SOCIAL EARPLUGS: A CASE STUDY ON INTEGRATING HUMAN AUGMENTATION IN HEARING PROTECTION

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ABSTRACT

Social augmentation refers to a human-computer integration technology that aims to enhance the user's social skills by supporting empathy, interaction and communication. This study investigated the implementation of social augmentation in hearing protection within the context of entertainment. Through a user-centred analysis, potential social augmentation functions for earplugs were conceived. Three innovative conceptual prototypes were then developed, each enriched with three social functions. Accordingly, each of these concepts should ensure that social skill is enhanced, facilitated or improved. To assess whether the concepts were successful, the social impact of the prototypes on the user and bystanders was evaluated and compared through questionnaires and focus groups using video footage. The results provided promising conclusions regarding the applied methodology and the potential for optimizing the iteration process of innovative human augmentation concepts.

Keywords: Social augmentation, Case study, Conceptual design, Design methodology, User centred design

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1 INTRODUCTION

Human augmentation is a human-computer integration technology that aims to improve human abilities (Guerrero et al., 2022). Augmentation technologies can be used by anyone, ranging from users facing disabilities or unhealthy situations that require them to use these products to users who want to improve their current abilities. Consequently, the vast field of human augmentation includes many different types of products such as prosthetics, glasses and other devices that mimic or replicate missing or lost functions, exoskeletons that can supplement our abilities, or interactive wearables that can surpass our human abilities. Moreover, the interdisciplinarity of the field implies a multitude of possibilities for enhancing an individual's sensory, physical, cognitive or social capabilities. As a previous study concluded, augmentation of users' social ability has not been thoroughly studied to date, despite its considerable future value (De Boeck & Vaes, 2021). Therefore, social augmentation is the focus of this study, which aims to enhance users' social capabilities by supporting collaboration, empathy, interaction and communication through wearable technology (Lee et al., 2018).

As a use case, this study investigated social augmentation in hearing protection, specifically earplugs, within the context of entertainment. Earplugs are often worn at social events like festivals, nightclubs, concerts, and other loud music events. These social environments and the many interpersonal scenarios they may entail can provide innovative opportunities to implement social enrichment functions in hearing protection, motivating the choice of this use case. Moreover, despite their discreet design, earplugs still carry a social stigma and are often considered "uncool" or "nerdy" (Beach et al., 2012).

The study was conducted as part of student Jill Sempels' master's thesis and was supported by doctoral research on human augmentation. Through a search for relevant social functions, ideation and conceptualization, a selection of three final concepts was made. This selection resulted in the development of research prototypes. Finally, a research setup was constructed to investigate and measure the social impact of the experimental prototypes.

2 AIM

This study aimed to explore the opportunities of social augmentation, test our applied research methodology, and derive potential design recommendations that could be useful to product designers. As a use case, social augmentation in hearing protection was investigated. The social impact of the conceptual earplug prototypes on the user and bystanders was assessed by addressing the following research questions:

RQ1: What social functions are desired/relevant in hearing protection and are they evident to bystanders?

RQ2: To what extent are the hearing protection concepts socially accepted by bystanders?

RQ3: Is the user perceived as positive or negative by bystanders?

3 METHOD

In the context of this design research, an overarching framing methodology of 'research through design' (RtD) was applied. The key feature of RtD is that it incorporates the practice of design and artefacts as research means to generate new knowledge that cannot otherwise be obtained. The knowledge gained can be implicit, residing almost entirely within the resulting artefact (Gaver, 2012; Godin & Zahedi, 2014). In addition, a mixed methods strategy was employed so that both qualitative and quantitative data allowed for the exploration of different perspectives among the multifaceted research questions.

More specifically, the study was approached in two phases, the design phase and the research phase, referring to the applied RtD methodology. During the first phase, a preliminary online survey was composed in search of relevant and desirable social enrichments in the field of hearing protection. Based on the results of the preliminary survey, several concepts were devised. A final selection of concepts eventually resulted in the development of three research prototypes, each augmented through the implementation of three similar social functions. Initially, the intention was to conduct observational field tests in natural settings. Due to the COVID conditions, however, real-life experiments were not possible, which is why videos of the prototypes demonstrating the social functions were created to be used for assessment.

