Moving, Sensing and the Oral Cavity

Position paper for attendance at CHI' 23 Workshop - Body x Materials.

Topic Area: Material as catalyst for human action

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1 ABOUT THE AUTHOR

Luke Franzke is a research associate and PhD student at Zurich University of the Arts, where he heads the Physical Computing Lab. His teaching spans technical subjects such as physical computing and creative coding to conceptual approaches in material practices and embodiment in design. His past research has investigated the role of emerging material technology in Interaction Design and Human-Computer Interaction [3–6].

His current research deals with the design of Intraoral Computer Interfaces [10]. He is currently developing a framework for multisensory design with specific guidelines for the design of oral experiences, based on the unique sensory acuity and cross-modal interactions of the mouth. This framework lays the ground for radical sensory experiences, cognitive and physical augmentation and novel modes of interaction.

2 INTRODUCTION

The oral cavity, and the various sensory and motor modalities relating to gustation, breath and talking provide us with rich mechanisms for sensing, acting and experiencing. This insight has led several researchers to envision and create human-computer interfaces for the mouth in the form of wearable devices for accessibility aides [11], discrete or invisible interactive devices [7], devices that augment human capabilities [1], add fidelity to virtual experiences[13] or for therapeutic treatments [10].

The experiences that the oral cavity allows us often give rise to moments of intense focus on the sensual. We even have a word for it: to "savour" something. It is curious that despite our life experience of deep focus on the sensory experiences of the mouth, it still comes as a surprise that some of the most tantalizing qualities of eating might in fact be purely auditory [14]. Despite, by definition, being conscious of what we are experiencing, we seem to often be confused by qualia or *raw feels*, and underestimate the considerable cross-talk between sensory modalities. Furthermore, the nature of the raw experience of these fine qualities is not passive "viewing" of sensory data as we might believe. According to O'Regan, these raw feels arise from actions, through our sensory-motor interactions with the world.

This position paper briefly summarizes the sensory-motor theory proposed by Keven O'Regan relating to qualia, or the raw feels of experience. This theory might provide some insight for designers working in multi-sensory contexts, and the author proposes it as a talking point for the workshop *Body x Materials* at CHI23

Finally, the paper presents an interactive artwork using a novel intraoral computer interface that demonstrates and investigates some of the phenomenological qualities mentioned relating to the mouth. The wearable device used in the artwork could be made available for demonstration at the workshop.

3 QUALIA AND THE SENSORIMOTOR THEORY OF CONSCIOUSNESS

The term qualia refers to an individual instance of subjective, first-person experiences such as the redness of a red apple, the ding of a ringing bell or the painful prick of a needle. It refers to the unique and ineffable qualities that collectively constitute consciousness and

might be considered the defining aspect of subjective experiences. The nature of qualia and how they relate to the physical world is both a question of the physical sciences and deeply philosophical. Chalmers famously positions that explaining the existence of such qualia constitutes the “Hard Problem” of consciousness, distinct from the so-called easier problems that are susceptible to investigation through cognitive science or other reductionist means [2]. Chalmers states that the fact we should experience these raw feelings as phenomenological experiences, rather than just process sensory information like an unconscious zombie, is irreducible to the knowledge of the constituent neurocognitive mechanisms.

There is considerable debate in philosophy and in the cognitive sciences on the nature of Chalmer’s hard problem, as well as on the supposed “hardness” of it. While the literature and the ontological debates form a difficult quagmire to navigate for a designer, the material is highly relevant to those working with the senses, cross-modal phenomena and multisensory design.

This position paper focuses on the sensory-motor approach of Keven O’Regan to the hard problem of qualia, which is intellectually penetrable for designers and may offer insights for design practice. O’Regan first proposed the sensory-motor approach to understanding qualia with Noë in 2001[9], and he presents it extensively in his 2011 book [12].

