NONVERBAL EMPATHETIC COMMUNICATION IN COACHING WEARABLES

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1.Introduction

Humans, as social creatures, communicate with each other quite often. Communication, from its very simple form to extremely complex forms, seems like an action carried out by all known living things but what is communication? Communication, according to dictionary.com, is imparting or interchange of thoughts, opinions, or information by speech, writing, or signs. So, according to this definition, the most common or intuitive methods of communication is via visual and verbal means while touch/contact is conveniently omitted. This is quite strange because touch, when closely inspected, is part of the bedrock rock of human communication and greatly enriches this action by adding a fundamental dimension, contact.

Genuine communication generally carries some form of emotion which sways the way the individuals involved will react. Emotion, according to dictionary.com, is an affective state of consciousness in which joy, sorrow, fear, hate, or the lie is experienced, as distinguished from cognitive and volitional states of consciousness. Emotion is expressed by means of communication and this very much includes touch.

With the rise of portable electronics and computers, coaching with physical human professionals is being supplemented using personal computers or mobile devices. The advantage of these devices is that they can be used by clients(and service providers) as frequently as possible and, in practice, constantly coach the client. When coaches or anyone in a teaching capacity intend to give feedback they have to communicate this in order for the feedback to be received. The degree of emotional content within these feedback varies greatly and affect the effectiveness of the feedback. Contemporary coaching wearable technologies which purport to give non-verbal feedback tend to lose the emotional content within communication when giving feedback to their users and instead usually give reminders in form of a monotonous message.

Capturing these emotional content, figuring out the various ways they can be embedded in non-verbal feedback in wearables is the driving force of this project and also making sure no facet of communication is lost when vocal communicative means is not applicable.

1.1Research Questions:

During the course of the current project several question were asked out of necessity. The answer to a question usually led to a situation which generated the next question. Some of these questions are not explicitly stated in this document or do not take the form in which they are listed here but had a constant underlying tone.

- **Question1**: What emotions can be communicated non-verbally?
- **Question2**: which of these emotions have been studied?
- **Question3**: Which of these emotions is exhibited during coaching and can they be explicitly identified?
- **Question4**: What are the primary characteristics of each of these emotions?
- **Question5:** What nonverbal feedback modalities can be incorporated to express these emotions in a wearable?

2. Background and context

2.1Background literature:

Previous work had already been done on tactile communication. Investigations into how people express themselves nonverbally were carried out. Some focused on communicating/conveying

emotion while others focused on generating and enhancing emotions. Those that sought to generate emotions in individuals, attempted to conjure certain emotions rather than covey them. They sought sensations associated with certain emotions and attempted to replicate them in a way that would have the same effect as natural sensations. This section succinctly describes papers written on previous work.

2.1.1 The communication of emotion via touch

Matthew J.Hertenstein, Rachel Holmes and Margaret McCullough

DePauw University

Paper summary: The paper studies how humans communicate emotions through touch. The study focuses on how and to what degree pairs of people can communicate distinct emotion. In this paper the communicating parties are split into two categories; the encoder: the person sending the distinct emotion and the decoder: the person receiving the distinct emotion. The point of interest was how well/accurately these emotions could be decoded, building and extending on the results of Hertenstein, keltner, et al. (2006) which showed that the emotions, fear, anger, disgust, gratitude, happiness and sympathy can be communicated through touch. In order to gain greater insight, they sought to give the participants more room and freedom to communicate using touch compared to the study conducted by Hertenstein, Keltner, et.al. (2006) i.e. the encoder in the pair was allowed to touch the decoder where ever was deemed appropriate. This was done because of the complexity associated with human emotion and communication, giving room for the vast possibilities of communicating.

They replicated the findings of the Hertenstein, Keltner, et.al.(2006) indicating that emotion could be communicated via touch. They wanted to show that the emotions were communicated in strictly controlled paradigm could be communicated in the less controlled paradigm. They also wanted to find out if there were emotions that could be communicated via touch.

Experiment and methods:

The following experiment was conducted:

The experiment was conducted using 248 participants i.e. 124 pairs predominately Caucasian from an educational institution. They split each pair into two, the encoder and decoder. The decoder was blindfolded led to a predetermined location in the room where the encoder was. They were both instructed not to talk. Eight emotions, fear, anger, disgust, sympathy, happiness, sadness, love and gratitude were displayed randomly to the encoder and who was told to communicate an emotion to the decoder via touch. The encoder was given discretion on how to communicate (how and where on the body) the selected emotion. A forced choice sheet was given to the decoder after each tactile display. This sheet had all eight emotions which had been presented to the encoder at the start of the session but also included a ninth option which stated that none of the afore mentioned emotions was felt.

The manner each emotion was communicated was documented based on duration and intensity. They documented the following actions: Squeezing, stroking, rubbing, pushing, pulling, pressing, patting, tapping, shaking, pinching, trembling, poking, hitting, scratching, massaging, tickling, slapping, lifting, picking, hugging, finger interlocking, swinging and tossing of the decoder's hand.

Analysis of the documentation showed that all eight emotions, anger, fear, sadness, love, gratitude, sympathy, disgust and happiness could be communicated with touch without significant confusion. They showed that just like vocal and facial communication, communication with touch can be

differentiated and is not solely for the pleasure of touch. They also indicated the various tactile behaviours associated with each emotion taking the principle equipotentiality into account.

The study showed that even between strangers the afore mentioned emotions can be communicated via touch.

Relevance of study in Hertenstein, Holmes, and McCullough(2009) to current study:

The results of the study and experiment performed by Hertenstein et.al. is relevant to this study because it produced the actions which are performed specific to the emotions; Anger, fear, love, sympathy, gratitude, disgust, sadness and happiness. Some examples of these actions are shake, squeeze, pat and stroke. A more detailed analysis of these results is described in the implementation section of this document.

The results also showed the body locations where these actions were exerted, their intensity and duration. This result was the advantage of giving the participants more room to express the selected emotion via touch.

These findings cover the aspect of what emotions have been shown to be able to be communicated via touch and the manner in which they are communicated. Though some emotions, love, anger and fear, may not be directly applicable to a professional context (the coaching context of this project) the others; happiness, sadness, gratitude, disgust and sympathy have a place within a professional context for feedback. The results of the latter emotions are studied further and applied in the current study.

2.1.2 Communicating emotion through a haptic link: Design space and methodology

Jocelyn Smith, Karon MacLean

Paper summary: The paper focuses on the communication of emotion via a haptic link particularly the design space which includes the virtual mediating model, type of human interaction and the haptic device.

The primary goal was to understand the design space and how its components could be altered to facilitate the communication of emotion via a haptic link. The human interaction component dealt with the question of how many individuals were interacting. The type of haptic device referred to the mechanical and aesthetics of the physical object being interacted with while the virtual mediating model dealt with the device translating the physical actions performed by an individual on the haptic device into a literal action, a metaphorical one or a completely new action which gives the same sensation.

The paper acknowledged the critical important role of the aesthetic form and complexity of the haptic device in providing detail and therefore possibly improving the chances of distinguishing one emotion from the other there by affecting the user's response. This knowledge was not applied and instead the functions of the haptic device were simplified, made affectively neutral and had a low degree of freedom. The device effected the same body location of each individual in the pair interacting. Co-location simplified things and can be seen in a natural interactions like a hand shake, for direct interaction, or a game of tennis for indirect interaction.

The paper considers the relationship between individuals interacting noting that the relationship/intimacy between individuals affects how they would communicate via haptic means. The meaning of a touch could also vary depending on gender and intimacy.

Interpersonal space was modelled to investigate how individuals communicate nonverbally by varying the degree of physical space between others depending on their relationship and intimacy.

Experiment:

Pairs were presented with a list of emotions which was sourced from Russel and Weiss Affect grid(1989). Both parties within the pair were tasked with conveying or identifying a selected emotion via the provided haptic device. Touch was the only mode of communication. This was done to see "what could be conveyed by haptics in isolation and minimize ambiguity bout channel role in a multimodal context". Participants were not allowed to communicate before the experiment commenced in order to reduce the chances that a communication code will be created between them. Three design space dimensions were examined closely because of their impact on the communication of emotion within a pair of participants. These dimensions were, the interaction metaphor, indication of interpersonal space and relationship. The goal was to see if each dimension affects communication alone or in combination with the others.

The metaphor to indicate close contact, close intimacy, was a handstroke. With a hand stroke, both parties receive and cease to receive feedback simultaneously. The metaphor for strangers and less intimacy was a game of pingpong where parties do not receive feedback at the same time. The feedback device was a pair of a single-degree-of-freedom knobs. One knob was supplied to each participant in the pair.

The pair sat side by side with a demarcating wall, an LCD monitor which showed the procedure and were only allowed to communicate using the knob. The emotions chosen were anger, delight, relaxed and unhappy. These were displayed in a randomly ordered list of 20 emotion words and were split in half, each half was given to each participant. The participants were asked to convey each emotion and were given a questionnaire at the end of the experiment. The questionnaire asked what made the conveying of emotion easy during the experience and what they would change.

Results and relevance to the current study:

The results showed that pairs who were couples preferred the high intimacy metaphor i.e. the handstroke metaphor while the others who were strangers preferred low level intimacy. Majority of the participant occasionally mirrored the feedback of an emotion they felt was being communicated, attempting to match strategy with their partners. Participants communicated successfully 54% of trials. Anger being the most successfully communicated at 62.2% of the time it was communicated. Relaxed came in second at 56.9% followed by delight at 49.2% and then unhappy at 47.6%.

These numbers do not reinforce the hopes that communication of emotion can be done via haptics alone but taking into account that these experiments were done with a single dimensional device which restricted the ability for participants to explicitly express themselves, it can be said that even when a limited haptic device is provided some emotions can be communicated majority of the time. For the current study, devices with higher degree-of-freedom are used to communicate, increasing the chances of emotion being effectively communicated.

The conclusion of how relationship affects how an individual perceives touch is relevant to the current study because the relationship with a coach and a client needs to be taken into account.

Though relationship i.e. the level of intimacy between participants was taken into account, this was at a very limited level and the context or situation was not simulated. This would have given the experiment a natural setting instead of just requiring certain emotions to be displayed. In nature, genuine emotions are conjured by actions and are not necessarily summoned at will.

2.1.3 Virtual Interpersonal touch: Expressing and emotions recognizing emotions through haptic devices

Jeremy N. Bailenson, Nick Yee, Scott Brave, Dan Merget, and David Koslow.

Paper Summary: The paper deals with the Virtual Interpersonal Touch(VIT), exploring the expression of emotion through force feed-back haptic devices. The paper states that personal communication has a large nonverbal aspect with communicates “subtleties of emotional states between individuals”. The paper does not focus on the constituents of basic/universal emotion but tries to identify the emotions that can be transmitted via virtual touch and a system of classifying and interpreting their virtual haptic translations. The paper acknowledges that other nonverbal actions, like facial expression, also contribute to interpersonal communication. It goes further to describe the facial traits when expressing surprise, fear, disgust, anger, joy and sadness.

