INTERNATIONAL DESIGN CONFERENCE – DESIGN 2024
https://doi.org/10.1017/pds.2024.172

Designing positive emotional experiences of wearable medical technology for type 1 diabetes

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Abstract

With the current strain on the healthcare service, wearable technology presents a solution. However, there is a lack of adoption from user groups due to a focus on clinical and financial factors. This study explores the implementation of positive design in medicine, outlining contributing factors to positive emotional experiences. Using a qualitative methodology in the form of semi-structured interviews with users and experts, a construct was defined consisting of five key psychological needs, including control, stimulation, competence, social factors, and purpose & growth.

Keywords: healthcare design, wearable technology, inclusive design, emotional inclusion, human-centred design

1. Introduction

The healthcare system is in crisis with rising costs and increasing pressure (Lewandowski et al., 2021), only enhanced by an aging population (Kim & Ho, 2021), hence the call for radical innovation. In recent years wearable technology has shown promise in solving this issue (Low & Ramayah, 2023; Zeng et al., 2022; Ferreira et al., 2021) reducing hospitalisations and enabling self-monitoring (Wang et al., 2020). However, Wang et al. identify a lack of consumer acceptance, with 30% of wearables being abandoned, in part due a focus on efficiency, low cost and clinical needs as key factors in the design of medical devices, using a disease model of design (Bogaert, 2022; Weatherly & Reay, 2022; Yoon et al., 2020; Pullin, 2009). Medical design and design for disability encounter sensitive issues, having a major effect on a user's self-image and emotions (Kim & Ho, 2021; Yang et al., 2021; Pullin, 2009) however, traditionally medical design is conducted by clinical engineers in an isolated laboratory, distanced from the real world (Hall & Lobo, 2018). The need for a different approach to medical design is blatantly clear, with the issue stemming from how we view medical conditions and what we prioritise.

1.1. Metaphysics and human-centred design

Typically, consumer acceptance can be assessed using the Unified Theory of Acceptance and Usage of Technology (UTAUT) (Kim & Ho, 2021; Wang et al., 2020). Wang et al., however, criticises the model as being limited in its use for healthcare devices. Additionally, the model considers technology acceptance to be determined by functionality and ease of use, disregarding other intangible factors and being limited in its inclusion of social influences.

Research shows that consumers are becoming more concerned with experiences, looking for meaningful exchanges (Giacomin, 2017) with acceptance being based on emotional reactions and intangible connections (Tan et al., 2022; Yang et al., 2021). Several authors have addressed these factors, including models such as Jordan's four pleasures (2000) or Giacomin's design for meaning (2017). More recently

Lim et al.'s 2020 model included cognition, emotion, social and value themes as key determining factors in what they term psychosocially inclusive design, improving quality of life for as many as possible in terms of social and psychological factors.
Similarly, person-centred care has been suggested as a new perspective on healthcare (Bogaert, 2022), considering the patient and other stakeholders as partners in their own medical treatment, mirroring human centred design principles (Giacomin, 2014; Weatherly & Reay 2022; Vougioukalou et al., 2019). However, Yang et al. (2021) states that human centred design often favours cognition over emotional factors despite emotion's growing importance in healthcare (Yoon et al., 2020; Niedenthal & Ric, 2017; Mugge et al., 2008), hence the need for an improved perspective.

1.2. Design for emotions

Positive design aims to provide a positive emotional experience in order to improve wellbeing (Yoon & Kim, 2022; Yoon et al., 2020; Desmet & Pohlmeyer, 2013), with Desmet & Pohlmeyer suggesting pleasure, virtue and personal significance in their framework rooted in positive psychology. While there is some research on the use of emotional factors in medical technology (Heiss, 2018; Tanure et al. 2014), Yoon et al. (2020) suggest that tools for designers need to be made more specific to the product's context with current models being too broad to have any significant impact.
The concept of eudaimonia, the self-realisation of one's daimon, or self (Ryff & Singer, 2008) states that well-being comes from the fulfilment of one's goals and personal development, specifically deep personal goals and aspiration relating to: self-acceptance, positive relations, personal growth, purpose in life, environmental mastery, and autonomy. Hassenzahl et al. (2013) aims to address these deeper goals, or virtues, in their approach termed experience design. The authors define experience as meaning-making and suggests that users first encounter conceptual consumption, the thoughts and intangible elements of their initial perception. We should first design the conceptual elements, including the user emotions and goals, and then design the material to reflect the conceptual. Hence Hassenzahl et al. list six basic psychological needs to address: autonomy, competence, relatedness, popularity, stimulation and security. It is the fulfilment of these needs, not necessarily in equal proportion and dependent on context, that creates a positive experience.