The sensorimotor theory of consciousness proposes a new approach to understanding qualia or raw feels. Rather than assuming that the brain generates raw feels, the theory suggests that raw feels should be understood as "things that we do." The quality of a feeling is defined by the law that describes the sensorimotor interaction involved when we experience the feeling. Having the feeling with a particular quality means being engaged in an interaction and mentally confirming that the sensorimotor laws corresponding to that quality are valid. We move our bodies as a way of checking if the neural activity is derived from the outside world. This applies to everything from subtle eye movements in *seeing* to gross motor movements in *feeling* with our hands. This theory offers a solution to the "hard" problem of consciousness by showing how sensory experiences arise from a complex interaction of our actions in the world and the resultant stimuli, rather than some mysterious emergent property of sensory data processing.

The sensorimotor theory is compatible with the Enactivist understandings of cognition, although focused on perception rather than broader definitions of cognition. The “Thousand Brains Theory of Intelligence”, by Hawkins et al. [8] describes neural mechanisms for perception which is also compatible with the sensorimotor theory. Cortical Columns are modular units of the cerebral cortex, which according to Hawkins, are based on a standard sensory-motor algorithm for simultaneous control and sensing mechanisms. It appears that the same algorithm is applied to all forms of sensory inputs, in a continuous flux of action and sense in order to extract qualia. Furthermore, Hawkins describes cross-linking of these columns for the exchange of information that could provide some mechanisms for explaining cross-modal and multisensory perceptions.

4 GUILTY PLEASURE: ORAL CAVITY IN MULTISENSORY EXPERIENCE

This paper presents the work *Guilty Pleasures*, by Tabea Feuz, Noe Arnold, Johannes Reck and Elena De Carlo. The artwork was developed in the context of the Interdisciplinary design practice module in the Bachelor Design program at the Zurich University of the Arts, under the mentoring of Luke Franzke.

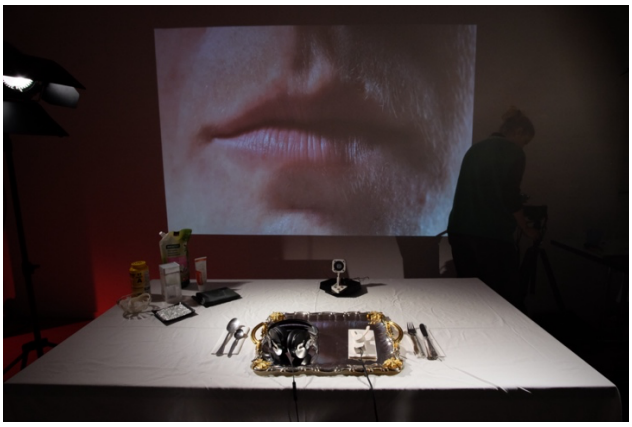

Figure 1. The setup of the *Guilty Pleasures* installation .

This installation offers a simulated dining experience that engages touch, smell, sight and intraoral acoustics. The inspiration for the project comes from pica syndrome, which is characterized by a hunger for, or impulse to eat non-edible objects. The installation features a device worn in the mouth that allows participants to hear the sound of fictitious meals being eaten through bone conduction, providing an embodied sensation of chewing and swallowing through acoustic cues. This immersive experience is enhanced by accompanying video and smells making it feel as though the participant is actually consuming the food. The result is a speculative, utopian-dystopian experience that challenges traditional notions of food and dining.

Figure 2. Students experimenting with custom built Intraoral Audio Interface.

The artwork plays with several key senses that constitute the multi-sensory experience of flavour and gustation, while not engaging taste itself. Of particular interest is the acoustic aspect. The role of sound while experiencing food textures in the mouth was highlighted in the now-famous experiments from Zampini and Spence, where the perceived crispness of potato crisps while eating was shown to be modulated by auditory cues [14]. In *Guilty Pleasures*, acoustic cues are gained by biting firmly on the device, which appears to provide a different experiential quality than would hearing the same tones through a standard sound source, highlighting the role of sensorimotor interactions in perception.

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