Introduction

In recent years, consumers' preference and trends for beer have been changing, and are currently looking for more premium beverages. Beer foam and bubble characteristics and dynamics have been identified as the most important quality traits as they are the main visual attributes that contribute to beer quality assessment. Sensory evaluation has been widely used to assess consumer acceptance of food and beverages, however, this method is only capable of obtaining the conscious responses from participants. Biometric techniques such as eye tracking, infrared thermography, facial expressions and heart rate from image analysis assessed through signal and computer vision algorithms, can result in more information related to the unconscious responses. Biometric studies coupled with sensory forms, are able to provide more information about consumer behavior from the conscious and unconscious responses.

Materials and Methods

A sensory session with 30 consumers and pouring videos of 15 beer samples was conducted. These samples were assessed visually using eye tracking technology with The Eye Tribe™ device (The Eye Tribe, Copenhagen, Denmark) along with a newly developed integrated camera system developed by the sensory group from the Faculty of Veterinary and Agricultural Science of the University of Melbourne. The latter includes a bio-sensory computer application, video recording and infrared thermography using the FLIR AX8 camera (FLIR Systems, Wilsonville, OR, USA). A multivariate data analysis based on principal components analysis and a correlation matrix (p < 0.05) were performed with 18 parameters from conscious responses (liking of foam height (FHeight), just about right of foam height (JARFHeight), liking of foam stability (FStability), JAR of foam stability (JARFStability) and perceived quality (Quality)), and biometrics. An artificial neural network (ANN) model for pattern recognition was developed in the Matlab Neural Network Toolbox™ 7 (Mathworks Inc., Matick, MA, USA) using 13 biometrics (body temperature (IR), heart rate (HR), fixation number (Fix#), fixation duration (FixDur), pupil size, neutral, happy, sad, disgusted, contempt, valence, arousal and horizontal head orientation (X-Head0)) and 15 foam and color-related parameters (maximum volume of foam, total lifetime of foam, lifetime of foam, foam drainage, bubble size (small, medium and large), CO2 color in two scales (L, a, b, R, G, B) and alcohol gas release (OH)) measured using a robotic pourer RoboBEER as inputs. The samples were classified into two categories: i) low liking of foam and ii) high liking of foam. The data were randomly divided using a random data division function with 70% (n = 305) for training using a scaled conjugate gradient training function, 15% (n = 65) for validation using a cross - entropy performance function and 15% (n=65) for testing using a default derivative function. As shown in Fig. 1, ten neurons were used in the hidden layer.

Results

As shown in Fig. 2a, the principal components analysis (PCA) was able to explain 61.2% of total data variability. The correlation matrix shows only the significant correlations (p < 0.05) between biometrics and the responses from the questionnaire. There was a positive and significant correlation between happy and liking of foam height (FHeight) and foam stability (FStability), and between FHeight, FStability and perceived quality (Quality). There was also a positive correlation between body temperature (IR) and sad, and a negative correlation between IR and pupil size (Pupil), disgusted, contempt and valence. On the other hand, heart rate (HR) presented an appositive correlation with Quality.

Figure 3a shows the ANN pattern recognition model with an 82% accuracy to classify beers according to low and high level of liking of foam height. The receiver operating characteristics (ROC) curve (Fig. 3b) shows that both categories present similar results with high true positive rates (sensitivity = 82%) and low false positive rates (specificity = 18%). Similar results were obtained after several retraining attempts.

Conclusion

The use of traditional sensory tests along with biometrics techniques for visual foam-related parameters of beer during pouring showed to be more accurate and useful to gather more information from consumers and to assess their perception of beer quality from the first impression. Therefore, the use of this techniques in conjunction may have significant potential applications for the beer industry.

References


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