1.3. Contributing factors

Factors identified in literature sit in five categories derived from studies on psychological needs and virtues considered essential for wellbeing (Ryff & Singer, 2008; Hassenzahl et al., 2013). Firstly, trust, privacy and autonomy, summarised here as degree of control (Low & Ramayah, 2023; Kim & Ho, 2021; Ferreira et al., 2021). Secondly, stimulation in the form of physical or psychological pleasure which can include factors such as aesthetics (Mugge et al., 2008), but also narrative as a psychological pleasure as discussed by Chapman (2015). Competence constitutes another psychological need, being the sense of accomplishment that people strive for, linking to usefulness and ease of use (Low & Ramayah, 2023; Norman, 2016; Pullin, 2009). Sociability is one of the largest areas identified, primarily constituting of expression of one's identity (Mugge et al., 2008), social acceptance, and a balance of expression and discretion as discussed by Pullin (2009) and Hall & Lobo. (2018). Lastly purpose & growth includes self-acceptance, which Pullin (2009) links to a spectrum of discretion and expression, and also memories as a factor in emotional attachment discussed by Chapman (2015).

1.4. Research question

Throughout the literature, there is a clear need for further work on technology acceptance for wearable devices, with little consideration for metaphysical elements such as emotion. Additionally, current tools are made too general in an attempt to apply to a broad context, but in actuality, they do not strongly relate to any context and so are not widely adopted by industry (Yoon et al., 2020). Therefore, the aim of this research was to apply a design thinking method to answer the following research question: *What are the contributing factors in creating a positive emotional experience of wearable healthcare technology?*
As several studies have suggested (Lim et al., 2021; Yoon et al., 2020; Giacomin, 2017), this research used specific case study to ensure specificity of the outcome. Glucose monitors for type one diabetes

https://doi.org/10.1017/pds.2024.172 Published online by Cambridge University Press

have shown promise in reducing hypoglycaemic events reducing burden on healthcare by providing safer and easier methods of maintaining the condition (Zhu et al., 2022).
Diabetes is also often associated with depression (Balogh et al., 2020) illustrating a need for intervention. As such, Lowes et al. (2015) suggest professionals need to address patient emotions with their study finding that due to relentless and invasive management, patients experienced negative emotions which led to poor quality of self-management.
To summarise, the case of wearable glucose monitors for type 1 diabetes, fits the profile of a wearable device as defined by Ferreira et al. (2021), and has a specific focus on healthcare services. The case also exemplifies several elements identified in the literature including issues surrounding poor well-being and happiness, with Lowes et al. directly calling for a more patient-centred and emotion driven approach to diabetes care.

2. Methodology

The study followed an interpretivist epistemology and qualitative methodology, capturing deeper understanding of social and experience-based issues and creating a preliminary construct for a context as of yet unexplored to the author's knowledge (Muratovski, 2016). While debated (Yang et al., 2021), qualitative research has been shown to have benefits within healthcare, discovering values, needs and experiences (Vougioukalou et al., 2019).
The primary method used in this study was ethnographic, semi-structured interviews, as used by several other similar studies on emotions and similar phenomena (Weatherly & Reay, 2022; Lim et al., 2021; Haines-Gadd et al., 2018), allowing the researcher to explore emotions and the underlying goals (King et al., 2019; Denscombe, 2021), while also allowing users the opportunity to express their truth without the bias of leading questions (Seale, 2018).
Additionally, with the ethical implications of a study investigating deeper emotions in vulnerable people, the study instead investigated the experience as a whole using a similar approach to Chen (2020), deriving emotions and their corresponding psychological needs using thematic analysis.
The study was conducted in two phases. The first phase focused on patients as Kim & Ho (2021) state they are most affected by social aspects and therefore would have the most valuable insight in terms of product experience. A second round of interviews was then conducted with medical experts to gain an additional perspective separate to that of the user groups, with medical experts being influenced by information, service and system quality (Kim & Ho, 2021).

2.1. Sampling and data collection protocol

The study was exploratory in nature and so used non-random, non-probability sampling techniques (Denscombe, 2021). Purposive sampling was used to identify participants with type 1 diabetes using glucose monitors, to produce the most valuable insights and develop an initial construct (Lim et al., 2021). A summary of the sample is shown in Table 1.
As a correlation between age and technology acceptance was identified (Hauk et al., 2018), the first phase focussed on one age range to maintain data dependability. As the age range with the highest prevalence of type 1 diabetes in the UK was those aged 15-29 (Rafferty et al., 2021), and a study on emotion elicitation showed that young adults saw higher levels of arousal than older adults (Fernández-Aguilar et al., 2018), the proposed demographic for the sample was young adults between 18 and 30 years of age. The participants were gathered from online diabetes forums including Diabetes UK and public forums on Reddit, as well as via advertisement on Bournemouth University campus.

