphenols have received considerable interest for their presumed beneficial effects including antioxidant, anticarcinogenic, anti-inflammatory, hypotensive or even anticoagulant properties (see Arranz et al., 2012, for a review). It has been shown that small daily intakes of wine can reduce the risk of coronary heart disease and atherosclerosis, this benefit is ascribed to the antioxidants properties of the phenolic compounds (Diaz et al., 2012; Mazza, Fukumoto, Delaquis, Girard, & Ewert, 1999; Radovanovic & Radovanovic, 2010; Renaud & de Lorgeril, 1992) which differ from those found in grapes.

However, there are some drawbacks in wine consumption associated with the ingestion of alcohol: a) consumption must be moderate (i.e. 1–2 glasses per day) in order to avoid alcohol related diseases, and b), many people, either by ethnical, social or religious reasons do not consume wine. Recently a new dealcoholized powder was obtained from freeze-drying red wine which contained the polyphenols but without the alcohol (Galmarini et al., 2013; Rocha Parra, Galmarini, Chirife, & Zamora, 2015; Sánchez, Baeza, Galmarini, Zamora, & Chirife, 2013). It is to be noted that 400 mL of this reconstituted beverage contains about the same amount of wine polyphenols that a glass (100 mL) of red wine.

In order to complete our assessment of the temporal changes in acceptance of this beverage, repeated liking measurements were combined with implicit taste reactivity methodology using facial expression patterns. It is believed that facial expression analysis may aid in finding rapid, uncontrollable micro-expression responses that influence acceptance and preferences (Leitch, Duncan, O'Keefe, Rudd & Gallagher, 2015). Furthermore, facial expressions appear to reveal more accurate hedonic response to beverages as they reflect the affective core process without contamination from higher-order appraisal processes (e.g., Berridge, 2000; Havermans, 2011; Pham, Cohen, Pracejus, & Hughes, 2001).

The aim of present study was to measure the temporal changes in acceptance with repeated liking measurements (explicit measures), combined with taste reactivity methodology using facial expressions (implicit measures) during consumption of a new healthy red wine-based powder beverage. Besides the two modes (explicit and implicit) in multiple-sip methodology were also used for exploring whether gender differences affected temporary acceptance.

2. Materials and methods

2.1. Participants

The study was carried out with 73 consumers, recruited from the Pontificia Universidad Católica Argentina, based on their frequency of consumption of fruit juices (at least 2–3 times a week) and red wine (at least once a week). The whole population was homogeneous, consisting of 35 females and 38 males; aged 18–41 years old (22.3 ± 3.2, mean ± standard deviation). The procedure was conducted in individual computerized booths and the participants' faces were filmed. Participants were informed about the purpose of the study and that the experimental procedure would be video recorded. All the subjects performed the tests in one session, signed an informed consent form and they were not compensated for their participation. The study was approved by the Ethics Committee of the Pontificia Catholic University of Argentina.

2.2. Samples

The two formulations used for the present work, called 35-4 and 40-5, were selected from a previous study (Rocha Parra et al., 2015) considering their different but highest acceptance ratings (6.1 ± 1.7 and 6.6 ± 1.3; p < 0.05) measured with a 9-point category scale in 144 consumers of both sexes, but without previous significant gender divergences using the simple-sip methodology. The formulation 35-4 was obtained by the combination (for one liter of reconstituted drink powder) of the 35 g of wine powder + 4 g of commercial sweetener (cyclamate 5700 mg/100 g; saccharin 2000 mg/100 g), and 40 g of wine powder + 5 g of commercial sweetener for the formulation 40-5. The formulations had the same concentration of raspberry aroma (0.01%, Symrise, Argentina) and thickeners (0.20%, Guar gum, Gelfix, Argentina) in both samples. The wine powder was obtained by freeze drying the wine according to a method previously described by Sánchez et al. (2013). The wine used was *Cabernet Sauvignon*, "Postales del Fin del Mundo" (*Bodega Fin del Mundo*) from a cold climate wine growing region (Neuquén province, Patagonia region, Argentina) with an original alcohol content of 13.7% in average and a pH of 3.8 (vintage 2013, aged in oak). Carbohydrates used as drying aids for encapsulation were a mixture of Maltodextrin (Dextrose Equivalent 10 (MD10) provided by Productos de Maíz S.A., Argentina) and Arabic gum (provided by Gelfix, Argentina). The solution of wine + carbohydrate was freeze-dried at room temperature in a FIC Ll-I-E300-CRT freeze dryer (Rificor, Argentina). The powder obtained had 3% moisture content and about 1400 mg polyphenols/100 g.

The samples provided to consumers were rehydrated the day of tasting and served in 10-ml transparent plastic cups at 15 °C and encoded with three-digit random numbers to record the sample.

2.3. Preliminary testing

In order to design the timing between sip, a preliminary test was made with 16 participants (13 women and 3 men) who evaluated one sip of both samples during 30 s by Time-Intensity (T-I) methodology taking into account the Taylor and Pangborn's (1990) results, in which the maximum levels of liking were observed at 20–30 s after the placement of the sample in the mouth. The results showed that the sample 35-4 presented a