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The second phase was to determine whether the prototypes would produce the desired results. The COVID-related safety conditions required switching to the use of videos, online questionnaires and focus group interviews with only a limited number of participants. Consequently, the social impact of the prototypes was assessed and compared using questionnaires for quantitative data and focus group interviews for qualitative data. While the questionnaire focused on collecting computable (calculable) information, the focus group interviews were aimed at finding out underlying reasons for particular choices through laddering. The research questions were examined using the following structure.

- **Comprehensibility.** Respondents were first given information about the study and social functions of the concepts, after which the videos of the prototypes demonstrating the social functions were shown. They were then questioned about the clarity and comprehensibility of each function for each concept. As for the focus groups, participants were asked which concept they thought was clearest for each social function and why.
- **Social acceptability.** The WEarable Acceptability Range (WEAR scale) was developed by Norene Kelly (2016) to assess and predict the social acceptability of wearables. The WEAR scale consists of 14 statements requiring participants to respond to their level of agreement, which can be loaded on two factors. As a first factor, 'aspirational desires' means that wearable products are deemed socially acceptable if what they symbolically communicate is positive and provides motivation to aspire (strive) to be like the user. 'Absence of social fears (anxiety)', as the second factor, implies that socially acceptable wearable wearables are not a threat to others. For this study, it was decided to make use of this validated questionnaire to evaluate the social acceptability of the three concepts. In addition, focus group discussions assessed the social acceptability of the concepts by asking participants which concept they personally would (not) wear and why, both from a current and future perspective.
- **Social perception.** According to Fiske et al. (2002), people make sense of each other according to two dimensions. First, by assessing someone's intention to harm or help them, representing the warmth dimension, and then by judging (assessing) the person's capacity to act on that perceived intention, representing the competence dimension. This validated two-dimensional questionnaire was used to assess the social perception of users wearing the conceptual products. Furthermore, focus group participants were asked to describe in keywords a person in a photograph. Each time, a picture was shown of another person wearing a different concept.
- **Behavioural effects.** This study investigated whether the concepts would influence behaviour and interaction between the user and bystanders. However, assessing behaviour through a questionnaire could produce incorrect and thus unreliable results, since reported behaviour is not always the same as actual behaviour. Therefore, we concluded that studying behavioural effects should be done in real-life contexts.

4 RESULTS

4.1 Design phase

4.1.1 Selection of social enrichment functions

The use case in this study stemmed from the problem of hearing damage sustained from prolonged and frequent exposure to high noise levels in the social context of going out. A preliminary survey, involving 108 respondents, was conducted to determine what social characteristics or features would be considered desirable when wearing earplugs while going out. Respondents were asked to rank a list of seven relevant aspects of experience when wearing earplugs according to importance. The three highest ranked aspects were used as inspiration for coming up with the social enrichments, namely: 'improving both the music and the overall experience', 'improving communication abilities', and 'feeling protected in terms of hearing and showing this to others'. This was respectively complemented by the following aspects: 'the first moment of putting in earplugs and getting used to it', 'having control over one's experience', and 'encouraging others to protect their hearing as well'. The aspect of 'letting others know how you feel' proved very uninteresting. Through futuristic exploration, brainstorming and co-design sessions, the following social functions in earplugs were identified as valuable and desirable:

1. The *'protection function'* is intended to show the music level in the environment to bystanders and inform them when it is harmful or detrimental to hearing. This function meets the user's empathy by allowing him to warn others that the music is too loud.

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2. The *'communication function'* is intended to signal to bystanders that the wearer has deactivated the hearing protection, meaning that the wearer is open to and wants to initiate communication.
3. The *'audibility function'* is intended to inform others whether the communication is loud enough to be easily understood.

4.1.2 Ideation of hearing protection concepts

All conceptual ideas were designed to incorporate each of the three functions in a different form, interaction and visual effect to allow for comparison. Three final concepts were conceived and prototyped, as shown in Figure 1.