Table 1. User group sample

Gender	Age band	Type of user	Length of use (years)
Female (n=5)	18-20 (n=2)	Flash (n=5)	0-2 (n=2)
Male (n=1)	21-25 (n=3)	CGM (n=1)	3-5 (n=3)
	26-30 (n=1)		6+ (n=1)

For second phase interviews with experts, medical practitioners working in type 1 diabetes care were selected for interview. The selection of this alternative perspective allowed the researcher to effectively

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gather data that may provide different insights as to the experience of treatment, that users may not be able to see or may be biased against.
Interviews started with sensitising questions (King et al., 2019) before using narrative enquiry methods (Curedale, 2019; Haines-Gadd et al., 2018; Niedenthal & Ric, 2017) as well as guided introspection (Xue & Desmet, 2019) before concluding with a debrief to return participants to a neutral state. Each interview took no more than 30 minutes, and the interviews were recorded with the participants' consent and ethical approval from Bournemouth University.

2.2. Data analysis protocol

Data collected from user and expert interviews were analysed simultaneously and followed Braun & Clarke's (2006) six step thematic analysis procedure. Data in the form of transcripts were processed and prepared for coding, separating different topics and including preliminary jottings as a way of familiarising the researcher with the data.
The data collected from interviews was coded through the domain and taxonomic coding method, discussed by Saldaña (2021). Data was analysed by identifying meaning from the transcripts related to deeper psychological needs or factors contributing to an emotional reaction. Taking into consideration the preliminary set of factors identified from the literature, the data was coded and themed into five domains including *Control, Stimulation, Competence, Social, and Purpose & Growth*, with a total of 69 codes split into further sub-themes which made up the overall factors contributing to the fulfilment of the five basic psychological needs.
A reliability check was conducted using a multi-coding process which firstly involved the code being checked with peers (including a researcher with 1 year of experience and a post-doctoral researcher with over 10 years of experience). Additionally, the code was grouped by a secondary coder into a construct that was then compared against the original construct. Overall, while codes were interpreted and placed differently, the majority of themes were similar with slightly different terms. However, some elements were altered after this review where the change made logical sense and benefited the construct's accuracy or ease of use. Finally, the main themes and their sub-themes were extracted shown as in Table 2.

Table 2. An illustration of the final construct

Psychological Need theme	Sub-theme
Control - The influence over the subject's surroundings and self, giving the user authority to govern their own experience	Medical control - physical control over their medical condition and treatment
	Autonomy - control to make their own decisions
	Automation - automatic control and decision-making by the device
	Trust - perceived reliability
	Privacy - sharing of information as determined by the user
Stimulation - the arousal of interest through pleasurable experiences	Physio-pleasure - Sensory pleasure from physiological stimulus
	Psycho-pleasure - Cognitive pleasure from psychological stimulus
Competence - User has the ability to carry out an action easily and effectively	Usefulness - The importance of the technology in the user's life
	Ease of use - Minimising difficulty in the operation of a device
	Convenience - Avoiding additional inconveniences or complications
Social - ability and means by which the user engages in society	Social acceptance - Equal inclusion in society
	Social activity - Engaging in social events and community
	Discretion - Spectrum of revealing or hiding user's condition to the public
Purpose and Growth - the sense of self and forward movement in a positive direction	Self-acceptance - The user acceptance of their condition and attributes
	Quality of life - Freedom and normality in the user's life experiences
	Activism - Acts of furthering the user's own social standing towards equality, including raised awareness and accessibility
Other	User individuality - The unique requirements of individual users and need for variety in technology available

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3. Results

Control: Most interviewees stated the benefits of wearable glucose monitors in their management of the condition and glucose level. Additionally, interviewees stated the importance of consistency in their glucose level also linking mental health control with one interviewee stating they "*feel like there isn't such a big weight on [their] shoulders" and they feel "positive towards [their] future*". These codes have been grouped under medical control.

Secondly, the theme of autonomy was highlighted, as identified previously by Ferreira et al. (2021), particularly regarding users' ability to check their own blood glucose level whenever they wanted, giving them the relief of knowing their own glucose levels and being able to make informed decisions. This was particularly highlighted by the example of users who knew something was wrong before the glucose monitor picked up on it. In contrast, some users expressed a wish for automation, including closed-loop systems, suggesting this would reduce stress and allow users to live without concern for their condition. Automation is also present in the safety features on these devices such as alarms.

