Persona-Technology footprint: an evaluation of 144 student's perceptions of a person using assistive technology

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ABSTRACT

The persona-technology footprint is the visual balance between the enabling technologies associated with an individual and the person. This design heuristic enables a practitioner to quickly assess the area of visible technology compared with that of the person. The objective of a designer is to minimise the perceived technology and emphasise the personality of the individual. This study looks to provide detail about the visual balance between areas of a person covered by assistive technology and which areas of a person it is important to ensure are visible. A survey of 144 undergraduate design students involved them choosing where they considered they no longer saw 'the person', due to them being covered by assistive technology. This involved three different line drawings: one that had different sections of the person's profile blacked out to represent the presence of equipment in front of the person; the second with the outer profile of the person visually broken by the overlapping blacked section; and, a line drawing of a person's head with blacked out sections that both covered areas of the head and broke the outer profile. The points chosen by students were collated and processed statistically using ANOVA. In all three choices, students chose the point where the person was covered up to the point of their eyes being covered. This suggests we view another person's eyes to represent them more than any other part of their body. Further studies are required to explore this outcome.

KEYWORDS

Technology footprint, Semantic differential scale, Design heuristic

Introduction

The persona-technology footprint is the visual balance between the enabling technologies associated with an individual and the person. This design heuristic enables a practitioner to quickly assess the area of visible technology compared with that of the person. The aim of this heuristic is to help a designer to emphasise the personality of an individual. This study aims to provide evidence of this phenomena; and, provide designer practitioners with more detail about the visual balance between assistive technology and individuals living with a disability.

The issue of stigma and social isolation of those living with a physical impairment is still an issue that has not been fully addressed. Many of those who would benefit from this heuristic are young people, children and adults who have a form of Cerebral Palsy and may have compounding impairments, such as learning difficulties. The online resource CerebralPalsy.org.uk estimate that 1 in 400 of babies are born with a type of Cerebral Palsy, with 1,800 new cases each year. (cerebralpalsy.org.uk 2018) A report by Scope (McCarthy 2014: 3) highlighted that many people in UK society still have a negative attitude about disability, with 67% still feeling uncomfortable talking with disabled people.

People living with Cerebral Palsy are often based in a powered wheelchair and use multiple pieces of technology, including alternative and augmented communication (AAC) devices. The authors' experiences of working with these groups is that the person is often obscured by the surrounding technology, making personal contact with the individual within the technology more difficult. This can lead to a further loss of identity, confidence and a 'voice' with which to speak independently of their needs and preferences. The following heuristic, person footprint, has been proposed to overcome some of the challenges of seeing the person over technology.

The persona footprint is the visual balance between the enabling technologies associated with an individual and the presence of that person (Torrens 2011). The design heuristic enables a practitioner to quickly assess the area of visible technology compared with that of the person. The objective is to minimise the perceived technology and emphasise the personality of the individual. Strategies for this include:

- Minimise the volume of the technology (compact electronics, body contoured supports and seating, fold-away items);
- Break the technology into smaller elements (battery pack on a belt, not part of the communication device);
- Use of colour to make technologies recessive (dark colours, matt textures);
- Customising the technology to the individual's personality and value system, branding (for example, symbols and colours of a favourite football team).

When using this heuristic there were still several questions that required an answer:

1) Which were the most important areas to keep clear of technology that maintained the perception of the person or persona?
2) What area could be covered before a viewer would see more technology than person?
3) Does breaking the outline of the person make a difference when covering with technology?

This initial study was completed to explore the perceptions of a section of able-bodied society towards images showing a decreasing amount of an identifiable person. As a first step towards a more sophisticated survey the study was expected to highlight issues of protocol and to determine what was being assessed by participants through their recorded responses.

Our view of what identifies us visually as a person comes from learning what another human being looks like and is closely aligned with child development. We learn how to recognise a face, two eyes, nose, and mouth along with the proportions and symmetry of human form. In terms of social psychology and visual semantics, early stage assignments of meaning carry through into adulthood. (Roback 2013)

Based on the assumptions that we notice eyes, then face then the body of a person, we can then crudely predict that these sections of an image of a person may be influenced through the visual obstruction due to surrounding technology. In addition, the priority will be in the order previously stated.

The mechanisms of visual perception rely on the identification of a profile in the foreground from background; processing of colour and texture, through to an understanding of a three-dimensional form. The study used the principles of gestalt and semantics to deconstruct the image used and to help analyse and explain the outcome of the study. There was a focus on the ‘law of simplicity’, ‘figure-ground relationship’, and social psychology principles of semantics, such as ‘symmetry’, ‘face-ism ratio’, ‘Attractiveness bias’, ‘von Restorff effect’, and ‘Uncanny valley’. (Lidwell 2010)

Method

144 first year undergraduate design students were recruited to take part in the study. The study conformed to the University ethics code of practice (Loughborough University 2018). This included compliance with the General Data Protection Regulation (Gov.UK 2018). The study was explained to them verbally as a group and a participant information sheet for the study provided. Each provided written confirmation of the study being explained to them and consent to take part.

The study had been designed to minimise other distractions using blanked-out areas and line drawings. Distractions included the participant’s visual analysis of types of technology (for example, computer screens, drinking devices, peripheral control interfaces) and social status. The objective was to gain initial insights into the areas of attention when choosing the balance point between seeing more technology than person. The use of line drawings over photographic or rendered images was to simplify the visual assessment of the image.