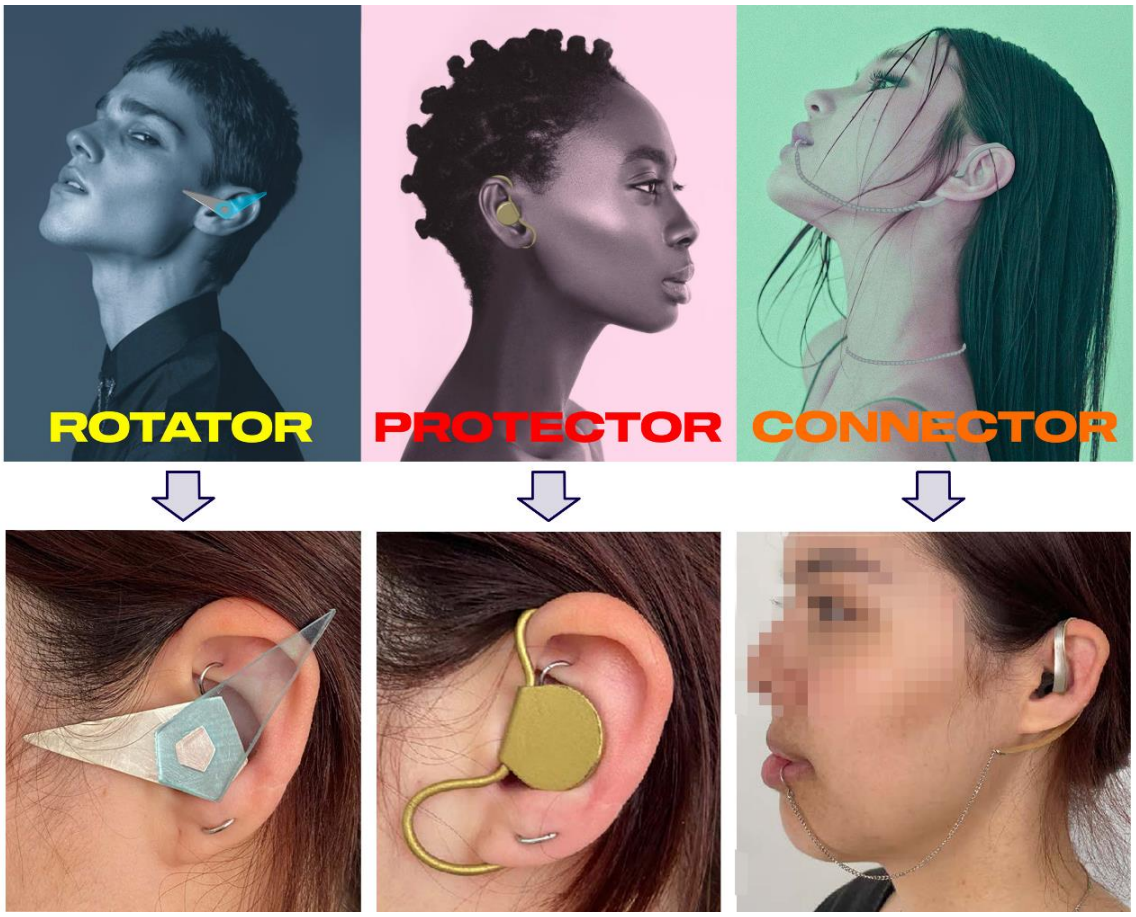

Figure 1. The three final concepts, entitled: the rotator, the protector, and the connector. These concepts were elaborated into prototypes. Work by Jill Sempels

Although each concept is intended to allow the user to perform all three social functions, each concept is named after the metaphor that illustrates its representation. For example, the Rotator focuses on informing others whether the user is open to communication, which can be activated by rotating a component that symbolizes an antenna to 'pick up signals', so to speak. The antenna then emits a signal of activation of the communication function by emitting a green blinking light. The Protector symbolizes the opening or closing of the ears and emphasizes the importance of hearing protection. When the Protector covers the ears, it means they are protected, and the user is not seeking interaction. When it opens the ears, it means the user is 'opening' the ears to more sound and is open to communication. The Connector focuses on expressing receptivity to communicate by drawing attention to the lip and thus the mouth by literally attaching the lip cuff to the lip.
With an eye on practicality, the prototypes were developed to the point where they could be worn for creating videos showing how the social functions work. Actual operation and lighting effects were edited into the videos afterwards using the program 'Adobe After Effects'. Illustrations of the social functions for each concept are shown in Figure 2.