Trust was a highly discussed topic with interviewees, primarily as a distrust in the accuracy of glucose monitoring devices, stating lag time and false readings created scepticism. One user felt their device was "*gaslighting*" them and another suggested that devices had deliberate built-in obsolescence. In support of this, the importance of developing trust was emphasised by one medical practitioners, stating a lack of performance from the device can lead to a lack of trust, not only in the device, but in the healthcare service, stating "*patients do have their own health beliefs*" that contribute to adoption. As such, it is crucial to consider these beliefs and ensure that trust is formed between the user and wider healthcare service, supporting previous findings by Low & Ramayah (2023).

Lastly, privacy was discussed, consisting of a desire to control who is given information regarding the user's treatment, with it being related to personal boundaries. In one example, a user describes family overstepping this boundary which negatively affected the user and caused frustration, again, supporting previous literature (Low & Ramayah, 2023; Ferriera et al., 2021).

Stimulation: This theme was illustrated by two primary categories, physio-pleasure and psycho-pleasure. Physio-pleasure in this data included aesthetic design and comfort of the device. Firstly, there were several mentions of a displeasure, or pre-empted displeasure, from the constant presence of the wearable device, which presents a significant problem for designers to address. The largest complaint was medical discomfort in the form of bleeding, pain, and scabbing or scarring from past injection sites. While these were mainly directed at finger prick tests, users explained that they also apply to wearable monitors, just less frequently. This reduced discomfort encouraged many interviewees to switch to wearable monitors, however the monitors have their own set of problems, primarily allergic reactions caused by the adhesives.

Psycho-pleasure firstly included intrigue and fun, with several users being interested in the devices, either from an intrigue in technological elements or from fun elements such as the inclusion of stickers for their glucose monitor. Additionally, the sub-theme included the avoidance of psychological trauma caused by finger pricking. It is apparent that while there is some evidence for the psychological pleasure of a medical wearable device, the example of a wearable glucose monitor is seen more as a functional item than an item involving enjoyment and leisure, and so expectations for this device are relatively basic.

Competence: Firstly, usefulness was demonstrated by several interviewees who highlighted the glucose monitor's necessity in their daily lives, being described as "*life-changing*" innovations that provide more data than they could ever have expected before. Additionally, these monitors help to prevent complications due to high or low glucose levels with several experts and users emphasising this as a key factor in their reasoning for using wearable glucose monitors. This, again, supports the findings of Low & Ramayah (2023) in their factors for medical wearables acceptance.

Ease of use is another factor Low & Ramayah, include in their factors for technology acceptance, with the UTAUT including this as a key element also (Kim & Ho, 2021). This is clearly reflected in the data and is unsurprisingly one of the largest sections. Wearable glucose monitors were linked with reduced burden and improved overall wellbeing. With clear indications of the user's blood glucose levels and predictions, it helped to simplify management of the condition and reduce confusion. However, expert interviews discussed how technology inexperience was often detrimental for the acceptance of these monitors with one expert stating that many users struggle with some of the features such as uploading

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data from the device or setting up alarms, making these devices unsuitable for some users. This only emphasises the importance of designing easy procedures and easily understandable technology.
Similarly, convenience was a factor for many interviewees, consisting of increased speed and portability with users expressing their delight at the simplicity of scanning on the go with a mobile phone. The main inconveniences associated with the devices were a lack of connectivity with other devices such as smart watches; the inconvenience of monitors getting caught in clothing or while playing sport; and product failure such as the device's incompatibility with water. As such, these illustrated that connectivity, intrusiveness, and preventing product failure are factors in the convenience of wearable glucose monitors.
Social: Within this theme, several users and experts cited stigma associated with type 1 diabetes and devices used in its treatment, and so social acceptance was defined as a key sub-theme. Users explained the pressures they are put under by others as well as the threat of discrimination. Overall, users expressed a lack of understanding and empathy, firstly from the general public, but also from their friends and family, who with the best intentions put pressure on users to be in control. Several users, and experts alike, expressed a lack of understanding or empathy from medical professionals, mainly in the form of excessive scrutiny for incorrect or alternative management techniques that are not approved by the NHS, as well as poor glucose control.
Social activity was also a significant sub-theme here, with interviewees discussing how these devices allow them to engage in hobbies. Additionally, some users discussed body image issues which restrict their social activity. Overall, a strong need for social interaction was identified as a key factor in positive wellbeing. Furthermore, a strong sense of community was identified, with users explaining that finding a person who you can relate to creates a sense of belonging. This community extends to online forums and groups for help and advice.
The final sub-theme in the social section is discretion. This topic is complex, with Pullin (2009) explaining this with two terms "Disability" and "disability", the former being those who openly express their disability as part of their identity, and the latter being those who wish to be more discreet. This applied to the users interviewed with some wanting to show off their device or even customise it to match their personal style, while others described wanting aesthetics that are not obvious to others. Additionally, users with "disability", as opposed to "Disability", expressed the need for discreet actions and operation of the device, one user suggesting the act of waving a phone on their arm is a lot more discreet than a finger prick tests.
Purpose & growth: Firstly, self-acceptance was discussed with medical experts, stating that a user must accept their condition before they can engage in treatment. However, this can sometimes be difficult as some users will experience negative body image with a wearable device being a constant reminder of their condition. Ultimately the goal of self-acceptance is to improve the user's confidence and capability.
Improving the quality of life was another theme identified in the data, primarily concerned with enjoyment of life, freedom and introducing some normality to users' lives. This included allowing users to accomplish significant achievements such as a successful career or going to university while the device helped them deal with the stress of these events.
Forms of activism were also observed in interviewees, by which the author means acts of furthering the user's own social standing towards equality. Several users discussed their part in spreading awareness about the condition and the associated technology, discussing accessibility, high cost, and the strict criteria restricting their access to free devices, as well as general inequality in the healthcare system. Some users, specifically called for action on this inequality and lack of accessibility forming a key part of their experience with diabetes technology.
One code, 'Individuality', did not fit into any one theme but instead covered a multitude of themes. User individuality, or the unique requirements of individual users, was discussed with several interviewees, explaining that the vast range of needs and desires users possess requires a variety of devices for the user to choose from, as "*it's not one size fits all, you have to make sure the right person has the right technology*".

