Does Stress Impact the Sweetness Perception of Sweeteners?

P2_101

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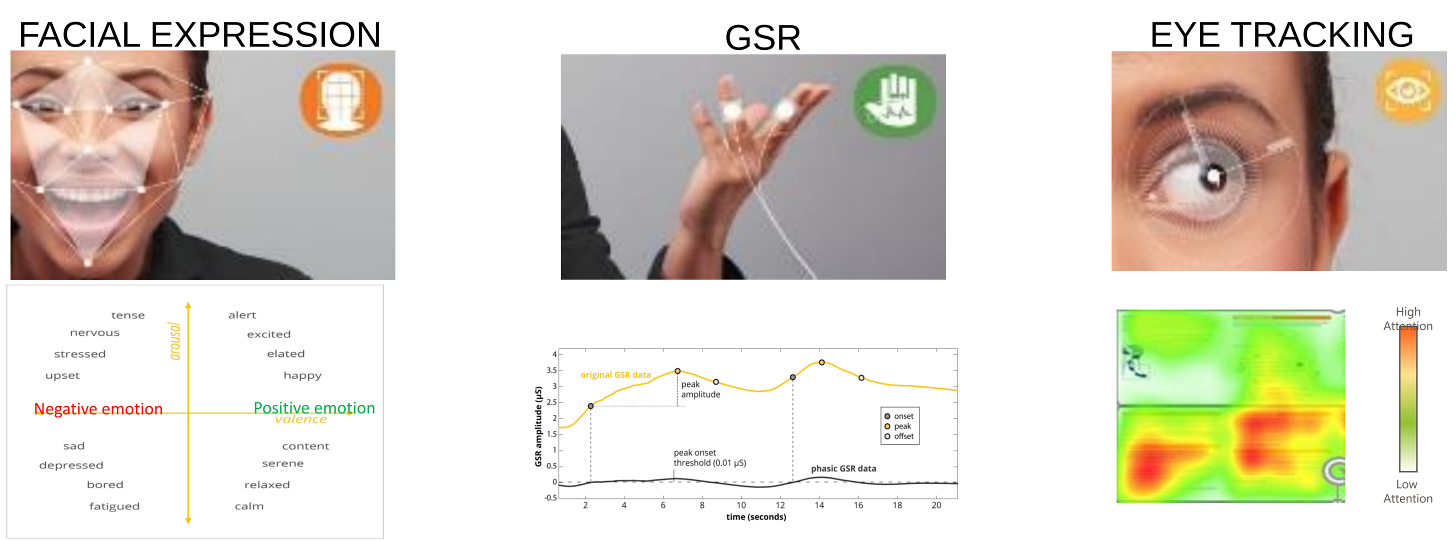
ABSTRACT

