Wigglears:

Wiggle Your Ears With Your Emotions

VICTORIA G. PENG

Exertion Games Lab, Monash University, Melbourne, Australia

victoria.peng@exertiongameslab.org

Human-Computer Integration is an extension of the Human-Computer Interaction paradigm that explores systems in which the boundary between user and computer is blurred. We build on this and explore its intersection with the fields of biodata and playful expression by presenting "Wigglears", a wearable system that will wiggle the wearer's ears based on skin conductance, aiming to explore playful solutions towards integrated biodata-based self-expression. Through an autobiographical study, we demonstrate the system's ability to fuel social dialogue, amplify positive emotions, and triggering refocus. We intend for our system to be a novel solution to expressing emotions within social interactions, and hope to offer insights towards the social implications of biodata-based integration as a social cue, to help further the research within Human-Computer Integration.

CCS CONCEPTS • Human-computer integration • Body Augmentation • Affective Wearable

Additional Keywords and Phrases: Biodata interfacing, playful expression

1 INTRODUCTION

Figure 1: The *Wigglears* system wiggles the wearer's ears.

Human-Computer Integration is an extension of the Human-Computer Interaction paradigm that explores systems in which the boundary between user and computer is blurred [6,7,12]. Integration offers a new perspective that might act as a steppingstone towards potential developments of cyborgs in the future [22]. Currently, there exists works in various fields related to Human-Computer Integration, such as bodily extensions [4,8], and biodata interfaces [1,2,10,16,18]. However, there is lack of research within the overlap of these areas, being integration in the form of biodata-based body augmentation, especially if aiming to support social interactions. Furthermore, we wish to combine the above areas with playful expression as inspired by the mechanical tail and artificial moveable ears designed by Svanæs [4]. We believe there is potential in this intersection (Fig. 2) based on research on the correlation of emotions and ear movement of animals [9,14], and hence we are inspired to explore this further.

The concepts explored in this project revolve around creating a bodily extension system as a form of innovative playful expression. The question we wish to address is: How can computer systems be integrated for playful expression, and what are the social implications? We provide a proof of concept towards using body augmentation within social situations, and hope to further the research within the Human-Computer Integration paradigm with this knowledge.

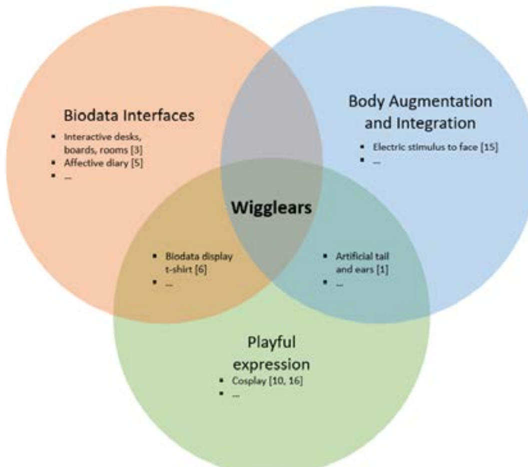

Figure 2: Relevant research areas and where they overlap, along with previous examples discussed in Section 2.

2 RELATED WORK

Previous research investigating the integration of computer systems and the human body has largely focused on bodily extensions [4], creating biodata interfaces to aid in emotional wellbeing support [2,10,16] or as external cues within social interactions [18]. We also draw upon concepts of animal ear movement [9,14] and cosplay for creative expression [19,20].

2.1 Integration and body augmentation

A previous example of a bodily extension system is the mechanical tail and artificial moveable ears designed by Svanæs, in which the remotely controlled tail and ears are used as a mechanical extension of the human body to enhance expression within theatre performances [4]. Our research aims to mirror the playful expression of the ears designed by Svanæs, however, the aforementioned design is controlled by a remote; what is not fully explored is how indirect control might change the experience. A study by Nacke et al. has looked at using both direct and indirect biofeedback within games, and has identified the need for more research within indirect control mappings [13]. Hence, we explore how shifting the control to biodata sensors will affect the integration between user and augmentation system.

Another example is “Electric Stimulus to Face”, which is a sound-controlled performance of electric stimulus applied to people’s faces [15]. This performance utilized tonal output to artificially stimulate the face and recreate facial expressions on the human. The experience is described as “surreal” due to the uncomfortable view of contorting the face [15]. We view this example as a form of body augmentation as the stimulus is able to control the user, however the user has limited control over the changes to their own face. From this example, we see the potential of body augmentation to create unique and “surreal” experiences.