The goal of the studies performed was to show the ability to deliberately suggest specific emotions via haptics. The deliberate expression of emotions could be misleading compared to “automatic leakage”, which is genuine. The studies take these differences into account during the experiments performed and focuses on the use of touch to deliberately express emotions.

The experiments tried to understand to what degree an emotion can be expressed between persons using a simple haptic feedback device. The device was a joy stick placed on its side i.e. the stick lying on the horizontal plain enabling it to be moved vertically in a handshake like gesture. The experiments had a small sample size whereby the results were more of a guide than a means of generating a hypothesis. There were three experiments.

In the first experiment, 16 participants were asked to interact with the joystick and deliberately express joy, anger, fear, disgust, sadness, interest and surprise. The joystick moved freely without any resistance and its movement was recorded. At the end of each experiment participants were asked to scale the possibility of another person identifying the emotion they generated.

In the second experiment, 16 other participants were played back the recording of the actions of the previous group of participants with the joystick. They were asked to identify the emotions and their accuracy was compared to the performance of a support vector machine, a machine that learned to classify the seven emotions. In the third experiment, 16 pairs of participants were asked to communicate the seven emotions using a 10second handshake. The results of this was used to further understand haptic communication.

The pattern, speed and intensity at which the joystick was moved by the users was recorded. These showed that there were differences in the way one emotion was expressed from another and these were common amongst individuals. This is to say that, indeed, even with a simple handshake gesture, emotions can be expressed. When recognising emotions from an actual human handshake and that from pre-recorded on the joystick, individuals were quite good and identified them higher than chance level.

With regard to limitations of the study and experiments carried out, the study did acknowledge the limitations of a simple feedback device thereby restricting how a complex emotion can be conveyed. The experiments was done in a very controlled environment requesting participants to express emotions artificially and deliberately. It would have been ideal to have authentic and more natural expression of emotions. The study expresses how facial cues could contribute to how actions are perceived and interpreted and how this could be grounds for further study.

2.1.4 Design and development of a user centric haptic jacket

Faisal Arafsha, Kazi Masudul Alam, Abdulmotaleb El Saddik.

The paper focuses on the design and development of a haptic jacket with several heat, pressure and vibration actuators in order to enhance the experience of the user. The jacket had several interaction (touch, tickle and touch) that could express six emotions: fear, love, joy, surprise, anger and sadness. The jacket aims to intensify or evoke the emotional state of the user. In order to get the features needed to be implemented in the jacket an online survey was carried out with 92 individuals responding.

In the online survey individuals were asked how each of the six emotions could be represented using haptics. For each emotion, a list of body parts (neck, left pectoral, right pectoral, left abdomen, right-abdomen, arms, shoulders and back) with three distinct feedback actions(heat, beats and vibration). The results showed where and how majority of the individuals that responded would represent each emotion. The results were considered in realisation of ideas in the current project and are discussed further in the ideation/realisation section.

Though there was a mention of helping the blind experience emotions of another by studying facial expressions and translating them to haptic feedback, unfortunately this is not explored. Instead the testing of the jacket is focused on if multimedia experience of users can be enhanced. This is achieved by asking individuals to wear the jacket, watch a <1 minute video and each feedback is given by the jacket based on the six emotions. At the first instance, the feedback was given correctly and then during the second, feedback was deliberately given incorrectly. After each instance participants were given a questionnaire with several statements on the experience where they could rate (1-5) how accurate these statements were. The results showed that the jacket did improve their viewing experience.

In conclusion, this paper focuses on enhancing i.e. supplementing already perceived emotions that are generated and received from another source, the video. The jacket does not express these emotions on its own but rather relies on already generated emotion. The survey carried out does show how and where individuals would express certain emotions with haptic sensations and this used in the current study.

2.2 Interviews

In order to gain insight into the world of tactile feedback and robotics, several experts in the field were interview. Some of them were experienced with social touch technology in wearables i.e. sensor based input while others had done work translating human communication cues to robotic gestures. They, being contemporary experts in the field, gave insight to what is currently being done, what has been, what could be done/improved upon and dead ends that should be avoided. This section introduces them; describes their background, their field of expertise and what they are

currently doing. It also discusses the interviews and hashes out points that were made during the interviews.

2.2.1 Merel De Jung

Merel is a PhD candidate at Human media interaction group, university of twente. Merel focuses on automatic detection, classification, interpretation of touch in social interaction between humans and artefacts. Her goal is to make computers behave socially intelligent.

Merel got her bachelor and master degrees in Psychology at the University of Twente. She was at the department of cognitive psychology and ergonomics where her master thesis was on automatic detection of deception through body motion by using support vector machines.

The discussion points:

- Merel's expertise on making computers feel and behave social (human perception) proved to be enriching to topic of nonverbal feedback in wearables. She stressed out points that had already been heard during previous interviews while expanding on them and laying out new things to consider. These points are:
- Positive and negative emotions are difficult to explicitly translate. This point had been stated before but was stressed out by Merel linking it with the next point.
- Context and relationship between entities matters.
- One to one mapping of emotions is difficult to achieve because of overlapping traits between emotions.

2.2.2 Jan Van Erp and Christian Willemse

Jan Van Erp, a part time appointee at human media Interaction at the University of twente, is a professor of tangible user interaction concerned with using haptic and tactile displays to interact with virtual agents and robots. He works to improve human-computer interfaces that would be of benefit to both entities. He is a senior scientist at the Netherlands organization for applied scientific research. Jan worked on a vibration vest that could help astronauts with spatial orientation. He has a masters degree in Experimental Psychology and a PhD in Computer science where he specialises in remote control interfaces, advanced human computer interaction, multisensory interaction and brain computer interfaces.

During this meeting Christian Willemse, who works with Jan, was introduced. Christian is a PhD candidate at Human Media Interaction, University of Twente. He specialises in mediated social touch. Christian has a bachelor and masters degree in industrial design and Human technology interaction respectively. Christian's topic for his master thesis was; the perception of multimodal feedback in bimanual tangible interaction which was done at the Netherlands organization for applied scientific research.

The discussion points:

- The afore mentioned individuals had conducted experiments whose results shed light on aspects of nonverbal feedback in general which could be applied to this project. They pointed out things that worked and were proven and things that came out inconclusive. These were:
- Intuitive concepts, actions or physical states that maybe thought to influence the emotions of a target individual do not always work. It is believed that a warm body temperature of an individual should make a target individual, when touched, feel relaxed and comfortable i.e.

physical warmth equates social comfort but this notion when put to test came out inconclusive.
- They pointed out that a pat tends to make individuals more willing to perform a task.
- Individuals need to be given time to bond in order to achieve emotional connection.
- The target individual should not have the wrong expectation. This applies when interacting with inanimate systems. They should not be expected to act like what they have experienced before but should communicate the familiar emotions.
- Most parameters like temperature might have effects but under strict and controlled conditions.

2.2.3 Gijs Huisman

Gijs Huisman Obtained his PhD which dealt with questions regarding how individuals distance apart can engage in emotional physical contact. Gijs has extensive experience in the application of haptic technology in this context and as of the 22nd march 2017, is currently working on the Hey-bracelet, a bracelet that can be used by individuals in a long distance relationship.

The discussion points:

- Translation of positive and negative emotions to haptic feedback (or any form of electronic feedback). This is currently quite difficult to do due to the complexities embedded in emotions themselves. This could be high or low arousal. This leads to the next point:
- The duration, frequency and amplitude of feedback. Each of these parameters should be varied in different combinations to give unique sensations that could possibly convey the desired emotion and also conjure the reciprocal emotion. But all these depend on the next point:
- The context in which contact is made is important. This is just to say that the emotion conveyed depends on the situation/scenario a particular haptic feedback is give. A particular haptic feedback could mean something completely different if the situation is change. The relationship between the individuals interacting also plays a crucial role on determining what emotions are conveyed/conjured.

Listening to all these points suggest that one should specify and explicitly state what the situation is. Also one should experiment for a specific situations and individuals in varying degrees of relationships. All this is done to make the initial steps taken into a translating something as complex as emotion as basic as possible by focusing on the most basic, though still relatively complex ,aspect before delving deeper. Translating complexities is for a later project.

2.2.4 Daphne Karreman

Daphne Karreman is an industrial engineer. She studied industrial engineering going on to obtain her masters in industrial design in two fields; Design for interaction and integrated product design. Daphne did not stop there, she went further and obtained her PhD at Human Media Interaction, University of Twente. Her research was on human-robot interaction in which worked on a Fun Robotic Outdoor Guide, FROG.

The FROG robot is an outdoor tourist guide. It is not humanoid, lacking limbs and the traditional human facial features. Daphne worked on giving it a personality and behaviour aiding in human-robot interaction. This is quite related to the work with regards to non-verbal communication.

Daphne employed various tricks to translate the behaviour of a human tourist guide into the behaviour of the robot without necessarily imitating the actions of the human counterpart. For example when an exhibition/site of interest is reached a human guide will move the attention of the tourist to the object of interest by pointing with hands(fingers) and using the eyes. The FROG robot achieved this using an antenna like structure on its head. It swivelled to scan the crowd to imitate the eye scanning done by a human guide and also pointed using its antenna.

The discussion points:

- The behaviour of human counterparts matter. Daphne tried to translate minute actions performed by human conventional tourist guides into actions that could be performed by FROG. What communicative behaviour do these individuals exhibit for each goal? Identifying these actions seem trivial but are vital in communication and, if absent, will make interaction look strange and out of place.
- Two or more emotions may have the same physical displays. During the discussion with Daphne, she explained that some emotions have very similar attributes and without the support of other means of communication can be mistook for the other. For example frustration and enthusiasm have very similar attributes.
- Consistency matters. When conveying a message the attributes, especially the unique ones, of the action need to remain consistent in other not to be confusing to the target audience.

2.2.5 Consolidated points from interviews and conclusion

The context and relationship between individuals (entities) communicating should be taken into account. Individuals need time to bond in order to comfortably communicate.

Subtle/minute actions, that can be noticed when observing individuals communicate with others, are important and would need to be exaggerated when being translated to non-verbal feedback in order to be clear and explicit.

Though one-one mapping of emotions, positive and negative, prove to be difficult at this point, an adequate mapping can be achieved by selecting certain emotions, breaking down(simplifying) them down to their most common exhibitive trait and creating an exaggerated action to simulate those unique traits.

Communicative actions usually vary in amplitude, frequency and intensity which make them distinguishable from one another.