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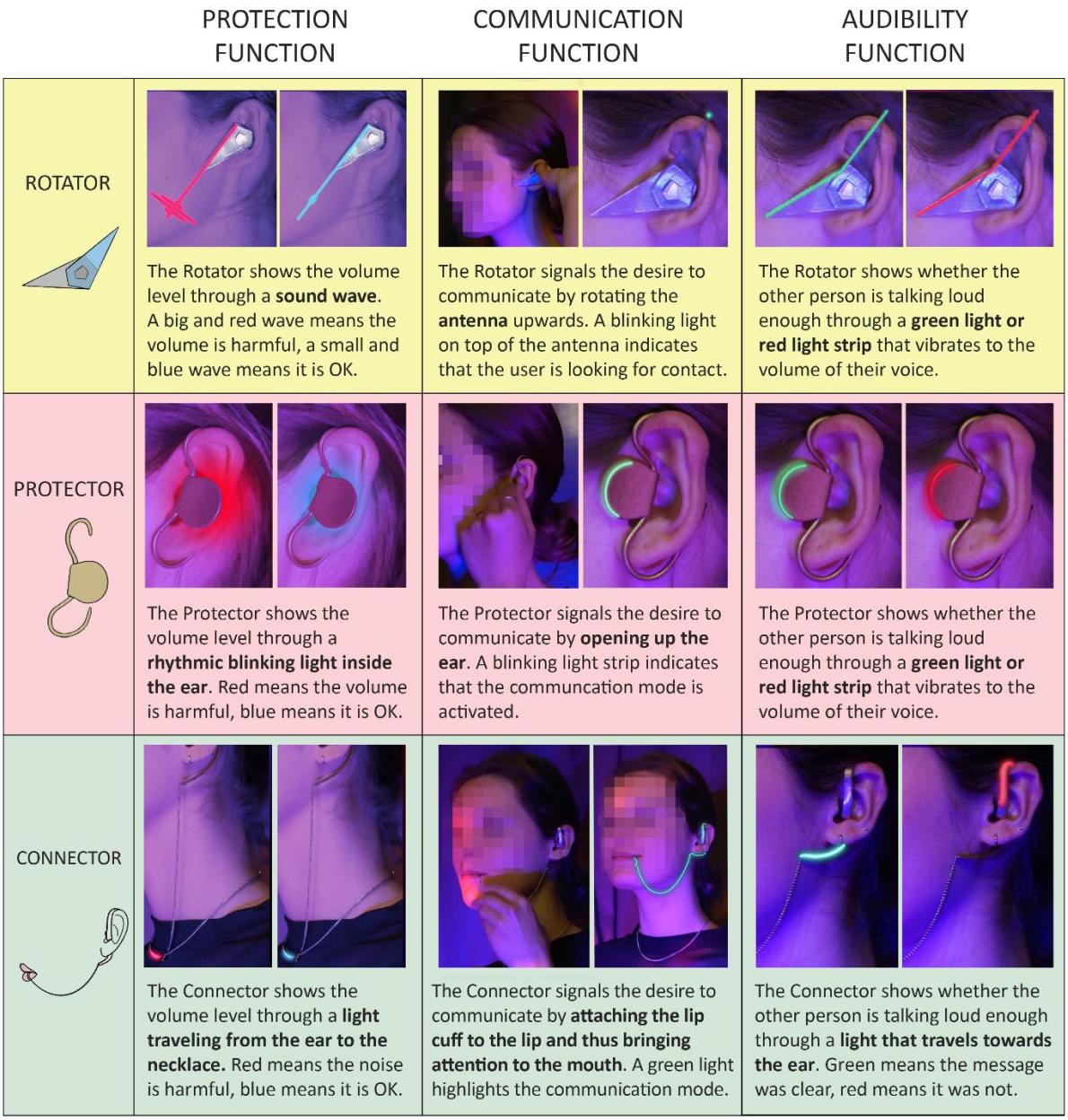

Figure 2. Visualisations of the three social functions per concept, i.e.: the protection function, the communication function, and the audibility function

The full video of all fragments showing the social functions for each prototype can be viewed by scanning the QR code in Figure 3. These video clips were used for our research.