4. Discussion

Reflecting on the research question - what are the contributing factors in creating a positive emotional experience of wearable healthcare technology? – the construct derived from the results (shown in Table

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2) helps to answer this with a series of psychological needs and factors directly related to the fulfilment of these needs through wearable healthcare technology.

The psychological need of ***'Control'*** was confirmed within the results of this study, demonstrated through a variety of factors. Autonomy, privacy and trust which formed the preliminary construct (Low & Ramayah, 2023; Ferreira et al., 2021) were confirmed with users demonstrating a desire to have control over their own treatment and decision-making processes, as well as the need for boundaries regarding their personal data. A lack of trust was evident with inaccuracies leading to users questioning the credibility of data provided. Hence, trust is a key factor in the fulfilment of control, and the construct's ability to illuminate an issue with current medical technology proves hopeful for the application of this research in other medical design scenarios. In addition, medical control and automation were also identified. Automation, however, must be carefully balanced with autonomy, as while both have been confirmed as key factors by user and expert interviews, they have the potential to be in direct competition.

'Stimulation' has been largely confirmed by this study, identifying both physiological and psychological pleasures, including pleasant aesthetics, comfort, playfulness and intrigue. However, while the data would confirm discussions by Jordon (2000) on certain pleasures, the results observed presented basic pleasures as opposed to the deeper psychological pleasures that Chapman (2015) included in their model of emotionally durable design. This study would instead suggest that medical devices, particularly wearable devices, are not so concerned with the factors of narrative, personification, or shared memories.

The need for '***Competence'*** was a factor widely discussed previously with models such as the UTAUT (Kim & Ho, 2021) as well as literature by Norman (2016) and Pullin (2009) explaining the details surrounding ease of use and usefulness. These factors were confirmed by this research, covering a wide range of codes such as a necessity, reduced burden and easy operation. In addition to this, convenience was added to the construct with users expressing the desire for speed, portability and connectivity as well as many more.

'Social' factors have changed slightly throughout this study, firstly confirming social acceptance as a significant factor, identifying stigma and discrimination surrounding diabetes. Additionally, with a lack of empathy and understanding from others, this study proves the struggle faced by people with medical conditions and how this can affect the design of assistive technology, as discussed by Pullin (2009). Expression of identity was confirmed in this study, alongside discretion. However, the data presented a divide in the user group, some desired a highly discreet device with minimal features and discreet operation, and others wanting to express their diabetes as part of their identity and personality, showing off their device or even customising it to fit their own style. Once again, this follows discussion from Pullin (2009) who describes the phenomena in terms of people with Disability (with a capital D), and those with disability (with a little d). This divide presents a complicated issue for designers and is beyond the capabilities of this research to investigate. However, it would present an opportunity to investigate this dynamic in future research. Finally, in addition to these confirmed factors, social activity and community were included in this construct, leading to a sense of belonging.

The final psychological need, ***'Purpose & Growth'***, was also confirmed with self-acceptance being a factor identified by multiple experts and users, varying from acceptance of the condition, to body image issues and even to developing confidence. In addition to the preliminary construct's concept of rejecting stigma, the factors of quality of life and activism were added, being significant factors in positive emotions.

Finally, individuality as a factor could not be categorised, with users and expert agreeing that no one product can suit every user, and so each new product should be in some way different to the current market, finding a niche of users to truly serve, expanding the options users have so they can find one that fulfils their individual needs.