The interviews were quite insightful and resource-beneficial to the current project. Several points were made across interviews but there was a major point that stood out and kept making appearances from one interview to another, this was the context. The word, context, was mentioned explicitly by Gijs while Christian and Jan mentioned how individuals needed to bond with the robot they were interacting with. Daphne had designed worked with a curating (guide) context while focusing on behaviour exhibited by parties within this context.

The context could mean relationship and bond with interacting parties and also the scenario in which interaction takes place. When context is taken into account it reduces the difficulty in

mapping positive and negative valence behaviour. Hence making nonverbal communication scenario dependant.

2.3Problem statement: Context Creation

What real world problem does the current study intend to solve or diminish? This section introduces personas that were created to vividly set the stage for the project.

3.1.Personas:

- Chris Pringles: Fitness instructor

Chris challenges his clients who which to increase their fitness level. He puts them through rigorous routines that challenge them both physical and mentally. Chris tell his clients when they are doing very good and encourages them to keep it up, slow down and take a break when needed. Chris also expresses disappointment when his clients refuse to perform well or attempt to drop out of his sessions. Chris is always excited at the being of each session showing his eagerness to work out and improve his fitness level together with that of his client.

- Chidinma Luther: Life style/wellness coach

Chidinma is a life style/wellness coach meaning that she deals with a lot of people with lifestyle habits that interfere with their everyday life and would want to change. Her clients usually are demotivated and have difficulty changing a habit they do not like. These people usually rely on Chidinma for emotional support therefore Chidinma frequently, if not always, tries to give out a positive aura to elevate the mood of her clients and make them more willing to comply/heed to her advice. Chidinma shows concern when her clients are regressing. She is disappointed, and to an extent angry, when her clients do not do an agreed upon assignment. She tells them that these assignments are for their own good and encourage them to diligently do them.

- Flt Lt David Davis: Platoon commander

Flt Lt Davis is a platoon commander in a joint special operations unit. Davis haven been trained to command, is on his second tour with twenty-seven enlisted men and an NCO, Cpl Usman McDanklee. Davis and his men often execute clandestine operations which almost always take place in dark and require radio silence. This leaves communication to only gestures and body contact.

In order to ensure complete success of a mission the moral of Davis and his men need to be high to keep this focus on each of their roles in the unit. Some men that are posted into his unit are fresh recruits who have just left the special operations bootcamp and have no live operations experience and do not know how to deal with the anxieties that come this. Davis has to covertly calm his men down, encourage them to execute the command given to them. There are times that a task needs to be executed immediately and Davis, displaying how urgent this is, has to tell his men to do this immediately.

- ***Sharon Classic: Obesity patient***

Sharon has been obese since her late teens when she stopped taking quarterly village survival run. Her size has never been an issue for her because she accepted it as part of her disregarding what people said about the potential health hazards which result from being overweight. She recently got married and wanted to have children but was told by her medical

professional that it would be possible/safe until she loses a couple of kilos. Having that in mind, she signed up at her gym, got workout routines from an online forum and nutrition tips which included meal plans.

After a week of following her newly acquired plan she began falling back to old habits. Sharon ate a lot of junk food, ordering from the local fast food restaurant, she skipped her work out sessions because she felt they were not working. Sharon lost motivation and gave up on ever having children.

Sharon's medical professional referred her to a lifestyle coach who helps her get over her demotivation and habitual excessive eating. Sharon meet with the coach once a week who spends a day with her monitoring what she is doing and giving feedback accordingly.

- James Abrams:

James is a video game designer and loves playing video games too. James sits for hours during his work days with minimal break which do not necessarily involve any active movement. This sedentary lifestyle does not end at work but also continues when he gets home from work. James takes a couple of minutes to prepare his dinner then proceeds to the couch in his living room to play his favorite role playing game. James recently stated having pain in his lower back and was told by the physiotherapist to incorporate about 30 minutes or more of active movement instead of seating all day. He was also told to set out some time in the day for stretching his body in order to improve his flexibility and mobility. James has a lot of difficult keeping to this and usually goes through most of his days being sedentary.

- Cpl Usman McDanklee:

Cpl McDanklee is a veteran with two three month tours under his belt but this is a new unit with different operation scenarios than he is used to. Cpl McDanklee has been posted into the joint special operations unit, a step up in his career. It is a multinational unit and this will be for the first time he is taking and giving orders to foreigners. Cpl McDanklee is quite anxious about his first mission and though he has been rigorously trained he does not know how he will perform under unfamiliar live conditions.

- Franklin Reno:

Franklin has always been a scrawny individual. He has been attending his local gym for the last 3 years and has gained confidence in his ability to build muscle. With all the compliments on his new looks he gets from his friends and family he believes he has a chance of winning the local bodybuilding contest but he needs to add some muscle and improve his proportions.
He employs the help of a fitness coach who he meets every two weeks to check his progress and give him advice. Franklin never knew it will take so much effort and tends to skip some workout and meals.

What are problem do some of these personas have in common? They all require frequent, private and inconspicuous coaching. While some need a way to communicate with their target audience remotely as they would if they were with them physically. These communicative actions should carry as much, if not more, emotional weight as when verbal communication is possible or permitted.

Though these personas were created before the expert interviews, initially as a tool to create a problem statement, they end up being more than that. The personas help indicate the relationship between parties thereby easing the major point, context, made during the expert interviews into the current project.

3.Results: Conclusions and Concepts

3.1.Literature study

The combined results of the research done in the papers proved helpful in creating a point of reference. The images (fig1,2,3 and 4) below were extracted from the paper, Hertentein et .al (2009). These show/depict the actions that were performed by test participants in the study conducted by Hertentein et.al.

Participants were in pairs and one individual of the pair was asked to communicate the emotions, anger, fear, happiness, sadness, disgust, love, gratitude and sympathy. These were performed naturally i.e. without any electronic aids, there by demonstrating what could normally be done in a natural setting.

The encoder-decoder gender combination of the pairs were varied; male-male, male-female, female-female and female-male. For the current study, the results of mixed pairs; male-female and female-male, were prioritised over the others. Since the context of the current study is a coach-client communication, the emotions; anger, fear and love were not considered due to the level of intimacy associated with these emotions.

Percentage of Encoding Behaviors of Tactile Displays That Were Accurately Decoded

	Encoder–decoder group											
	Male–male			Male–female			Female–female			Female–male		
Emotion	Tactile behavior	*M*	*SD*	Tactile behavior	*M*	*SD*	Tactile behavior	*M*	*SD*	Tactile behavior	*M*	*SD*
Anger	Shake	38	44	Shake	32	41	Push	29	35	Push	32	42
	Push	24	39	Push	29	40	Shake	28	39	Shake	14	33
	Squeeze	20	32	Squeeze	11	25	Squeeze	21	36	Hit	12	25
	Hit	9	25	Lift	7	13	Hit	9	22	Squeeze	11	21
	Pat	4	10	Hit	6	25	Lift	4	8	Slap	10	28
Fear	Shake	29	40	Shake	14	29	Squeeze	36	40	Press	21	33
	Squeeze	21	36	Contact—NM	13	30	Shake	9	25	Contact—NM	15	34
	Contact—NM	15	27	Squeeze	13	27	Tremble	8	22	Shake	14	30
	Press	10	25	Lift	11	15	Contact—NM	8	23	Lift	11	15
	Lift	9	16	Press	5	14	Press	7	14	Squeeze	10	24
Happiness	Shake	25	32	Shake	28	35	Swing	21	29	Swing	28	36
	Squeeze	23	39	Lift	23	21	Hug	17	32	Lift	21	19
	Pat	23	32	Hug	21	35	Shake	16	24	Shake	13	29
	Lift	16	20	Swing	13	24	Squeeze	16	28	Squeeze	10	19
	Hug	13	29	Squeeze	6	22	Lift	13	16	High five	3	9
Sadness	Contact—NM	27	39	Hug	36	47	Nuzzle	23	35	Nuzzle	24	39
	Hug	27	42	Nuzzle	34	44	Contact—NM	19	33	Contact—NM	23	40
	Nuzzle	25	40	Contact—NM	16	33	Stroke	18	28	Stroke	23	30
	Squeeze	16	31	Lift	11	16	Hug	17	34	Rub	10	29
	Lift	10	17	Squeeze	5	14	Lift	8	13	Press	7	23
Disgust	Push	49	46	Push	35	41	Push	27	38	Push	28	34
	Contact—NM	12	27	Contact—NM	19	30	Squeeze	11	26	Slap	14	34
	Squeeze	10	25	Lift	11	23	Lift	11	19	Lift	8	12
	Shake	10	22	Shake	10	24	Slap	7	22	Kick	6	16
	Lift	5	14	Toss	6	17	Shake	7	18	Contact—NM	5	13
Love	Hug	61	45	Hug	53	41	Hug	59	43	Hug	34	39
	Pat	20	28	Stroke	15	27	Stroke	8	21	Contact—NM	17	32
	Stroke	8	24	Contact—NM	10	22	Lift	8	14	Stroke	11	21
	Contact—NM	6	22	Lift	8	16	Press	6	15	Lift	8	13
	Tap	5	20	Pat	8	18	Contact—NM	5	18	Nuzzle	7	21
Gratitude	Shake	49	28	Shake	49	25	Shake	29	26	Shake	31	26
	Lift	26	18	Lift	28	17	Lift	18	13	Lift	18	16
	Pat	19	29	Hug	6	13	Hug	16	26	Pat	17	30
	Contact—NM	8	21	Contact—NM	6	15	Pat	10	23	Hug	9	23
	Hug	4	20	Pat	6	12	Contact—NM	3	10	Contact—NM	9	18
Sympathy	Pat	43	34	Hug	24	38	Rub	25	32	Rub	24	29
	Hug	22	39	Rub	23	37	Hug	23	33	Hug	19	35
	Contact—NM	22	31	Contact—NM	21	31	Pat	17	21	Contact—NM	19	32
	Rub	10	23	Pat	18	30	Contact—NM	14	23	Pat	16	25
	Stroke	9	22	Stroke	12	23	Stroke	13	21	Stroke	12	18

Note. Contact—NM = contact, but no movement.

Figure 1 Actions associated with each emotion was derived from this table. Image extracted from The Communication of Emotion via Touch

Duration and Intensity of Tactile Displays That Were Accurately Decoded

	Duration (s)		Intensity (%)							
			None		Light		Moderate		Strong	
Encoded emotion	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Ekman's emotions										
Anger	4.5	5.1	5.0	11.1	6.9	16.6	33.0	36.4	55.1	41.4
Fear	7.6	8.5	0.6	2.5	17.7	26.2	57.1	35.4	24.6	35.0
Happiness	5.8	3.7	0.8	3.7	16.0	30.3	35.5	29.9	47.6	35.7
Sadness	6.4	4.3	0.7	2.9	65.1	41.3	31.4	39.9	3.3	8.6
Disgust	5.8	7.0	8.8	17.6	12.4	23.1	40.2	33.6	38.6	37.4
Prosocial emotions										
Love	5.3	4.7	1.6	7.1	35.0	37.8	56.7	38.8	6.7	21.5
Gratitude	6.0	4.6	0.6	3.2	16.6	21.8	73.3	28.4	9.6	20.9
Sympathy	6.4	5.6	1.0	5.5	65.5	38.1	32.2	36.7	1.4	7.3

Figure 2The intensity and duration of action is showed the in the image above. Image extracted from The Communication of Emotion via Touc

The images above(figure 1 and 2) shows what actions were performed, the intensity at which they were performed and how long they took place. The images below(figure 3 and 4) show the body parts that were interacted with.