Figure 3. Full video of the three functions per concept (also accessible via the following link: https://youtu.be/MDu1jilWgXg). Work by Jill Sempels

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4.2 Research phase

The online questionnaire was available from April 28 to May 17, 2022. Respondents were asked to rate only one of the three concepts given at random, otherwise the questionnaire would be too long. They were then given the opportunity to rate the other two concepts each time as well, so the number of respondents varied for each section. A total of 86 respondents participated, including 42 men and 44 women. 58 respondents were 19 to 25, 15 respondents were 26 to 35 and 13 respondents were 35 or older. These figures reflect the distribution by gender and age, but do not apply to the individual sections. For each section, the number of respondents is provided. A p-value less than 0.05 was indicated as statistically significant.

In parallel, the focus group was subdivided into two interviews (out of safety measures related to COVID-19), each with three participants aged between 19 and 25, and an equal distribution of male and female participants across both focus group interviews.

4.2.1 Comprehensibility

The questionnaire assessed the comprehensibility of each function for each concept using 10-point Likert scales (1 = very unclear, 10 = very clear). Respondents were given background information about the study and the functions of the concepts. The results are shown in Table 1.

A nonparametric Kruskal-Wallis test ($F(2) = 34.26$; $p < 0.001$) found a significant difference in clarity of the protection function between the three concepts. Both the Rotator and the Protector were found to represent the music level significantly more intelligibly than the Connector ($p < 0.001$). However, the Rotator was not, compared to the Protector ($p = 0.224$).

Furthermore, a significant difference was found in the comprehensibility of the communication function between the three concepts ($F(2) = 13.81$; $p = 0.001$). The Protector was perceived as significantly more comprehensible in showing openness to communication than the Rotator ($p < 0.001$), as was the Connector compared to the Rotator ($p = 0.013$). However, the Protector was not significantly clearer than the Connector in terms of communication function ($p = 0.645$).

Regarding the completeness of the audibility function among the three concepts, a Kruskal-Wallis test showed that there was no significant difference ($F(2) = 0.35$; $p = 0.838$).

Table 1. Questionnaire's results regarding the comprehensibility of the functions per concept

	ROTATOR		PROTECTOR		CONNECTOR	
n	65		65		64	
Values	M	SD	M	SD	M	SD
PROTECTION FUNCTION	**7.08**	2.09	**6.58**	2.29	4.73	2.24
COMMUNICATION FUNCTION	**4.89**	2.46	**6.52**	2.08	**6.14**	2.96
AUDIBILITY FUNCTION	**6.97**	2.25	**7.09**	2.09	**7.16**	2.32

As for the focus groups, participants were asked individually which concept they thought was clearest for each social function and why.

Accordingly, they found both the Rotator and the Protector to be clearer than the Connector in representing the noise level (i.e., the protection function), consistent with the results of the questionnaire. Since the light effects of the Protector were located in the ear, the connection to hearing was very clear according to the participants, while the projected light effects of the Rotator represented a sound wave, which clarified the connection to music volume. However, the Connector's light effects seemed to be more ambient lighting.

When it came to indicating willingness or ability to communicate (i.e., communication function), the Protector was found to be the clearest, which was also consistent with the questionnaire results. Participants stated that the Protector's metaphor of 'opening and closing' made a lot of sense. The Rotator was found less clear because the light effect was too discrete to notice, indicating that visibility is an important factor. The Connector's metaphor of bringing the lip cuff to the mouth was not well understood by participants.

Finally, all participants felt that the Connector was the clearest in terms of one's audibility during a conversation (i.e., the audibility function), as the light effects clearly showed that the sound travelled to the wearer's ear, symbolizing that one's voice entered the ears and was registered. Moreover, participants stated that visibility is a crucial factor when it comes to clarity, especially when imagining

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being in a real social setting and having a one-on-one conversation. In that perspective, they found the Connector to be the clearest because it was also visible in a face-to-face situation.