4.1. Contribution to knowledge

This study has brought a design thinking approach to the medical design industry which has been traditionally dominated by a focus on functional factors (Weatherly & Reay, 2022). The result is an alternative to this approach, highlighting the roles of emotions within medical design, and providing a contextual construct for future designers to use from the start of the design process as a guide or checklist to create design criteria and specifications for new products.

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It is hoped that adoption rates of these much needed devices can be increased by allowing designers to better understand and empathise with the target users, while also providing guidance on how future research can be conducted to apply this approach to other medical design scenarios.
The study has shown rigor in its particular focus within the field of emotional design, targeting the psychological needs that result in emotional responses (Hassenzahl et al., 2013), as well as taking the advice of other authors (Yoon & Kim, 2022; Yoon et al., 2020) to research a specific case study to provide more insightful models for use by designers. The methodology of this study has been chosen carefully, following a qualitative methodology, reflected in all the research activities conducted in the acquisition of this data.

4.2. Research limitations

While this study has been successful in reaching objectives and answering the research question, there are certain unavoidable limitations to this research. Firstly, due to limited time and resources this study only managed to include a total of nine participants for interviews. Future study with a larger sample size would be recommended to validate the construct further. In addition, it would also be recommended that this larger sample have a more representative gender mix, as this study was biased towards female participants. While this was suitable for a study conducting exploratory research, in order to confirm the construct a more proportional sample is needed.
While it was not possible in this study due to time and resource constraints, it would also be recommended that research be conducted with designers to validate the construct's usefulness in creating new products, as suggested by Haines-Gadd et al. (2018).

5. Conclusion and future study

This study has aimed to explore the factors contributing towards positive emotional experiences within wearable medical technology, hoping that the construct derived from the results will be useful to designers in creating future products. With the importance of wearables for the future of the healthcare system, and the current lack of adoption due to intangible factors, this study has highlighted key influential factors determining user acceptance.
A literature review concluded that fulfilment of basic psychological needs can elicit long-lasting positive emotions and psychological wellbeing, affecting a patient's acceptance of technology. Through a set of interviews with user groups and experts, wearable glucose monitors for type 1 diabetes have been examined through thematic analysis to confirm that a sense of control (including medical control, autonomy, automation, trust and privacy), stimulation of physio and psycho pleasures, competence (including ease of use, usefulness and convenience), social factors such as acceptance, activity and discretion, and purpose & growth from self-acceptance and quality of life are significant psychological needs that can be satisfied by considering the associated factors to elicit a positive emotional experience of medical technology.
Limitations in the current study would provide an opportunity for further research to confirm this construct's reliability with a larger scale study. This may also include input from designers, ensuring the construct is useful and creates effective change to the design process.
Additionally, this study left some factors requiring further investigation. Firstly, to see if Chapman's (2015) model of emotionally durable design has an application in medicine and to what extent, and secondly, further examining the dichotomy of discretion and expression within assistive technology.

References

Balogh, D. B., Molnar, A., Husszu, A., Lakat, T., Hodrea, J. et al. (2020), "Antidepressant effect in diabetes-associated depression: A novel potential of RAAS inhibition", *Psychoneuroendocrinology*, Vol. 118, No. 8, pp.1-8. https://doi.org/10.1016/j.psyneuen.2020.104705

Bogaert, B. (2022), "Moving Towards Person-Centered Care: Valuing Emotions in hospital Design and Architecture", *Health Environments Research & Design Journal*, Vol. 15, No. 2, pp. 355-364. https://doi.org/10.1177/19375867211062101

Braun, V. and Clarke, V. (2006), "Using Thematic Analysis in Psychology", *Qualitative Research in Psychology*, Vol. 3, No. 2, pp. 77-101. https://doi.org/10.1191/1478088706qp063oa

https://doi.org/10.1017/pds.2024.172 Published online by Cambridge University Press