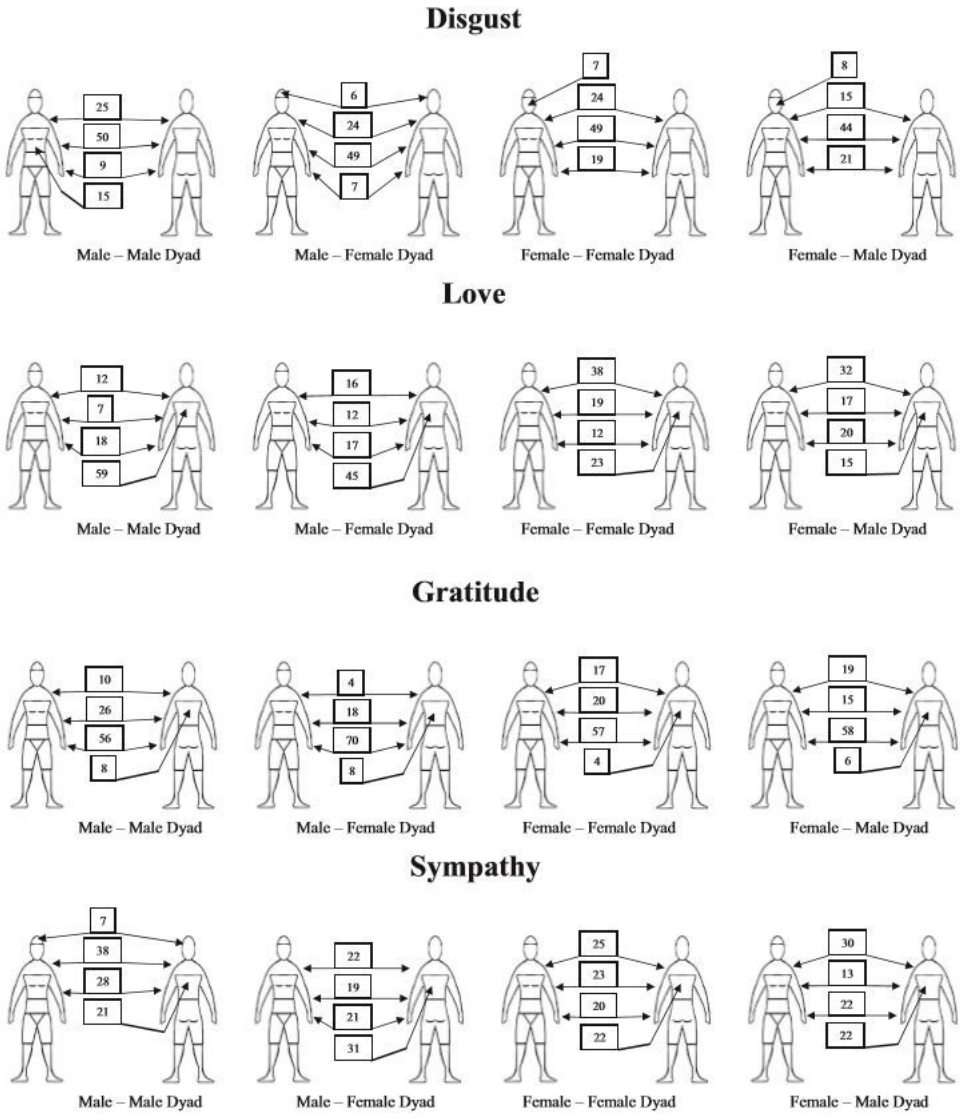


Figure 3 Imaged extracted from The Communication of Emotion via Touch

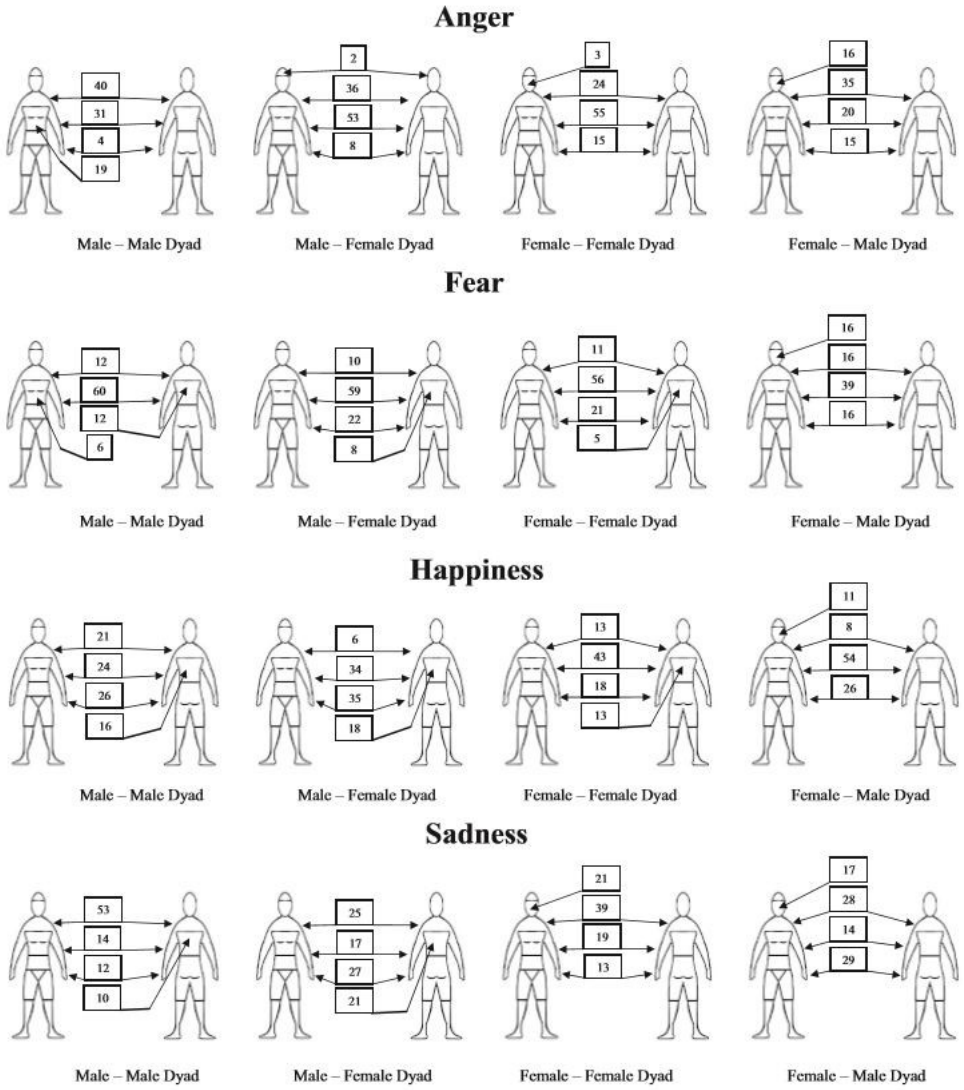


Figure 4 Image extracted from The Communication of Emotion via Touch

Emotion/feedback	Body location	Action	duration	Intensity
Sympathy	Mid/upper back	Rubbing latitudinal	7seconds	light
Disappointment	Single Upper arm	Push/contact(no movement)	6seconds	strong
Happiness	Both Upper arms	Shake/swing	6seconds	strong
sadness	shoulder	Burrowing(appendage)	7seconds	light
Gratitude	hand	Shake/lift	6seconds	moderate

Table 1 table showing merged results from literature study

Table 1, was created based on the combined information gotten from the tables and diagrams in Figure 1, 2, 3 and 4. The body parts interacted with narrows down the choice of what type of wearable can be created while the interaction type, intensity and duration guides the choice of actuators that can be incorporated into the wearable.

While on the topic of actuators, the paper by Faisal Arafsha et.al(2013) on the design and development of a user centric affective haptic jacket outlined their choice of feedback sensations associated with certain emotions(love, joy, surprise, anger, sadness and fear). Due to the fact that a jacket covers the upper body, all focus was on upper body locations. Unlike the other papers they intended to conjure these emotions in users rather than convey them.

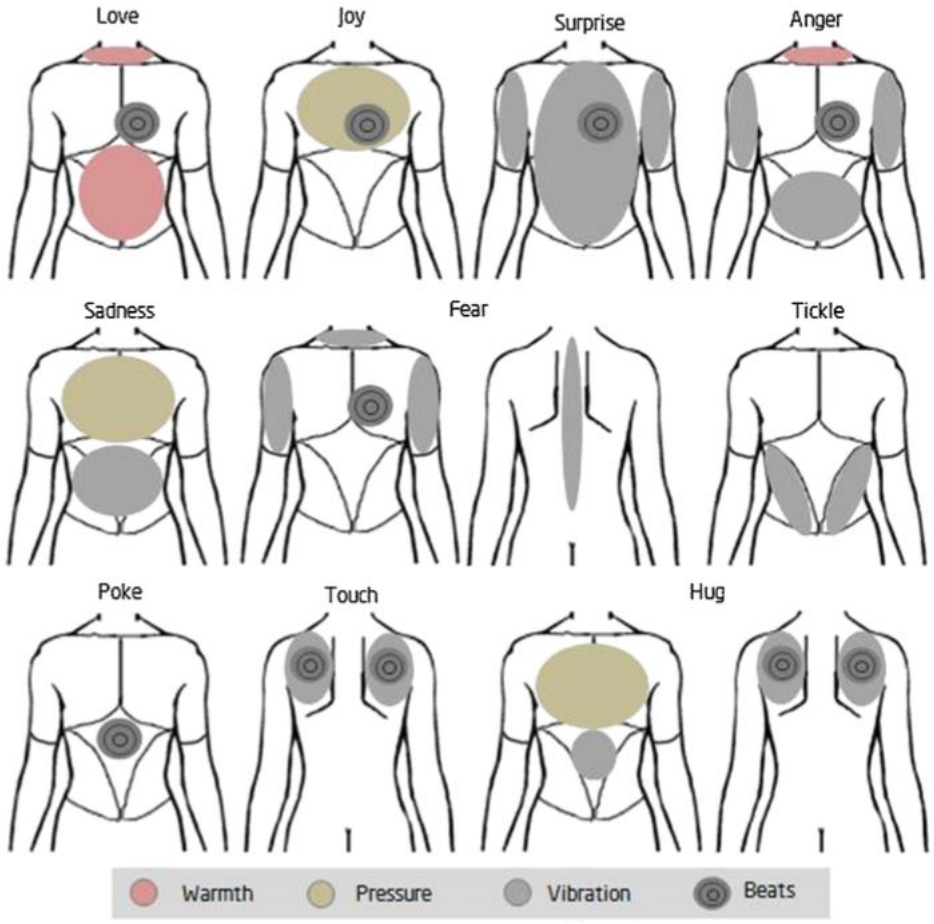


Figure 5 image extracted from Design and development of a user centric affective haptic jacket by Faisal Arafsha & Kazi Masudul Alam & Abdulmotaleb El Saddik

3.2 Persona Experiment:

A particular type of interaction can be assigned multiple messages. The interaction can convey different intentions depending on context. Information gathered from the interviews with experts in the field indicated that the context of communication and relationship between interacting parties determines the how an interaction will be perceived.