4.2.2 Social acceptability

The WEAR scale was used to assess the social acceptability of the three concepts; it consisted of 14 statements requiring participants to indicate their level of agreement using 6-point Likert scales (1 = strongly disagree, 6 = strongly agree). Table 2 shows the number of participants for each concept, the mean WEAR score ranging from 1 (extremely low social acceptability) to 6 (extremely high acceptability), and the standard deviation. Items with an (R) were scored inversely because agreement represents lack of social acceptability.

A significant difference was found between the averages of the WEAR scores of the three concepts via a one-way ANOVA ($p < 0.001$). A Tukey post-hoc test indicated that the Connector was significantly less socially acceptable as a wearable than the Rotator ($p = 0.018$) and the Protector ($p < 0.001$) by respondents. However, there was no significant difference between the Rotator and Protector ($p = 0.583$). In addition, a one-way ANOVA was performed to analyse the 14 statements separately. Significances were only found with the Connector and are highlighted in bold in Table 2; for some statements, such as 'I could imagine myself aspiring to be like the wearer of such a device', the Connector scored significantly lower than the Protector, while for other statements, such as 'this device is consistent with my self-image', the Connector scored significantly lower than both the Rotator and Protector.

Table 2. Questionnaire's results regarding the comparison of the concepts' WEAR score

	ROTATOR		PROTECTOR		CONNECTOR	
n	65		65		64	
Values	M	SD	M	SD	M	SD
FULFILMENT OF DESIRES	3.82	**1.24**	4.03	**1.20**	3.46	**1.40**
1. I like what this device communicates about its wearer. $F(2,191) = 0.863$; $p = 0.423$	4.05	1.10	4.20	1.12	3.95	1.01
2. I could imagine aspiring to be like the wearer of such a device. $F(2,191) = 5.936$; $p = 0.003$	3.26	1.15	**3.58**	1.26	2.81	1.41
3. This device is consistent with my self-image. $F(2,191) = 7.094$; $p = 0.001$	**3.15**	1.27	**3.43**	1.30	2.58	1.37
4. This device would enhance the wearer's image. $F(2,191) = 3.894$; $p = 0.022$	3.37	1.05	**3.74**	1.08	3.20	1.21
5. The wearer of this device would get a positive reaction from others. $F(2,191) = 4.365$; $p = 0.014$	**4.14**	0.86	**4.26**	0.85	3.77	1.22
6. I like how this device shows membership to a certain social group. $F(2,191) = 0.342$; $p = 0.711$	3.45	1.28	3.46	1.20	3.30	1.27
7. This device seems to be useful and easy to use. $F(2,191) = 14.069$; $p \approx 0$	**4.29**	1.18	**4.58**	0.93	3.50	1.44
8. This device could help people. $F(2,191) = 2.409$; $p = 0.093$	4.86	0.92	4.94	0.88	4.56	1.25
ABSENCE OF FEARS	4.69	**1.22**	4.65	**1.26**	4.53	**1.35**
9. (R) This device could allow its wearer to take advantage of people. $F(2,191) = 0.092$; $p = 0.912$	1.80	0.83	1.86	0.93	1.86	1.01
10. (R) Use of this device raises privacy issues. $F(2,191) = 0.060$; $p = 0.942$	1.94	0.98	2.00	1.06	1.95	1.13
11. (R) The wearer of this device could be considered rude. $F(2,191) = 0.204$; $p = 0.816$	2.14	1.10	2.25	1.10	2.25	1.18
12. (R) Wearing this device could be considered inappropriate). $F(2,191) = 1.060$; $p = 0.349$	2.08	1.04	2.05	0.93	2.30	1.22
13. People would not be offended by the wearing of this device. $F(2,191) = 0.930$; $p = 0.396$	4.06	1.40	3.72	1.54	3.81	1.46
14. (R) This device would be distracting when driving. $F(2,191) = 3.108$; $p = 0.047$	2.94	1.33	**2.69**	1.33	3.28	1.37
TOTAL WEAR SCORE	**4.20**	**1.30**	**4.29**	**1.27**	**3.92**	**1.48**

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The social acceptability of the concepts was assessed in the focus group discussions by asking participants which concept they personally would (not) wear and why, both from a current and future perspective. From a current perspective, the interviews revealed that the Connector was unanimously the least preferred and thus least socially acceptable, due to its eccentric design. Some participants also questioned the usability and comfort of the lip cuff, while others indicated that they did not associate with the style of the concept. Overall, four of the six participants opted for the Protector, finding the Rotator too expressive. Thus, the results of the focus groups were consistent with those of the questionnaire. However, when participants were asked which concept they would wear in the future, they more often chose the Rotator and even the Connector.