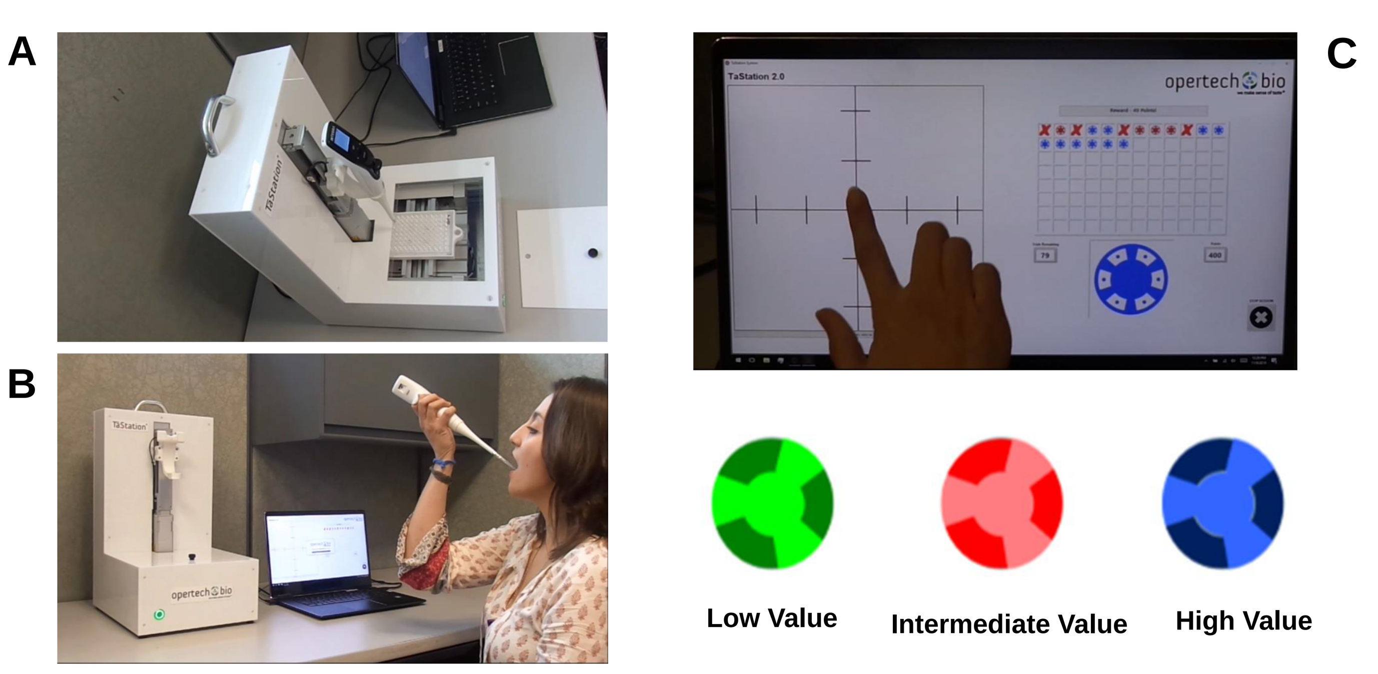
Taste perception can be regarded as consisting of two separable processes—taste quality and hedonics. Taste quality is a function of sensory input through receptors expressed on type II cells of the taste bud and can be objectively measured in humans by discrimination assays. Taste hedonics is regarded as subjective, and physiologic and emotional correlates of hedonics can be assessed through biometric measures. We sought to examine and clarify the impact of mild environmental stress on taste, particularly focusing on individuals' abilities to detect bitter tastes of Non-Nutritive Sweeteners (NNS). To this end, we used the TaStation®, an automated game-like system for rapid measurement of taste discrimination, and iMotions biometric measurements of Facial Expression, Eye Tracking and Galvanic Skin Response. Eight subjects were participated in the discrimination assessment and the subjects were biometrically monitored while performing a taste discrimination to record detection tastes of sucrose, acesulfame potassium (ACE K), aspartame (ASP), rebaudioside A (REB A) and sucralose (SCRL). In a control test, Bitterness was indicated most often on high concentrations of ACE K and REB A. Negative emotional valence derived from facial expression, also occurred most often on high concentrations of NNS. In an experimental condition, a mild environmental stressor—a randomly presented noxious buzzing sound and a time-out in the course of the game—was introduced. The stressor increased overall errors in the discrimination task. The effect of the stressor resulted in increased bitter perception and decreased sweet perception of NNS. Individual differences of detecting bitterness were observed. Our results suggest that a mild environmental stressor impacted the sensitivity of some subjects to the bitter off tastes of NNS, although it is not clear whether the stress affected taste quality or the hedonic response to the stimuli.

METHODS



Participants in the study were fitted with a Galvanic Skin Response (GSR) Shimmer kit that produces peak signals based on skin conductance during sweating. Two cameras collected facial recognition data. The Affective module within the iMotions software package was used to identify facial action units or individual expressions to classify emotional states. Eye tracking data was also collected

TāStation®



A) Robotic pipette randomly selects a well from a 96-well plate, withdraws 0.2 ml and presents pipette to subject