This suggests that if one wants to design or devise a means of communication, the context in which this means will be applied should not be overlooked but rather placed at the centre of the development research. For the current study the context was set from the beginning; health-coaching. This led to creation of personas as a problem statement and facilitated an experiment based on these personas.

In order to see how health coaches interact with their clients, an experiment using the personas for a lifestyle coaching and fitness coaching scenario was conducted. This was done to recreate a realistic situation that could be observed to generate information that would be used for the project.

Participants were sourced to play the role of each persona i.e. one participant played the role of the coach and the other the played the role of the client. They were both given separate scripts and instructed privately so one participant does not know exactly what the other will do. This was done to make their reactions as genuine as possible reducing the chances of forced/fake displays of emotion. Though this experiment was scripted, participants were asked to improvise within the bounds of the script. Experiments conducted in the past took place under tightly controlled conditions. For example, in Hertenstein, Holmes, and McCullough(2009) the encoder was provided with a list of emotions and was asked to display these emotions on command to the decoder.

The experiments had a positive and the negative scenario where coaches gave positive and negative feedback respectively. In the positive scenario the coach expressed excitement, enthusiasm, encouragement and satisfaction. While in the negative scenario the coach expressed negative messages like, disappointment and sadness. It should be noted that during all experiments coaches were not allowed to talk and were asked to wear a mask in some instances to hide their facial expressions. This was done to force them to exaggerate their non-verbal communication techniques thereby clarifying possible actions used in nonverbal communication. The mask was used to gauge the contribution of facial expression to successfully communicate non-verbally.

Appenx.1 includes the detailed scripts of this experiment.

3.2.1. Results of persona experiments

After reviewing the video and questionnaires, several common actions were performed by participants when communicating certain emotions. The following describes the body language of the coach.

Emotion	Action description
Enthusiasm (Happiness and excitement)	Repeated action at constant speed • A single clap followed by other short rhythmic movement, showing enthusiasm. • Touch on shoulder • Dancing rhythmic motion.
Encouragement (go-on, approval)	• Slow rotational motion supplemented by another action (thumbs up), pat on the shoulder. • Various random quick movements or continuous exact action with low constant frequency. • Nodding head slowly, thumbs while still nodding then just nodding i.e. one action first, two simultaneously then initial action alone.
Frustration	• Fast (hand) movements
Disappointment	• Hanging oscillating action (hung head shaking) • Slowly shaking of head. • Shake head then proceed to cross arms.
Seeking attention	• Quick light single-double touch/pat

Table 2 Actions and how they were performed during persona interview

Certain generic actions were observed to have been performed by the coach using their limbs and other body parts.

Human body parts performing action	Actions performed
• Lips • Limbs/hands • Shoulders • Head	• Pouting combined with head nod • Patting and tapping • Head nodding • Clapping • Thumbs up • Jumping • Dancing • Arm cycling • Shrugging of shoulders downward

3.3 Conclusion of results

In conclusion, in order to optimally personify a wearable, it is ideal that the wearable has features that can perform actions which could be perceived as the actions listed above. This will give the user the notion that the wearable has empathy i.e. displaying actions the user can identify with. During the ideation phase these actions were studied and linked to the body parts that perform them. Common emotions from the persona experiment and literature study were combined. Attributes of happiness and enthusiasm were merged to one message. Those of gratitude and encouragement were combined to mean “good-job” /”go-on”. Frustration and sadness were combined to become disappointment.

4.Ideation: Concepts

Participants who assumed the role of the coach used several common body parts to communicate with their clients. The same body parts were used to communicate different messages but what made them distinguishable from one another were the variations in sequences and patterns in which each message was conveyed. During the expert interviews, Gijs Huisman had brought up the significance of the amplitude, duration and frequency of a sensation or action when attempting to explicitly convey an emotional messages. This was taken into account when deriving the manner in which a wearable would give feedback.

The diagram shows the result of the combination of the study of body parts used and the variable patterns of actions performed. The device, the Backafly, has a core (head) and four limbs. The backafly is integrated into a vest/singlet and interacts with the shoulder blades and mid to lower back. Frequency, intensity and duration of interaction help to convey distinct feedback emotions. Human body parts are not literally copied but are represented using 3 parts: two sets of paddles (a

small set and a large set) and a core. These parts move independently, simultaneously and consecutively.

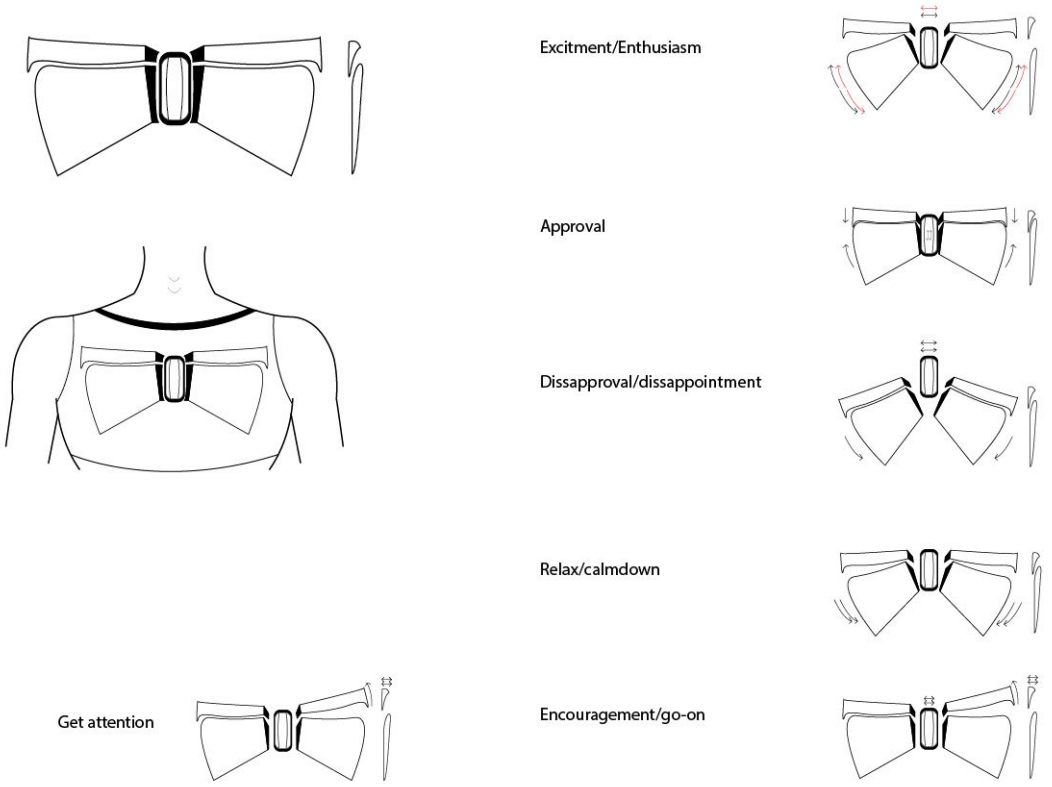


Figure 6 The backafly. Each flap moves independently with a DOF>2 this mechanically challenging to develop but possible

Excitement: the lower large paddles and core move rhythmically. The device is basically dancing.

Approval: All parts come together closely imitating pouting lips while the core moves slowly several times imitating a nod.

Disapproval/disappointment: All paddles move downward once then core moves slowly but faster than in the case of approval.

Relax/calm-down: Lower paddles move down several times (less contact when going up) while upper paddles stay stationary.

Encouragement/go-on: core moves several times and a single upper paddle taps simultaneously.

The behaviour of the device was solely derived from the results of the persona experiment and interviews. Information gotten from passed literature was not considered.

The backafly was hypothetical, exploring what could possibly be done not necessarily at the time this study was taking place. The backafly was also not developed due to mechanical challenge and would have needed an extended amount of time which this study did not have at the time; therefore it could not be not be tested in the field. But then, what can be presently made and tested when considering all information gotten from the interviews, literature study and experiment? What modalities can be developed and tested in order to be used in future proposed wearables?