Chapman, J. (2015), *Emotionally Durable Design: Objects, experiences and empathy*, Routledge, London; New York.
Chen, K. (2020), "Why do older people love and hate assistive technology? – an emotional experience perspective", *Ergonomics*, Vol. 63, No. 12, pp. 1463-1474. https://doi.org/10.1080/00140139.2020.1808714
Curedale, R. (2019), *Design Thinking Process & Methods*, Design Community College Inc, Los Angeles.
Denscombe, M. (2021), *The Good Research Guide: Research methods for small-scale social research projects*, Open University Press, London.
Desmet, P. M. A. and Pohlmeyer, A. E. (2013) "Positive Design: An Introduction to Design for Subjective Well-Being", *International Journal of Design*, Vol. 7, No. 3, pp. 5-19.
Fernández-Aguilar, L., Ricarte, J., Ros, L. and Latorre, J. M. (2018), "Emotional Differences in Young and Older Adults: Films as mood induction procedure", *Frontiers in Psychology*, Vol. 9, pp. 1-14. https://doi.org/10.3389/fpsyg.2018.01110
Ferreira, J. J., Fernandes, C. I., Rammal, H. G. and Veiga, P. M. (2021), "Wearable technology and consumer interaction: A systematic review and research agenda", *Computers in Human Behaviour*, Vol. 118, pp. 1-10. https://doi.org/10.1016/j.chb.2021.106710
Giacomin, J. (2014), "What is Human Centred Design?", *The Design Journal*, Vol. 17, No. 4, pp. 606-623. https://doi.org/10.2752/175630614X14056185480186
Giacomin, J. (2017), "What is Design for Meaning?", *Journal of Design, Business & Society*, Vol. 3, No. 2, pp. 167-190. https://doi.org/10.1386/dbs.3.2.167_1
Haines-Gadd, M., Chapman, J., Lloyd, P., Mason, J. and Aliakseyeu, D. (2018), "Emotional Durability Design Nine – A tool for product longevity", *Sustainability*, Vol. 10, No. 6, pp. 1-19. https://doi.org/10.3390/su10061948
Hall, M. L. and Lobo, M. A. (2018), "Design and development of the first exoskeleton garment to enhance arm mobility for children with movement impairment", *Assistive Technology*, Vol. 30, No. 5, pp. 251-258. https://doi.org/10.1080/10400435.2017.1320690
Hassenzahl, M., Eckoldt, K., Diefenbach, S., Laschke, M., Lenz, E. and Kim, J. (2013), "Designing Moments of Meaning and Pleasure. Experience Design and Happiness", *International Journal of Design*, Vol. 7, No. 3, pp. 21-31.
Hauk, N., Hüffmeier, J. and Krumm, S. (2018), "Ready to be a Silver Surfer? A Meta-analysis on the Relationship Between Chronological Age and Technology Acceptance", *Computers in Human Behaviour*, Vol. 84, No. 7, pp. 304-319. https://doi.org/10.1016/j.chb.2018.01.020
Heiss, L., 2018. Designing Emotional Technologies: Collaborating across design, health and engineering to humanise wearable health technologies [online]. Thesis (PhD). RMIT University. Available from: https://orcid.org/0000-0002-3283-4478
Jordan, P. W. (2000), *Designing Pleasurable Products*, Taylor & Francis, London; Philadelphia.
Kim, T. B. and Ho, C. B. (2021), "Validating the moderating role of age in multi-perspective acceptance model of wearable healthcare technology", *Telematics and Informatics*, Vol. 61, pp. 1-12. https://doi.org/10.1016/j.tele.2021.101603
King, N., Horrocks, C. and Brooks, J. (2019), *Interviews in Qualitative Research*, Sage Publications Ltd, London.
Kraaijeveld, S. R. (2021), "Continuous Glucose Monitoring as a Matter of Justice", *HEC Forum*, Vol. 33, No.4, pp. 345-370. https://doi.org/10.1007/s10730-020-09413-9
Lewandowski, R. A., Lewandowski, J. B., Ekman, I., Swedberg, K., Törnell, J. and Rogers, H. L. (2021), "Implementation of Person-Centred Care: A Feasibility Study Using the WE-CARE Roadmap", *International Journal of Environmental Research and Public Health*, Vol. 18, No. 5, pp. 1-11. https://doi.org/10.3390/ijerph18052205
Lim, Y., Giacomin, J. and Nickpour, F. (2021), "What is Psychosocially Inclusive Design? A Definition with Constructs", *The Design Journal*, Vol. 24, No. 1, pp. 5-28. https://doi.org/10.1080/14606925.2020.1849964
Low, M. P. and Ramayah, T. (2023), "It isn't enough to be easy and useful! Combined use of SEM and necessary condition analysis for a better understanding of consumers' acceptance of medical wearable devices", *Smart Health*, Vol. 27, pp. 1-13. https://doi.org/10.1016/j.smhl.2022.100370
Lowes, L., Eddy, D., Channon, S., McNamara, R., Robling, M. and Gregory, J. W. (2015), "The Experience of Living with Type 1 Diabetes and Attending Clinic from the Perception of Children, Adolescents and Carers: Analysis of Qualitative Data from the DEPICTED Study", *Journal of Paediatric Nursing*, Vol. 30, No. 1, pp. 54-62. https://doi.org/10.1016/j.pedn.2014.09.006
Mugge, R., Schoormans, J. P. L. and Schifferstein, H. N. J. (2008). "Product Attachment: Design Strategies to Stimulate the Emotional Bonding to Products", In: Schifferstein, H. N. J. and Hekkert, P. (eds.), *Product Experience*. Elsevier, San Diego, pp. 425-440.
Muratovski, G. (2016), *Research for Designers: a guide to methods and practice*, Sage, Los Angeles.
Niedenthal, P. M. and Ric, F. (2017), *Psychology of Emotion*, Routledge, New York; Oxford.