B) Subject self-administers to the tongue

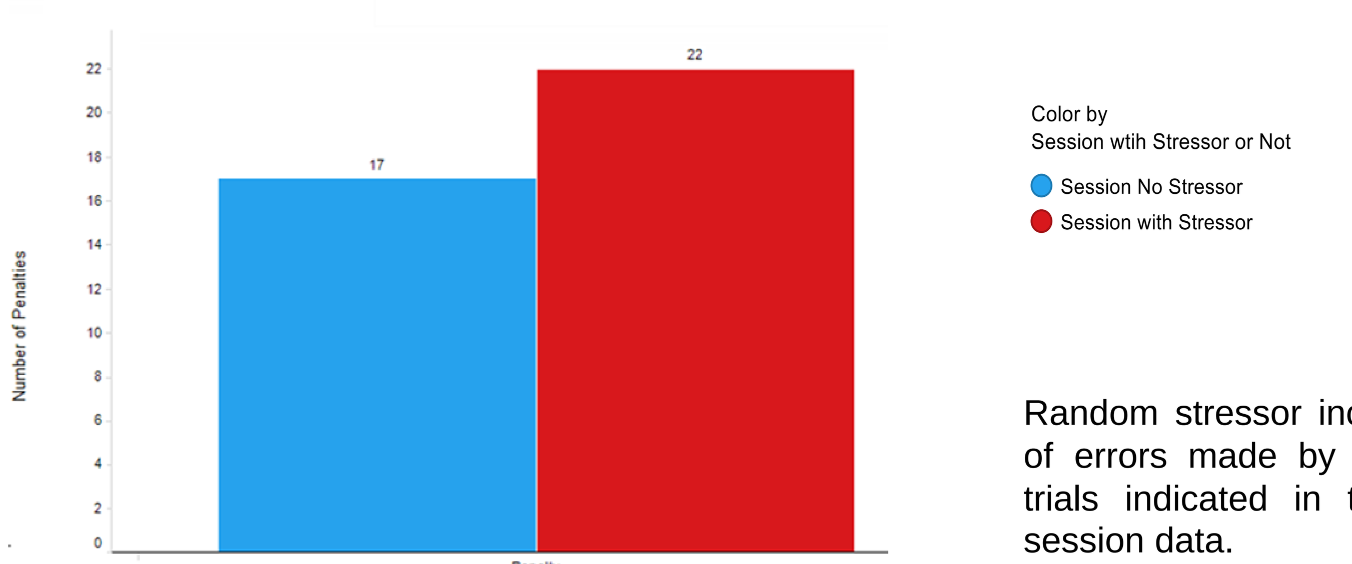
C) Subjects are instructed to search for poker chips buried in a visual field. The taste stimulus is clue to their location. After tasting, the subject is prompted by the computer to touch the screen. The response has a consequence—reward or penalty—then on to the next trial. Subject completes all 96 trials in ~45 minutes.

D) For more details, see Poster P2_168

MILD STRESSOR GENERATION

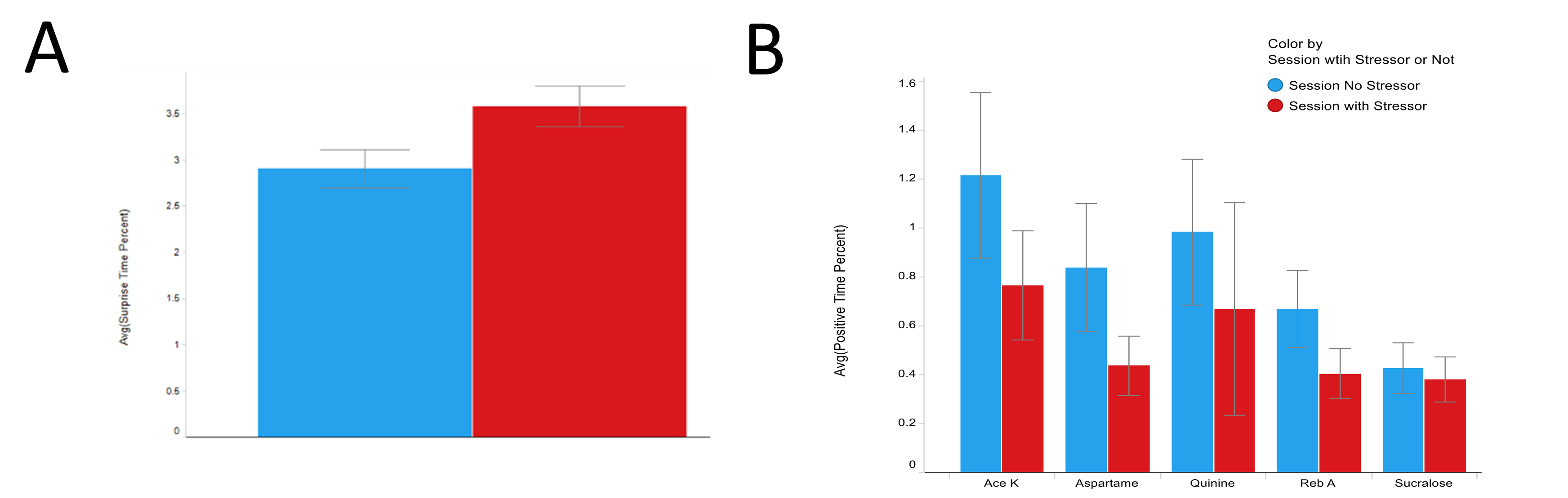
A mild environmental "Stressor," consisting of a loud buzzer sound, was presented randomly and unpredictably throughout the TāStation® test session in which the concentration-response functions for sweet taste of five sweeteners (rebaudioside A, sucralose, acesulfame potassium, and sucrose were quantified. Bars shown in blue represent data obtained from test session in which no stressor was present; bars shown in red indicate data for, sessions with the stressor