2.2 Biodata interfaces

There exists extensive research towards displaying biodata readings from sensors, particularly through visual interfaces. Some examples include the affective diary [2], interactive desks, boards, and rooms [10], as well as user-designed personal interfaces through a toolkit [16]. These works all look at representing a person’s biodata as an interactive visual interface to aid in emotional reflection. From these we learn that providing biodata information can allow users to actively engage with and reflect upon their emotions. However, these interfaces are designed for personal reflection, and hence there is still limited understanding of the impact of such designs on social interactions of day-to-day life.

There also exists research on biodata interfaces that have been exposed to other people to explore the social implications of such interfaces. An example of this is the thermochromic T-shirt “Hint” that acts as a biodata display that changes color upon increased skin conductance [18]. The authors reported that the participants had various interpretations of each change of the T-shirt’s color, and suggest framing the bio-signal interface as a social cue. However, biodata interfaces have not yet been combined with bodily extensions to explore the possibilities integration can provide.

2.3 Ear movement

Ear wiggling is an action that some people have the ability to control. The notion of communicating emotions from ear movement is inspired by the natural ear movement of animals, as sometimes seen with dogs’ ears facing forwards or pulled-back. A study has observed that pigs have a higher frequency of ear movement upon decreased positive emotions [14]; these observations are useful to assess the welfare and emotions of pigs. Furthermore, a study on cows has observed a longer upright ear posture correlating with excitement [9]. Although the emotional state is somewhat different in these two examples, both behaviors are easily observable and make it easy to understand the emotional state of the animal. We chose to focus on creating a similar experience of movement of ears in humans that can be used as a communicator of emotions.

2.4 Playful expression and cosplay

The experience we wish to create is similar to cosplay, as cosplay acts as a form of unique personal expression for playful enjoyment and experiences [19]. Cosplay, however, leans towards performance and the imaginative self, and is commonly motivated by events such as conventions, whereas our system aims to be integrated with one’s real self and self expression. In a study on the effect of cosplay on fan identity, Lamerichs describes cosplay as a “performative activity”, combining playfulness and performance of identity through the identity of a character [17]. The key point we learn from this is how cosplay acts as an enabler for a person to playfully express their identity. We wish to achieve a similar effect of self-expression through our system.

2.5 Gap in design knowledge

As outlined, previous research exists in the fields of integration, body augmentation, biodata-based self-reflection interfaces, and biodata-based social cues. However, a knowledge gap lies within the intersection of these areas, specifically, integration in the form of body augmentation based on biodata readings, and the social implications of such a system. Hence, our research aims to provide knowledge that lies within this overlap, by exploring how systems should be designed when aiming to integrate with ear movement for playful expression.

3 DESIGN AND RATIONALE

We constructed a wearable system that consists of a motor attached to a headband, a Galvanic Skin Response (GSR) sensor, and an Arduino. The user wears the headband on their head and the two finger-gloves of the GSR sensor on the index and middle fingers of their non-dominant hand, while the Arduino is inside a bag that is worn across the body (Fig.3). The Arduino is programmed to receive data from the GSR sensor and determine whether there has been a significant change in skin conductance level, prompting the motor to move.

Figure 3: Design of the final prototype of the wearable system; The user wearing a headband with motors behind their ears.

We chose to use a headband as it is generally accessible and relatively comfortable, though other headwear we considered included caps and sweatbands. Another reason for using a headband is that the ends of the headband conveniently sit right behind the user's ears, which is an appropriate spot to position the motors. We use a power bank when testing the system to allow for the system to be portable, so the user is not restricted to being connected to a computer.

4 METHOD

Our research was conducted using a "research through design" approach [11], in which prototypes are created in an iterative way, along with an autobiographical design approach [3], in which the researcher is also the first-hand user of the system aiming to learn through usage.

We present three prototypes of the system. Each prototype was tested for 2 weeks each, during which the user was required to document thoughts and experiences daily, as well as record an hour of video footage per day of the system in use. The user was required to wear the system for at least 3 hours per day during this period.

The initial prototype used a naïve approach towards measuring skin conductance levels using a variable threshold. The threshold was calculated as an average of 500 measurements. We calculate the difference of each measurement from this threshold, and if the difference was above 50, the motors would be run, and the threshold would be recalculated.

The second prototype uses a fixed threshold and tolerance that is calculated as follows. At the beginning of each session of wearing the system, the user must watch a 2-minute slide show of photos provided by The Geneva Affective PicturE Database (GAPED) [5] from the "neutral" category, during which the program takes the average of all measurements across the 2-minute period as the user's threshold value. We use a fixed sample rate of 10Hz. Similar to the first prototype, the motor was programmed to run when a difference above 50 was sensed. Other values we tried were 10, 25, 75, and 100.

The final prototype draws upon learnings from both the first and second prototypes, and finally implements the full system with both ears. We once again use a fixed threshold and a tolerance value of 50. The design was reworked to use a backpack instead of a cross-body bag to reduce the intrusiveness of the system.