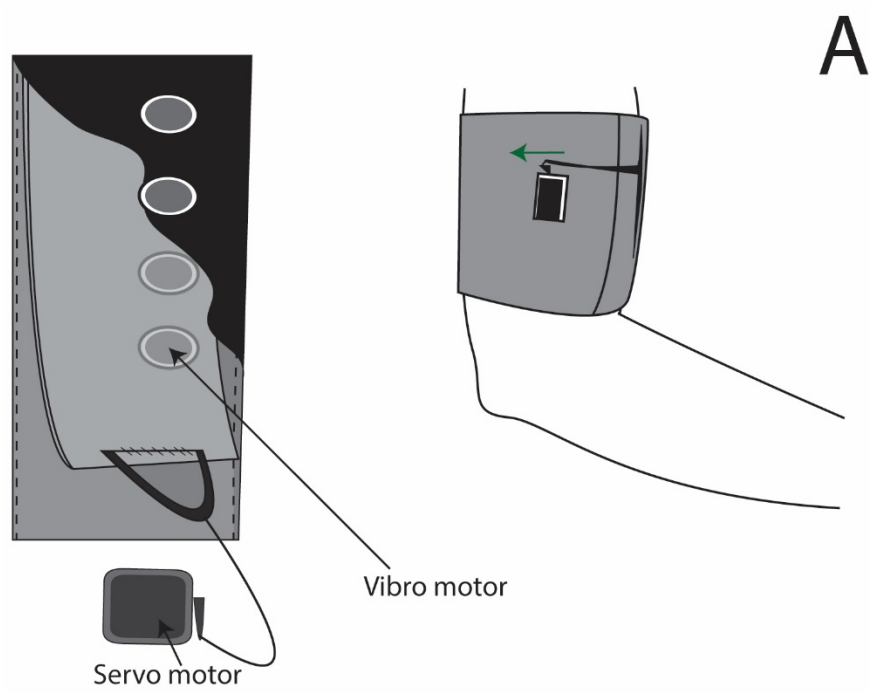
4.1 Realisation: Design

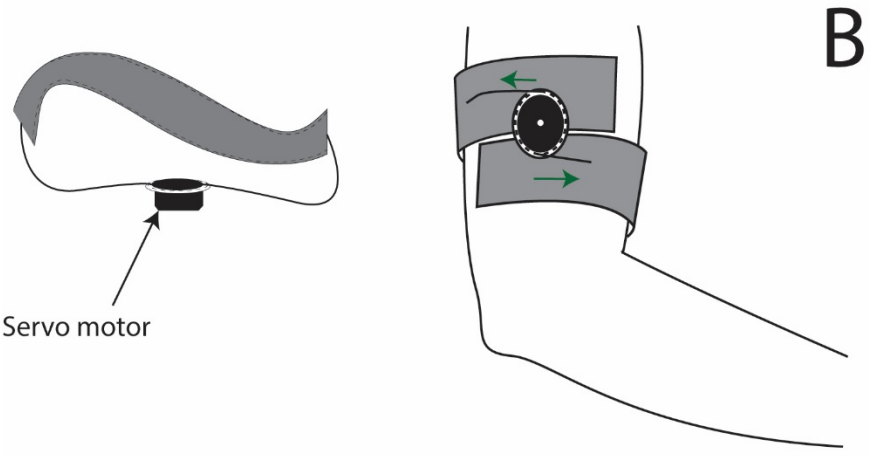
Looking at the list of actions performed, some recurring actions that seem fundamental to the list were taken out. These tactile actions; rubbing, striking (patting or tapping) and pressure were chosen. Visual actions ,like nodding and shaking, that could be extrapolated were also chosen. The next step was to consider actuators that could be used to exert these actions. Vibration motors, pneumatic pumps, servos, shape changing (mechanical) materials were all considered. Pneumatic pumps were considered to produce some form of pressure but were crossed out because of their current size and noise they produce. Vibration motors and servos were utilized for the realisation of a platform for testing while shaping changing materials will be considered for future work. Two servos were used to two create flaps that could tap on the shoulder blades of the user while two independent vibration motors were placed just above the roots of the flaps. These flaps were made using light formboards. The setup also included a combination of vibration motors and a servo incorporated into a sleeve which could be wrapped around the arm.

Two vibration motors were situated on the left and right side of the upper spine, close to the neck. Five vibration motors were placed within the sleeve linearly. The servo motor on the sleeve was used to pull on an inner fabric in order to create the felling of pressure in conjunction with heavy vibration from the vibration motors.

In order to control the all actuators, the Arduino UNO controller board was used. The Arduino board is relatively easy to use for prototyping due to its user-friendly IDE and circuitry. An excerpt of the code used can be seen in the appendix.

With these actuators, three sensations could possibly be given: pressure, rubbing, poking and taps. Illustration of these devices are shown in the imagines below.


A
Vibro motor
Servo motor


B
Servo motor

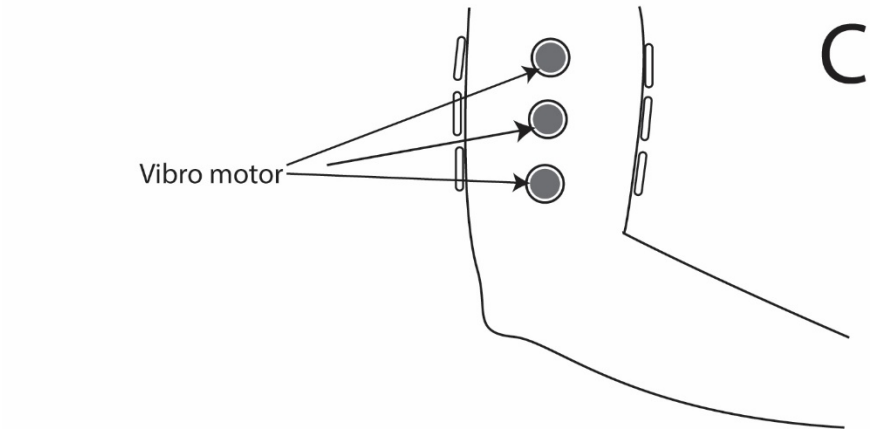

C
Vibro motor

Figure 7 A: A wrap with an inner sheet of fabric that is pulled by a servo to create pressure. The outer material is lined with vibration motors to enhance the sensation of pressure. B: Both ends of the wrap is attached to the servo, pulls in opposite direction

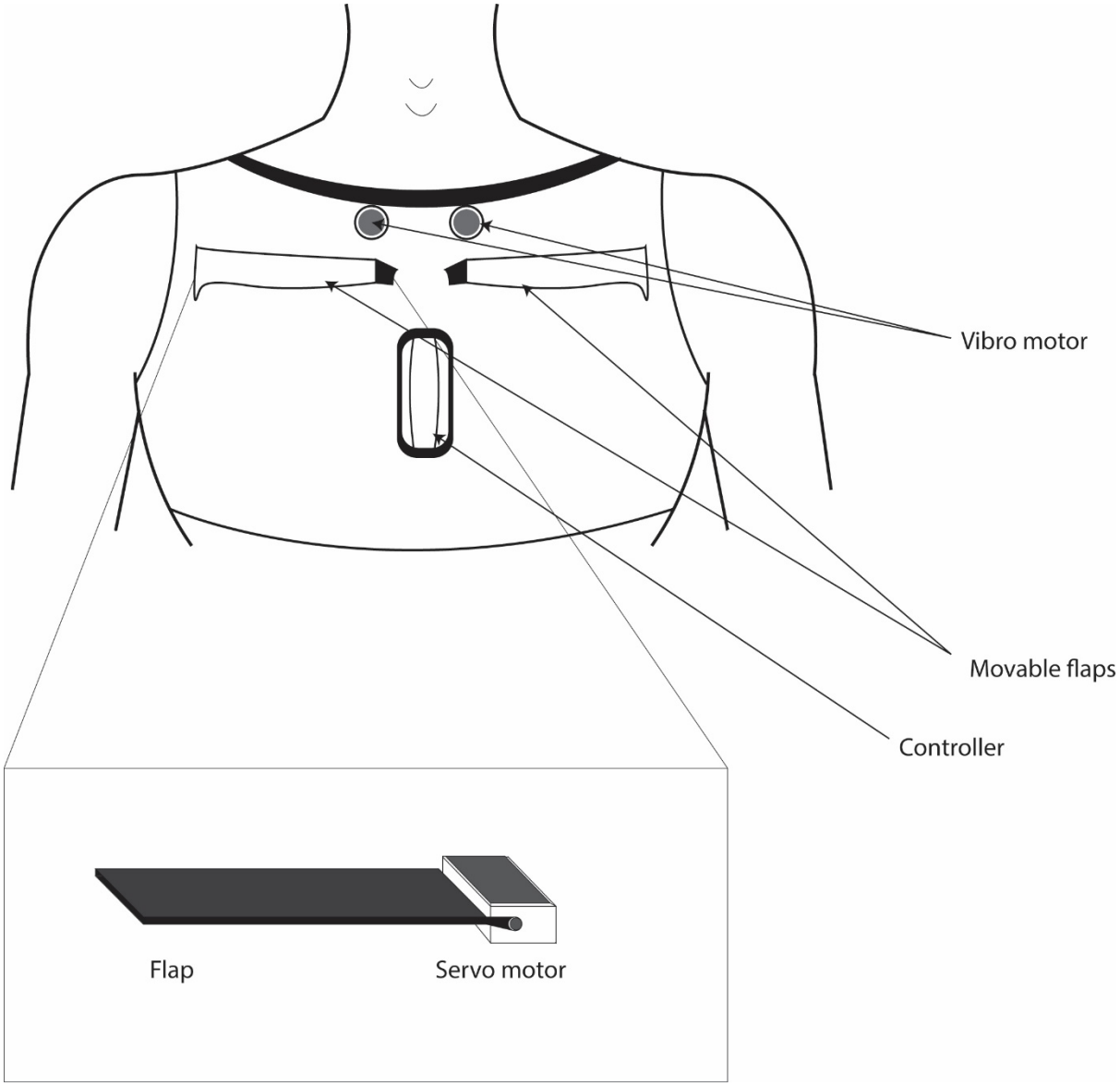


Figure 8 Actuator setup

4.1.1 Experiment

A short experiment with these devices was conducted. The aim of this experiment was to see if the actuators worked as predicted i.e. if taps were felt as taps and pressure was caused and also if the patterns conveyed the right message. Appendix.2 is a table showing the actuator patterns for each message.

In this experiment the scenario was as follows:

Assume you currently have a diet coach. Your coach has accompanied you to your weekly grocery shopping in order to watch how you select food to purchase. Your coach will communicate the following five messages with you while you shop:

- Excitement: This means the coach is extremely proud of how you are doing. This could be sent at any time regardless of performance
- Good-job: Approval stating your current choice is good.
- Look-at-this: This means you missed something good (referring to previous item). Go back to previous item.
- Calm down.
- Disapproval: You have had too much of current choice, drop item.

Tick under each item you choose.

In order to cancel a choice, make a cross (an “x”) underneath the tick.

You can ignore the coach’s advice but still take note of the message.