4.2.3 Social perception

The social perception was assessed through the dimensions of warmth and competence, which consisted of 8 statements for participants to rate using 7-point Likert scales (1 = not at all, 7 = extremely). As such, the participants were asked to rate the wearers of the earplug concepts according to the warmth dimension (appealing, amusing, poorly (reversed scored) and repulsive (reversed scored)) and the competence dimension (capable, competent, professional and competitive). The results can be found in Table 3.

According to a one-way ANOVA, there were no significant differences found between the means of the warmth dimension of the three concepts ($p = 0.931$).

For the competence dimension, however, there was a significant difference in the overall mean scores between the concepts ($p < 0.001$). A Tukey test showed that both the Rotator and the Protector are seen as significantly more competent than the Connector ($p < 0.001$). There was no significant difference between the averages of the Rotator and Protector ($p = 0.852$).

Table 3. Questionnaire's results regarding the comparison of the concepts' warmth and competence scores

	ROTATOR		PROTECTOR		CONNECTOR	
n	65		65		64	
Values	M	SD	M	SD	M	SD
Warmth	**4.88**	1.83	**4.83**	1.90	**4.88**	1.78
Competence	**3.72**	1.51	**3.65**	1.55	**3.07**	1.57

Focus group participants were asked to describe in keywords a person depicted in a photograph. Each time, a picture was shown of a different person wearing a different concept. Participants indicated that the Rotator was considered very futuristic and high-tech. However, they also described it as communicative by design because of the metaphor of an antenna. Furthermore, the Protector was associated with the words responsible and protective, as well as accessible and approachable, which closely match the characteristics of the warmth dimension. The Connector received varied responses; some participants associated it with a microphone and thought the wearer looked like a singer, while terms such as "punk," "gothic" and "edgy" also came up because of the metal chain and lip cuff.

5 DISCUSSION

This chapter describes the key insights gained from the methodology used in this research and a list of design recommendations for product designers looking to develop human augmentation.

First, we outline our findings on the efficiency of working with recorded videos of the prototypes. The videos showed the prototypes in a simulated context, which were later edited to demonstrate the socially enriched functionalities and interaction of each concept. Since simulations were possible, high-quality working prototypes were not required, which was both time and cost effective. In addition, the videos allowed for controlled input for the participants, enabling consistency in what they were shown. Nevertheless, the videos were not always clear or visible enough for the participants and, more importantly, the artificial test setup could never reproduce a truly realistic impact as in a natural environment.

Second, we discuss the validated questionnaires, the WEAR scale and the warmth and competence scales, which were used to examine social acceptance and social perception, respectively. The main results of the scales were consistent, demonstrating their usefulness. Moreover, zooming in on the

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individual statements proved insightful, as they shed light on overall metrics and provided valuable indicators for designers planning the next iteration of a wearable prototype.

Third, we evaluate the usefulness of the focus group interviews for design input, which complemented the questionnaires. Since exploring the social impact of wearable concepts through virtual means was challenging, the focus group interviews brought clarity and additional insights. The interviews enabled the use of the laddering technique, which allowed further questions to be asked on topics relevant to our research. However, the results of both the questionnaire and focus group interviews were based on pre-recorded videos, which may have had an unrealistic effect. Therefore, when conditions permit, we encourage experiments in natural settings over controlled settings when it comes to investigating the social impact of conceptually rich prototypes, in order to maintain a level of realism.

In addition, the following design recommendations were derived from our study, which may be useful in developing (social) augmentation products.