MILD STRESSOR INCREASED NUMBER OF ERRORS



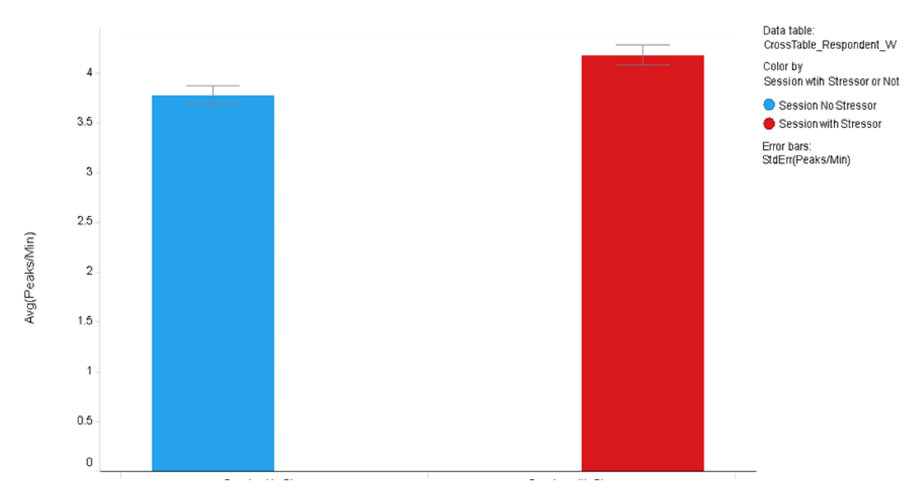
Random stressor increased the number of errors made by subjects on control trials indicated in the TāStation® test session data.

FACIAL EXPRESSION: SURPRISED PARTICIPANTS AND HAD LOW POSITIVE RESPONSE IN PRESENCE OF STRESS



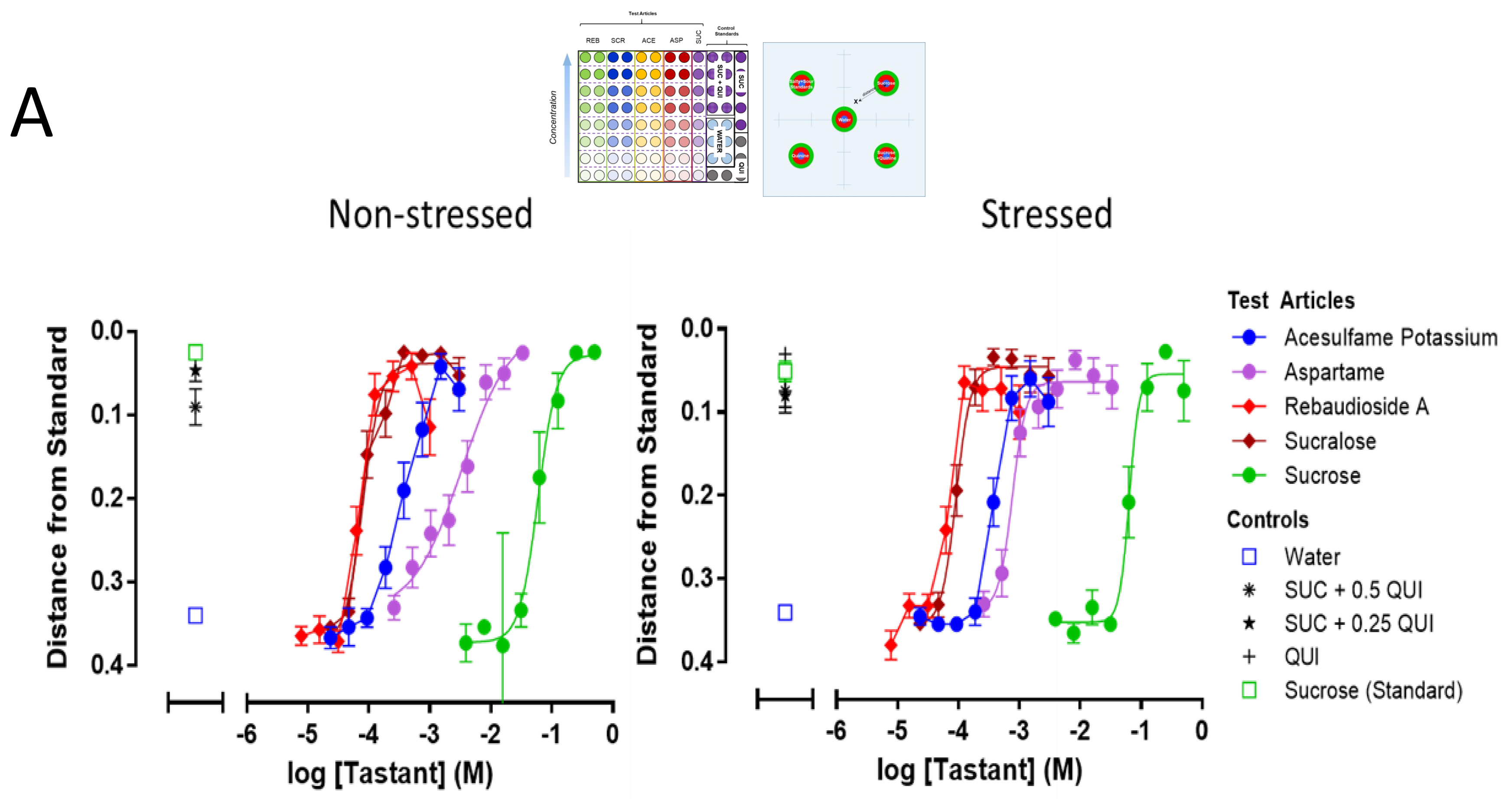
A) Indicates a higher overall degree of surprise from the facial expression analysis. B) Across each sample, absence of stressor showed more positive valence. Interestingly, Ace K had a strong positive response VS other samples.