5 RESULTS

Our results come from the diary of both the user's thoughts and experience, as well as the responses of others who came in contact with the system in use. The user documented situations in which the system made their ears wiggle, listed possible reasons for the movement, and also noted what they thought was the effect of the system. We also noted that the final prototype was generally more noticeable to others because both ears would wiggle. Figure 5 provides a word cloud of the user's documentation on the effect, which allows us to visualise and gauge the user experience of the system. We filter out all words that are non-descriptive and are only necessary for sentence grammar, as they are unrelated to the user's experience. We decide on three groups for the effects of the system: the system's ability to fuel social dialogue, motivated by "*noticed*", "*felt*" and "*feeling*"; the system's ability to externalise and amplify positive emotions, motivated by "*excited*", "*playing*" and "*reacting*"; and finally, the system's ability to interrupt states of emotion, motivated by "*shocked*", "*unsure*" and "*thinking*". We also discuss how the system affects the user's agency, motivated by "*control*", and explore the user's experience, as motivated by "*confirmation*", "*self-conscious*" and "*awkward*".

Figure 5: Word cloud generated from diary.

5.1 The user's experience

The user notes that in some cases, they would have expectations of when their ears might move, and when their ears did actually move in those situations, it would feel like a confirmation from the system of their emotions. The user reflected that towards the start of working with the system, they generally focused more on thinking about what caused the ear movement, and relying on the system to better understand their own emotions, whereas towards the end, they noticed that they shifted their focus to how the ear movement made them feel. This change in perspective is likely a result of becoming more familiar with the system and moving closer to integrating with the system. The ear movement would also make them more aware of when they were feeling a strong emotion, which would be interesting to further reflect on and consider when they may be unconsciously making emotional decisions in their day-to-day life.

The user also notes a shift in the agency of their ears over to the system. Although the ear movement is based on their biodata, at the same time they felt a loss of agency as they do not have concrete control of their biodata responses. Furthermore, they felt in some situations the ear movement made them attract unwanted attention, such as in situations when they felt the movement of the ears was giving the wrong impression as to how they felt. For example, when the user was watching a presentation via Zoom, they felt the ear movement was not appropriate for this situation as it could perhaps suggest to the presenter that they were not taking the presentation seriously, so in this particular situation it was preferable for the ear movement to go unnoticed.

5.2 Fuel social dialogue

In many cases when the user's ears wiggled, people around them would tend to point out to the user that their ears moved. Sometimes, it was not clear as to what emotion the ear movement was triggered by, and as a result the conversation would then usually lead towards what people thought caused the ears to wiggle. Questions about how the user felt was common throughout conversation, for example "*did that make you excited*?".

Figure 6: Family members noticing the ear movement.

5.3 Externalise or amplify emotions

The ear movement helped externalise how the user was feeling to people nearby. For example, when watching a movie, each time the user's ears wiggled, the system was effectively externalising each time they felt an emotional reaction to a part of the movie.

When the ears moved in line with one of the user's actions or expressions, the system was seen to effectively amplify the emotion. For example, when they laughed out loud, and at the same time their ears wiggled, someone nearby commented that the "*laugh seems more real*".

5.4 Triggering refocus

The user also found that in some situations during which they were bored or distracted, their ears would sometimes wiggle, and the ear movement would grab their attention and help them refocus. This was mostly seen when the user was watching lectures and presentations while tired, or in scenarios when the ear movement was unexpected and hence caught the user by surprise.

6 LIMITATIONS AND FUTURE WORK

As a result of the external situation, there were limited chances to test the system face-to-face. We tried to minimize the effect of this by substituting face-to-face meetings with video calling, however we also found that it was a lot more difficult to notice the ear wiggles through a camera. Furthermore, GSR measurements by themself do not provide enough information to analyze and pinpoint a specific emotion, hence the ear movement and the user's emotions were not an exact one-to-one correlation. This would mean that it would not always be clear as to why the ears were wiggling, however as outlined in Section 5, we found that this often facilitated more interesting conversations about what people thought made the ears moved.

Future work in this area could look towards using different sensors to analyze the user's emotions, and allocate specific ear movements to specific emotions. Furthermore, it would be interesting to explore the implications of having a user's ears controlled by another person's biodata, and explore how this affects companionship, emotional privacy, and shared experiences.

7 CONCLUSION

In this paper, we present a novel system that will make the user's ears wiggle upon sensing biodata. We look at previous works that have explored bodily extensions and biodata interfacing, and combine these concepts with playful expression. Research through design and autobiographical design was employed to arrive at three prototypes for the system. We explore and analyse the system's ability to fuel social dialogue, amplify positive emotions, and triggering refocus.

Through this research, we provide a proof of concept towards using body augmentation within social situations, and hope to further the research within the Human-Computer Integration paradigm with this knowledge.

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