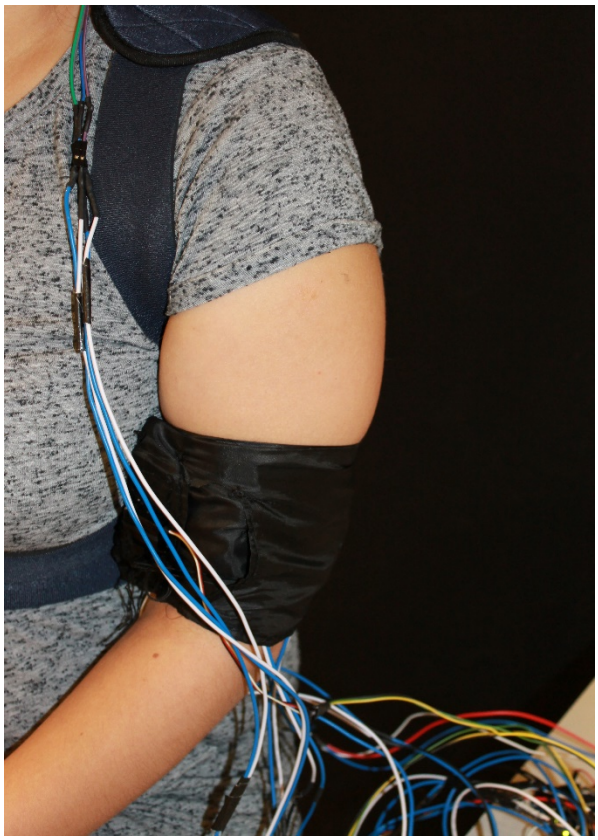


Figure 9 arm wrap on a participants. It features five vibrationmotors and a servomotor

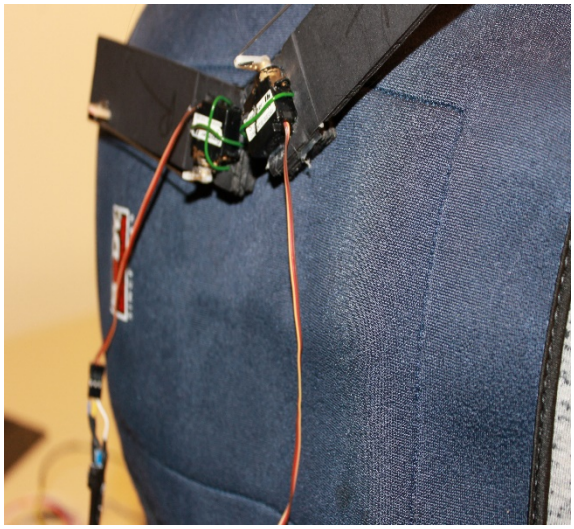


Figure 10 flaps for taps. This features 9 gram servos and light weight foam boards

Figure 11 Materials used for the experiment

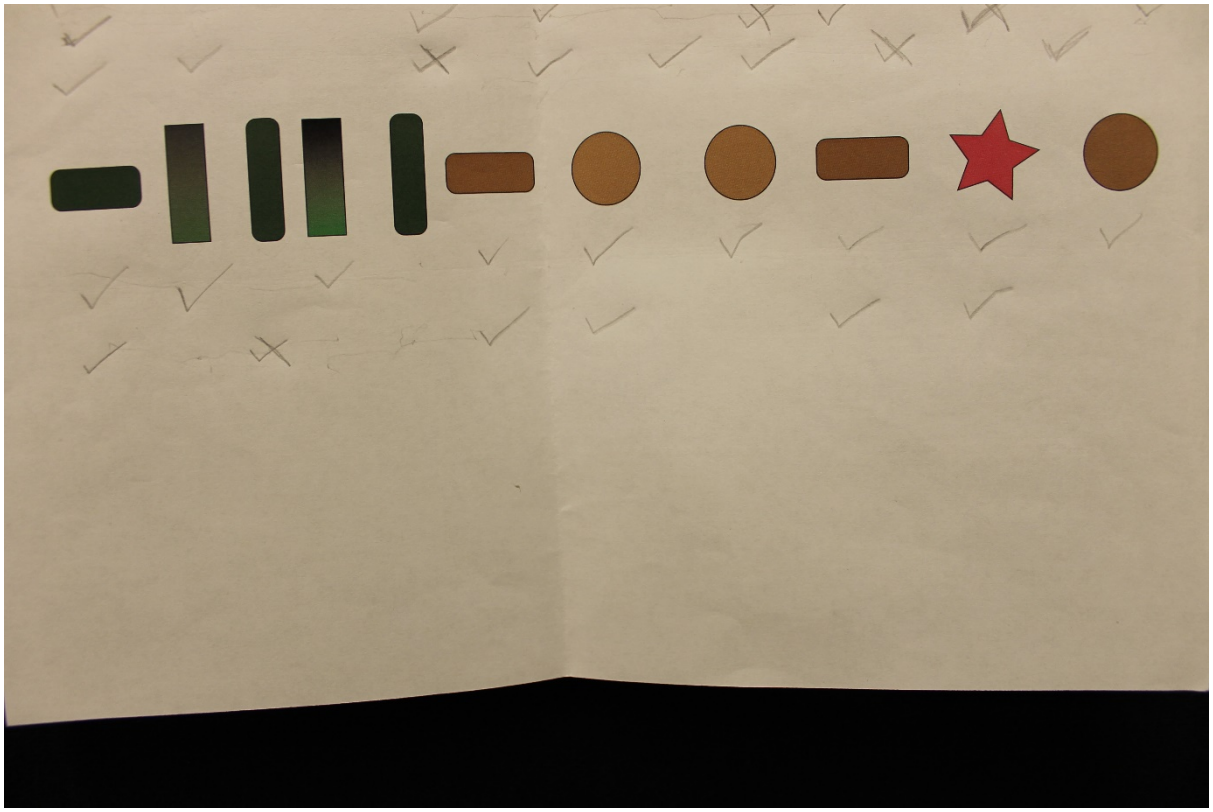


Figure 12 "shopping isle". Candy can be seen as bright coloured shapes while the green shapes are healthy items. Shapes with gradients are not necessarily healthy.

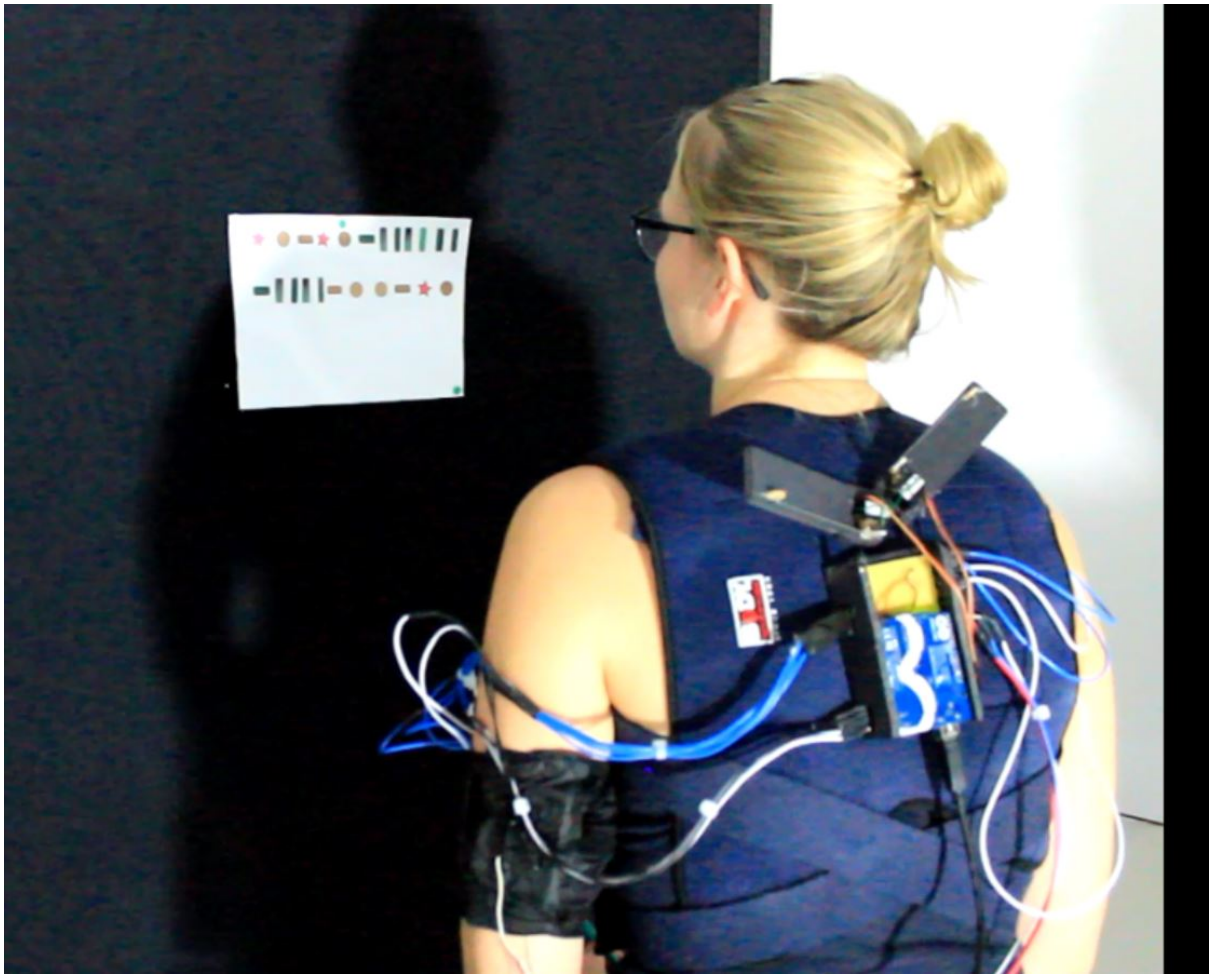


Figure 13 The second experiment. The piece of paper on the board represented a shopping isle while the shapes on the paper represent grocery items

Participants were provided with a sheet of paper simulating shopping isles and feedback messages were sent via an Arduino controller connected to a laptop. The results were mixed, some participants did understand the messages being sent while others were confused or nervous because they did not want to do anything wrong. It was clear that the actuators did work, excitement and disapproval were identified but the patterns in between these two extremities needed to be clarified.

Participants also expected the device to act the way inanimate objects they are used to do i.e. they did not expect empathy but rather coded messages, like vibration in a mobile phone, that will tell them when they do the wrong or right thing.

5.Conclusion

5.1.Lessons learnt

5.1.2 The experiments

The persona experiment was quite insightful, providing a vantage point from which the project could be propelled. It was helpful making the script loose and giving participant free reigns of how they wanted to act though keeping them with in the pre-set context.

Feedback is usually given right after an action has taken place. In the case of the life-style coach, the coach was to give feedback on actions that were carried out a relatively long time before they met. During the realisation stage this proved more difficult to work with than a situation where immediate feedback is given hence why a grocery shopping scenario was created. This is situation where immediate feedback can conveniently be given.

Several experiments were carried out through the course of this project. The first one was performed to figure out how coaches communicate nonverbally with their clients in setup scenarios. These were done without the introduction of artificial means of communication i.e. no devices. The second experiment saw the introduction of electronic tactile feedback. Users in this experiment were tasked with identifying the various messages that were being communicated to them. The purpose of this experiment was to find out if these messages could be deciphered by the user. Participants in this experiment were not informed, explicitly, about the purpose of the experiment. These experiments were insightful on the aspect of the wearable itself and in unexpected areas like participant behaviour and perception.

These experiments were quite open i.e. participants were not told how to behave or given a guide line they should follow. In the second experiment participants were not told that the experiment was on non-verbal communication and therefore the wearable would not be giving any audio feedback; any noise generated by actuators within the wearable should not be disregarded as it has no communicative value. Without this clarification, participants considered both audio and tactile sensations as part of the message being communicated. This was discovered after several participants had participated and led to the experiment being stopped mid stride.

Ideally, a third experiment identical to the second should be carried out to find out to what degree did the audio sensations affect the way the users interpreted the messages being sent. The experiment would have also stated to the participants what they should expect. Instead a third experiment with a different setup was carried out.