Norman, D. A. (2016), *Living with Complexity*, MIT Press, Massachusetts.
Pullin, G. (2009), *Design Meets Disability*, MIT Press, Massachusetts.
Rafferty, J., Stephens, J. W., Atkinson, M. D., Luzio, S. D., Akbari, A. et al. (2021), "A retrospective epidemiological study of type 1 diabetes mellitus in Wales, UK between 2008 and 2018", *International Journal of Population Data Science*, Vol. 6, No. 1, pp. 1-29. https://doi.org/10.23889/ijpds.v6i1.1387
Ryff, C. D. and Singer, B. H. (2008), "Know Thyself and Become What You Are: A Eudaimonic Approach to Psychological Well-Being", *Journal of Happiness Studies*, Vol. 9, No. 1, pp. 13-39. https://doi.org/10.1007/s10902-006-9019-0
Saldaña, J. (2021), *The Coding Manual for Qualitative Researchers*, SAGE Publications Ltd, California.
Seale, C. (2018), *Researching Society and Culture*, SAGE Publications Ltd, London.
Tan, H., Zhao, X. and Yang, J. (2022), "Exploring the influence of anxiety, pleasure and subjective knowledge on public acceptance of fully autonomous vehicles", *Computers in Human Behaviour*, Vol. 131, No. 6, 1-11. https://doi.org/10.1016/j.chb.2022.107187
Tanure, R. L. Z., Echeveste, M. E. S., Zaffaroni, F. C., 2014. Assessment of Health Devices Regarding User Requirements: The Emotional Dimension [online]. In: Braidot, A., Hadad, A., eds. VI Latin American Congress on Biomedical Engineering CLAIB 2014, Parańa 29-31 Oct 2014. Parańa: Springer Cham. Available from: https://doi.org/10.1007/978-3-319-13117-7_250.
Vougioukalou, S., Boaz, A., Gager, M. and Locock, L. (2019), "The contribution of ethnography to the evaluation of quality improvement in hospital settings: reflections on observing co-design in intensive care units and lung cancer pathways in the UK", *Anthropology & Medicine*, Vol. 26, No. 1, pp. 18-32. https://doi.org/10.1080/13648470.2018.1507104
Wang, H., Tao, D., Yu, N. and Qu, X. (2020), "Understanding consumer acceptance of healthcare wearable devices: An integrated model of UTAUT and TTF", *International Journal of Medical Informatics*, Vol. 139, pp. 1-10. https://doi.org/10.1016/j.ijmedinf.2020.104156
Weatherly, K. and Reay, S. (2022), "Exploring a human-centred approach to improve the usability of medical devices used in an outpatient intravenous antibiotic treatment", *Design for Health*, Vol. 6, No. 2, pp. 204-220. https://doi.org/10.1080/24735132.2022.2091839
Xue, H. and Desmet, P. M. A. (2019), "Researcher introspection for experience-driven design research", *Design Studies*, Vol. 63, pp. 37-64. https://doi.org/10.1016/j.destud.2019.03.001
Yang , X., Wang, R., Tang, C., Luo, L. and Mo, X. (2021), "Emotional design for smart product-service system: A case study on smart beds", *Journal of Cleaner Production*, Vol. 298, pp. 1-12. https://doi.org/10.1016/j.jclepro.2021.126823
Yoon, J. and Kim, C. (2022), "Positive Emodiversity in Everyday Human-Technology Interactions and Users' Subjective Well-Being", *International Journal of Human-Computer Interaction*, pp. 1-16. https://doi.org/10.1080/10447318.2022.2121564
Yoon, J., Pohlmeyer, A. E., Desmet, P. M. A. and Kim, C. (2020), "Designing for Positive Emotions: Issues and Emerging Research Directions", *The Design Journal*, Vol. 24, No. 2, pp. 167-187.
Zeng, X., Deng, H., Wen, D., Li, Y., Xu, L. and Zhang, X. (2022), "Wearable Multi-Functional Sensing Technology for Healthcare Smart Detection", *Micromachines*, Vol. 13, No. 2, pp. 254-275. https://doi.org/10.3390/mi13020254
Zhu, T., Uduku, C., Li, K., Herrero, P., Oliver, N. and Georgiou, P. (2022), "Enhancing self-management in type 1 diabetes with wearables and deep learning", *npj Digital Medicine*, Vol. 5, No. 78, pp. 1-11. https://doi.org/10.1038/s41746-022-00626-5