RELATING SENSORY PERCEPTION TO CHEWING DYNAMICS

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ABSTRACT

Understanding the mechanism behind the dynamic changes of food structure during oral processing is the key area for food texture studies. Food texture is a sensory perception derived from the structure of food, and oral processing plays an important role in this perception. This research aimed to establish a method to explore the relationships between oral processing and sensory perception, using biscuits of varying compositional and structural properties as a model food system.

The initial study verified the capability of the Temporal Dominance of Sensations (TDS) technique to describe the textural aspects of a model food system whose structural properties change throughout oral processing. By standardizing the time-axis of the TDS curves from first bite to swallow, the technique was able to discriminate the textural properties of the samples of different sugar to fat ratios over the consumption period. The key differences of this type of standardization method were the attribute dominance rates and range in times to select the first dominant attribute. Moderate training of panellists on the definitions of the attributes showed performance improvement; clearer TDS curves (higher dominance rates) and reduced times to make the first dominant attribute selection (at least 10% faster). It was observed that subjects used a greater number of chewing cycles to process a food sample when they were also performing a sensory task such as TDS. The observation holds regardless of the level of training.

When the TDS task was performed initially (the first sample), subjects need time to explore and learn the task hence slower chew frequency. This effect can be eliminated by introducing warm up samples before each session to ensure familiarity to samples and task. Overall, the samples were discriminated in their textural properties throughout chewing. The TDS technique appeared to be relevant to relate to the changing food properties in the mouth. The hardness levels of the sample marked an influence at the early stage of a chewing sequence, influencing the first dominant attributed selected and the oral processing. As food evolves during oral processing, other associated attributes become dominant in response to changing structural properties in the mouth. All samples undergo various structural changes in the mouth before reaching a definite state

before swallowing. Two types of masticatory adaptations were present; adaptation to the task performed and adaptation to the altered textural properties in the mouth.

The reproducibility of the TDS curves was also performed. This study demonstrated that for a food sample with five attributes to be evaluated in triplicate, at least 10 subjects were needed (i.e. 30 observations). This is true as the TDS technique is based on food evolution in the mouth. Further exploration of the TDS technique was performed using Discrete Point TDS. The technique offered new information that the typical TDS technique could not. The method was capable of differentiating the dominant attribute at each specific stage during mastication. This is not measurable with the conventional TDS technique and is less time consuming. In addition, intensity scores were found to complement the standard TDS data.

The present study also showed the need to combine the TDS technique with masticatory recordings to investigate the dynamic mechanisms of the food behaviours throughout food oral processing. The simultaneous recording of the TDS technique, electromyography (EMG), and electromagnetic articulograph (EMA) confirmed that human masticatory apparatus adapted (chew frequency) to the altered textural properties caused by changing food sample composition and structure which also continued to evolve in the mouth. Evaluation of dynamic changes in sensory perception at various mastication stages helped in explaining the food evolution in the mouth and its responding oral processing strategies. The early chewing stage was dedicated to the fracture mechanism of the food where attributes such as *hard* and *crunchy/crispy* were most dominant. Mid chewing was dedicated to effort used to masticate food into a bolus which was suitable for swallowing; this included effort to reduce food particle sizes and incorporate saliva and the attributes *crumbly* and *dry* were most dominant. The end of chewing was dedicated to removing food materials from around the mouth for swallow, where *sticky* was most dominant. These associations supported the hypothesis that masticatory parameters are controlled by the sensory input and are linked to food properties, where a range of different food structure is responsible for the changes in the chewing strategies.

Findings from this research demonstrated the strong correlation between the TDS profiles and chewing dynamics provided a new and improved technique for the food industry, in particular for designing foods with desired sensory properties. Moreover, the study confirmed that a complete understanding of texture can only be obtained through collaboration among different disciplines.

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Peer-Reviewed Publications

1. Ashley K. Young, Jean Ne Cheong, Duncan I. Hedderley, Marco P. Morgenstern and Bryony J. James. (2013). Understanding the Link between Bolus Properties and Perceived Texture. *Journal of Texture Studies*. *44*, 376-386.

2. Foster KD, Grigor JM, Cheong JN, Yoo MJ, Bronlund JE and Morgenstern MP. (2011) The Role of Oral Processing in Dynamic Sensory Perception. *Journal of Food Science. 76*(2), R49-R69.

Conference Presentations

1. Jean Ne Cheong, Kylie D. Foster, John M.V. Grigor, John. E. Bronlund and Marco P. Morgenstern. *Development of a Dynamic Sensory Technique for Relating Texture Perception to Oral Processing Behaviour*. 2nd International Conference on Food Oral Processing - Physics, Physiology, and Psychology of Eating. Beaune, France. 1st - 5th July 2012 (*Oral Presentation*).
2. Jean Ne Cheong, Kylie D. Foster, John M.V. Grigor, John. E. Bronlund and Marco P. Morgenstern. *The Effect of Sensory Training on Dynamic Sensory Perception and Chewing Behaviour*. Biomouth 2011. Palmerston North, New Zealand. 28th - 29th November 2011 (*Oral Presentation*).
3. Jean Ne Cheong, Kylie D. Foster, John M.V. Grigor, John. E. Bronlund and Marco P. Morgenstern. *Dynamic Texture Perception of Solid Foods*. The NZIFST Conference - Science to Reality: New Zealand and Beyond. Rotorua, New Zealand. 27th June - 1st July 2011 (*Oral Presentation*).
4. Jean Ne Cheong, Kylie D. Foster, John M.V. Grigor, John. E. Bronlund and Marco P. Morgenstern. *The Use of Temporal Dominance of Sensation (TDS) for Dynamically Evaluating Biscuits with Small Structural Variations*. 5th Annual New Zealand and Australia Sensory Symposium, The New Zealand Institute of Food Science and Technology. Christchurch, New Zealand. 8th - 9th February 2011 (*Oral Presentation*).
5. Jean Ne Cheong, Kylie D. Foster, John M.V. Grigor, John. E. Bronlund and Marco P. Morgenstern. *A Multidisciplinary Approach to Investigate Dynamic Sensory Perception*. 10th Annual Functional Foods Symposium - Brains, Bounce & Baby Boomers. University Of Auckland, Auckland, New Zealand. 16th November 2010. P13 (*Poster Presentation*).
6. Jean Ne Cheong, Kylie D. Foster, John M.V. Grigor, John. E. Bronlund and Marco P. Morgenstern. *An Improved Approach to Investigate Human Masticatory Behavior and Sensory Perception*. International Conference On Food Oral Processing - Physics, Physiology And Psychology Of Eating 2010. University Of Leeds, Leeds, United Kingdom. 5th -7th July 2010. P74 (*Poster Presentation*).