Before the experiment, participants were told it was a non-verbal experiment and all audio sensations should be disregarded. All five messages were played, consecutively, to the participant in order for them to know each message pattern (where each message begins and ends). After this, a list of the messages was provided to the participant while the researcher also had an identical list.

Participants were tasked with identifying each message. This was done playing a tactile pattern to the participant who was in turn required to mark which message on the list does the tactile pattern belong to. When a tactile pattern was played the right message corresponding to it was marked on the researcher's list. For example, the "excitement" pattern is played first, a "1" is used to mark excitement on the researchers list while the participant is required to place a "1" behind the message thought to correspond to the tactile pattern. The number used to mark the message is dictated by when the pattern, being referred to, was played. Therefore, if a "5" is behind a message it means the tactile pattern was the fifth played pattern. This helped when evaluating the results of the experiment.

Evaluation was done by comparing participants marked list with that of the researcher's. At the end of each session, participants were asked questions about how they experienced each tactile pattern and it was revealed that there was a tactile sensation that were not intended to be felt. The servo-motors used for tapping gave out a gentle vibration. The existence of this vibration was not known during the experiment and therefore was not factored while the experiments were running. It is currently unknown to what degree this affected the way each tactile pattern was interpreted.

5.2Future work

When the opportunity arises the next step for this project will be to perform a series experiments with previous mistakes corrected i.e. with quiet servos and a vivid explanation to participants. The series of experiments will explore various possibilities of actuator placement on the body with different combinations. It will also explore the use of different materials, fabrics and experiment setups. These experiments will be setup identically to those that were initially conducted.

One or two more messages will be added to the list. The new messages will be less extreme compared to anger or disappointment. When actuator patterns are created a study similar to that conducted in Hertenstein, Holmes, and McCullough(2009) will be carried out. In this case the encoder will be the device and test participants will be the decoders. This will be used to check if the messages are perceived correctly.

Feedback: Empathy rich messages

Is emotion a necessary element when giving feedback? The initial thought that emotion is the foundation of feedback, though true, detracted and consumed the scope of the current study. Empathy, the ability to place oneself in another's shoes, seems to be the key to giving effective feedback. Cognitive empathy, helps see the view point of another while compassionate empathy involves actually acting on that advantage to help out the person in need.

A hybrid of these two forms of empathy should strengthen the bond between a client and a coach. The client, sensing that the coach does actually know what the situation feels like and is only looking out for the good of the client, should readily take feedback (correction).

The relationship between empathy and feedback should be thoroughly investigated in the course of developing feedback automated feedback devices. For now, four messages gotten from research conducted and initial studies were used. These messages, enthusiasm, encouragement, disappointment and frustration (disapproval), were attempted to be translated to non-verbal feedback in wearables.

Appendix.1

Experiment 1

Positive scenario.

Persona 1: Chris Pringle, experienced Fitness instructor

Persona 1b: Franklin Reno, novice bodybuilding champion aspirant.

<u>You are Franklin</u>

During all Experiments the coach will not speak.

Chris and Franklin have their weekly workout session. During the last session, Franklin was getting easily frustrated and mentioned that he wants to quit because he dislikes to follow up on the complete plan. Chris explained to him that it is very important for the overall effect. Since that week, Franklin has taken great care of his diet plan and tried to follow it very well but he still doubts the necessity.(Yet, Franklin is eager to perform well during this workout).

Script:

- *You meet your fitness coach, Chris, in a room. Chris is not allowed to speak so do not expect him to.*

- *Chris tells you to perform 5 squats.*
- *Be hesitant at first then perform 7 squats.*
  END

You are Chris

Chris and Franklin have their weekly workout session. During the last session, Franklin was getting easily frustrated and mentioned that he wants to quit because he dislikes to follow up on the complete plan. Chris explained to him that it is very important for the overall effect. Since that week, Franklin has taken great care of his diet plan and tried to follow it very well but he still doubts the necessity.(Yet, Franklin is eager to perform well during this workout.)

(just for Chris):
Since Franklin gets easily demotivated, Chris has to make sure that Franklin feels rewarded for his actions and to support him well during the workout. He needs to encourage Franklin to keep on doing his exercises. Franklin does several arm exercises very well. So Chris approves and encourages him.

Script:

- *Meet with Chris, welcome him and make him enthusiastic.*
- *Tell him to perform 5 squats. If he hesitates oblige him.*
- *When he does them completely approve of this.*
- *If he out performs excitedly approve of this.*

END

Negative Scenario

You are Franklin

Chris and Franklin have their weekly workout session. Franklin is resistant in doing the exercises properly. He refuses to take Chris advice. For example, he has to do push-ups but is not going low enough. This keeps on going through the entire session.

Script:

- *You meet with your coach, Chris, in a room.*
- *You act unmotivated for today's session.*
- *You receive instructions for 5 squats.*
- *You perform the first two badly (don't go low)*
- *Pause for a moment and be reluctant*
- *Refuse to do the rest.*
- *You receive feedback from your coach.*

END

You are Chris

Chris and Franklin have their weekly workout session. Franklin is resistant in doing the exercises properly. He refuses to take Chris advice. For example, he has to do push-ups but is not going low enough. This keeps on going through the entire session.

For Chris: You are disappointed that Franklin is not putting in effort in his work out. You disapprove of how he is doing exercises he knows very well and you disapprove the attitude he is displaying during your session.

In the session, you will be showing your client which exercises to do (show a card)

Script:

- *You meet with Franklin.*
- *He is unmotivated*
- *Try to motivate him and instruct him to perform 5 squats*
- *He does not perform the squats well and pauses.*
- *Disapprove*
- *Try to motivate him.*
- *He refuses.*
- *Be disappointed.*

END

Experiment 2

Positive scenario.

Persona 1: Chidinma Luther, Lifestyle coach.

Persona 1b: Sharon Classic, obesity patient.

<u>You are Sharon</u>

Your coach would not be speaking

Sharon and Chidinma have their weekly meeting in which the coach asks Sharon how the last week went, how she felt with keeping up her diet, what went good and what did not go so good.

Sharon explains that she has achieved her diet goal for the week. She ate more vegetables and did not eat fast food. She still struggles with sticking to her diet and is unsure whether she can keep up with the dietplan.

Script:

- *You meet with your coach.*
- *Present your result (a piece of paper) of the previous week to your coach.*
- *The coach looks at your results*
- *The coach gives you feedback*
- *State your current struggle with your diet and act unsure about being able to keep up*
- *The coach expresses how she feels.*

END

<u>You are Chidinma</u>

Sharon and Chidinma have their weekly meeting in which the coach asks Sharon how the last week went, how she felt with keeping up her diet, what went good and what did not go so good.

Sharon explains has achieved her diet goal for the week. She ate more vegetables and did not eat fast food. She still struggles with sticking to her diet and is unsure whether she can keep up with the dietplan.

For Chidinma: You are excited that Sharon was able to follow up on her dietplan. You try to show your enthusiasm and try to encourage her even more in her exercises.

Script:

- *Meet with Sharon.*
- *Receive results from Sharon.*
- *Be excited about Sharon results and approve of it.*
- *Listen to Sharon's problem.*
- *Encourage and Motivate her.*

END

Negative Scenario:

<u>You are Sharon</u>

Chidinma and Sharon have their weekly session. Chidinma asks how the last week went. Sharon explains that she disapproves with some of the steps in her diet and work-out plan, although she approved of them last week, and has opted not to do them. For example, she does not realize why she should eat so much veggies when she does sports.

Script:

- *You meet with your coach.*
- *You present the week's result to your coach.*
- *Your coach shows how she feels about it.*
- *You state that you do not want to stick to the plan anymore.*
- *Your coach expresses how she feels.*
- ***END***

<u>You are Chidinma</u>

Chidinma and Sharon have their weekly session. Chidinma asks how the last week went. Sharon explains that she disapproves with some of the steps in her diet and work-out plan, although she approved of them last week, and has opted not to do them. For example, she does not realize why she should eat so much veggies when she does sports.

Chidinma disapproves of Sharon arguments.

Script:

- *You meet with Sharon.*
- *You receive her results.*
- *Show you are disappointed.*

- *She complains to you.*
- *Disapprove of this.*

END

Appendix.2

Messages	Actuator patterns
Excitement	All actuator are activated following a rhythmic “left and right“ pattern
Calm down	Gradual increasing and decreasing vibration on the arm
Attention	Double tap
Good job	A slow double tap followed with a double vibration on the neck
Disappointment	Arm sleeve tightens and all vibration motors on both the neck and arm are activated for about 6 seconds

Appendix.3

Figure 14 Persona Experiment: Several tactile and visual actions were performed to convey messages. In the image above a hug (relatively intimate) is being given. It should be noted that the individuals are of the same sex.

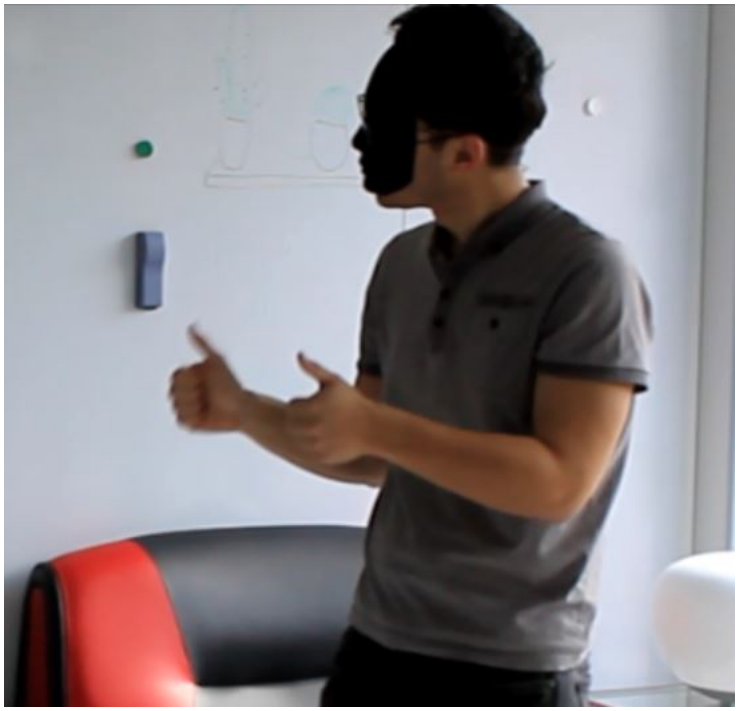


Figure 15 A mask was worn by encoders preventing the use of facial expressions to communicate. In the image above a visual action is performed to communicate. Visual actions were extrapolated to tactile feedback during the realisation of the prototype

Figure 16 "real world" application. A screenshot of a video describing how a wearable will coach during grocery shopping

Figure 17: Arduino IDE with sample code for flap operation

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