- Designing innovative functions that are immediately understandable at first glance is challenging. Intuitiveness is the key to understanding advanced features, which can be enriched by association, a link to the intent or subject of the product (in this case hearing). Light effects to indicate something, for example, can mean anything. Using commonly known semantics or gestures as links (e.g., a sound wave to the music or putting your hand behind your ear to activate the new function) can enhance this.
- Metaphors can be useful for comprehension, but only if they make sense. The Protector is therefore a good example, where the metaphor of closing and opening the ears is well understood as the (in)ability to communicate. However, the lighting effects representing the sound level of the Connector seemed more like ambient lighting, as there was no connection to the music.
- Visibility was found to be an important factor in assessing the concepts' clarity and social impact. If a wearable is inconspicuous to bystanders, it may have less or even no social impact. However, noticeability and clarity must be tested in a real environment to obtain reliable results.
- During the design phase, photos of the intended context were used to sketch on (or over), which helped create different usage scenarios. As such, using public photos, as well as personal photos of specific scenarios and contexts, to sketch over can be useful during the development of innovative products.
- When it comes to the development of stigmatising human augmentation products, such as protection artefacts in this case, it becomes especially crucial to evaluate their social acceptability. This is because such products are often viewed with aversion, and their success depends on overcoming these negative attitudes. Therefore, it is essential for these products to avoid negative emotions and evoke positive ones to gain acceptance and desirability among users.
- The main results of the validated questionnaires, the WEAR scale and the scales for warmth and competence, were consistent. Style and eccentricity of the concepts were found to be dominant factors in terms of social acceptability and social perception. Accordingly, the Protector was considered most socially acceptable because it was the least conspicuous and perhaps ordinary design, while the Connector was considered least socially acceptable because it was associated with incompetence as too eccentric and unconventional. Furthermore, the Rotator was seen as highly competent on average, which could be due to its geometric and sharp design. While the Protector with its round shape was more associated with warmth. The Connector was seen as the least competent, which again could be due to its unconventional and eccentric appearance. This statement is consistent with Raymond Loewy's (1951) theory of "Most Advanced, Yet Acceptable" (MAYA), which states that designers should give users the most advanced design, but no more advanced than what they could accept.
- User-centred design is critical in the development of social augmentation because it is important to know whether the user wants to share certain information. For example, the preliminary research showed that sharing personal emotions was not desirable in wearable technology and that people are open to prompting others to behave well (wearing earplugs), but not asking them to do so, which was considered in developing the concepts for social augmentation.
- Finally, there is a possible shift into the future, as people stated they were much more open to wearing distinctive and unconventional wearables, such as the Connector. Only the future can tell if that will be the case.

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6 CONCLUSION

Social augmentation refers to human-computer integration technology that aims to improve social skills by supporting collaboration, empathy, communication tools and interaction. This study investigated the implementation of social augmentation in hearing protection as a use case using a RtD approach. Accordingly, the study was structured into a design phase followed by a research phase. First, a user-centred analysis resulted in the development of three innovative conceptual prototypes, each enriched with the implementation of three social functions. Second, the social impact of the conceptual earplug prototypes was evaluated and compared through questionnaires and focus groups using video footage.

The purpose of our study was to explore the potential of social augmentation and test our applied research methodology, which allowed us to formulate some design recommendations for future product designers. Assessing the social impact of conceptually rich products proved to be a complex task, especially since it could not be examined in a realistic social context due to the pandemic. It was necessary to switch to the use of videos, online questionnaires and focus group interviews with only a limited number of participants. The validated WEAR scale and the warmth and competence scale were useful tools to assess social acceptability and perception through virtual means. The results of these scales were consistent with those of the focus groups, although the focus group interviews were valuable in getting answers about the underlying reasons for certain responses.

Overall, the online questionnaire and focus group interviews provided useful insights that will guide our future research and can contribute to the design community. The applied research method provided a more controlled alternative to conducting research in a natural setting when comparing multiple conceptual designs to one another. However, the results of both the questionnaire and focus group interviews were based on pre-recorded videos, which may have produced an unrealistic effect. Therefore, if conditions permit, we advocate real-life experiments when researching the social impact of conceptually rich prototypes to maintain a level of realism.

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