GSR: EMOTIONAL INTENSITY WAS HIGHER WITH THE STRESSOR



Emotional intensity, as indicated by GSR, was significantly higher at 90% CL when the random stressor was presented.

GSR: EMOTIONAL INTENSITY WAS HIGHER WITH THE STRESSOR



Non-stressed:

	EC50	90% Conf Int	%Bitter Responses
ACE K	0.33 mM	0.24 - 0.47 mM	14
ASP	3.33 mM	1.76 - 6.32 mM	5
Rebaudioside A	0.06 mM	0.03 - 0.16 mM	16
SCRL	0.08 mM	0.07 - 0.10 mM	3
Sucrose	59 mM	47 - 74 mM	0

Stressed:

	EC50	90% Conf Int	%Bitter Responses
ACE K	0.37 mM	0.32 - 0.42 mM	13
ASP	0.77 mM	0.60 - 1.00 mM	9
Rebaudioside A	~0.06 mM	Uncertain	17
SCRL	0.09 mM	0.08 - 0.11 mM	6
Sucrose	64 mM	56 - 72 mM	1

B **Bitter Responses of Subject 1064F**

	% Bitter Responses	
	Non-stressed	Stressed
Acesulfame Potassium	13	44
Aspartame	0	25
Rebaudioside A	13	44
Sucralose	0	25
Sucrose	0	6

Concentration-response functions for 5 sweeteners, "Non-stressed" (left panel) and "Stressed" (right panel.) A) The concentration-response functions for sweet taste were consistent with established receptor activity. As a result of the training procedure which trained subjects to a sensitive discrimination capacity for detection of bitter off-tastes, the sweet responses to some of the sweeteners declined at the higher concentrations in favor of bitter responses (i.e., responses on either the "sweet-bitter" or "pure bitter" targets.) Impact of stressor was not apparent in the group data. ***Inset:*** Test plate and touch-screen configurations. **B)** The stressor increased bitter off-taste detection in some sensitive individuals (results for Subject 1064F shown above).

CONCLUSIONS & IMPLICATIONS

- Mild environmental stress does not impact sweet taste directly, however, it does impact sweet taste indirectly as the bitter taste of NNS impacts sweet perception due to the interaction between two taste modulations
- An individual difference was observed on the bitterness of NNS in the non-stress condition generally. The individual difference was more pronounced in the stress condition
- When people are stressed (e.g. sickness), the bitter taste sensitivity could be higher which may impact sensory experience of systemic medicines.
- A comparison between biometric and hedonic self report indicate that biometric tools provide more discrimination when self-report is flat (details are not shown here). Biometric tools are encouraged to measure emotional responses in addition to self-report.
- Eye tracking data was less useful for assessing emotional response.