Line drawings were created using Adobe Photoshop software. One was based on the image of a young woman with cerebral palsy, sitting in a powered wheelchair and the other an image of a young woman’s head. The image of the young woman in the wheelchair suggested a positive body language and she was smiling. The image had been chosen to match a similar age range to the participants and wearing clothing that would be easily identifiable to them. The image of the young woman’s head was chosen because she had an androgynous hairstyle and symmetrical face. Similarly, the female image chosen for the whole-body illustration had a visually androgynous appearance in body proportion, (shoulder width to hip width ratio for example). A three-quarter view point had been chosen to suggest depth perspective, but also provide a view of two sides of a wheelchair and user. This was done to provide the opportunity for insights from viewers about the importance of the wheel, backrest and armrest within the image. Both drawings were modified to initially remove any obstruction to viewing the whole person or their head.

The young woman in the powered wheel chair line drawing was sectioned into seven sectors. There were two modified versions, one where the blocked sections were within the profile of the person, the other where the outer profile of the person was broken by other shapes. The boundary between the blacked-out sections and the image of the person still remaining was considered the partline. Partline is a term normally associated with the physical gap visible between assembled components within a product. Industrial designers influence a viewer’s perception of this partline through its juxta position in relation to the outer profile of the product. The shapes represented in the broken outline user profile are based on the profiles of common AAC equipment, such as screen, additional brackets and headrest. The breaking of the outer profile was to test if it affected the viewer’s ability to identify the person. An example of camouflage (dazzle pattern) the images interfered with the ‘law of simplicity (pragnanz), identifying a profile shape from the background.

Each sector was then sequentially blocked out with a solid black print until only the eyes were not covered. The sheet was incorporated into a larger survey. The scale was a modified form of

Semantic Differential (SD) scale where, rather than words being at either end, the extremes of image provide the polarising action. Semantic Differential (SD) scale was originally developed by Osgood *et al.* (1957) for use in psychology-based interventions, but was rapidly adopted by the other disciplines to inspect associated research questions. As posited by Osgood *et al.* (1957), no standard scale was intended and it can be modified in accordance to the purpose of research (Osgood, Suci and Tannenbaum, 1957, p. 76). The test method elicits a viewer's reaction to the way the lexical world appears to them (Osgood 1964). The stimuli of the SD scale can be a concept, topic, event, product or activity reliant on research objectives (Martin and Hanington 2012, p. 156). In this method the subject's perceptions of the semantics attributes of the products are quantified on a seven-point scale that is comparable to the Likert scale (Hsu, Chuang and Chang, 2000). Available studies suggest the versatility of this method to probe a range of research questions (Davis *et al.* 1999; Hsu, Chuang and Chang 2000; Alcántara *et al.* 2005; Aros and Aros 2009; Ajani and Stork 2014; Lanutti *et al.* 2015; Carneiro *et al.* 2016). Based on the SD method, researchers have modified and developed their own version (photo elicitation semantic differential, PESD) (Fellinghauer *et al.* 2011). Based on published studies, the SD scale method appears to be an effective way to evaluate a viewer's perception towards an artefact or image.

The three SD scale sheets were shown twice in the survey, at pages four, six and seven of the ten-page survey. The order of images in the second presentation of the series was reversed and each image reversed. A concern was that the convention of reading of Latin-based text from left to right may affect the choice made between two similar sections. The reversing of the images in order and mirroring their appearance from the first to second test sheet was to provide an internal validity check.

The term 'technology' was defined to provide a consistent meaning for the viewer to apply. The interweaving of the two studies provided the opportunity for the participants to forget their first choices made on each sheet. On each sheet the participants were asked instructed and asked: "In this study we are referring to Technology as items such as: glasses, wheelchair, computer screen, head rest, harness, helmet or earphones (which are the black-out sections). Without thinking about it too much, please choose the image where you first see more technology (black shaded section) than person. (Tick the box below the image to choose)" The ten-page survey in total took 20 minutes to complete, with explanation and survey collection.

One week later, a sample of eight students, four male and four females, were asked to volunteer to take part in a second phase of work to complete the same survey digitally, whilst using eye-tracking equipment. A SensoMotoric Instrument (SMI) RED 250, eye-tracking system was used to monitor fixations and SMI BeGaze software for post-processing. An operator asked the questions and put the answers on the physical sheets whilst the participant viewed the images digitally on a screen. This was to be answered by tracking where they were looking when making their decisions about ranking.

A further ethics approved protocol was used with this study, including a participant information sheet and a written consent document. The hard-copy survey was used in a digital format on the Tracksys supplied SMI RED 250 eye tracking system. This was used to follow fixation pathways during completion of the survey. The SMI RED 250 is considered accurate and gathers information every 10 milliseconds (ms). SMI Experiment Center 3.6 was used coupled with iView X™, to record the data at the rate of 120 Hz.

Eye-tracking movement was measured based on eye-tracking metrics such as fixation. The test was conducted with a 21.5-inch monitor (at 1680 x 1050 resolution). The distance between the computer screen and participants varied in the range of 40cm to 50cm. The size of the displayed map visual (stimuli) was 1680 x 1050 pixel to match with the monitor resolution.

Once sitting comfortably, the participants were asked to maintain their posture without moving their face or head; this was helped by the participant putting their hands onto the table in front of them. A calibration test was run followed by a four-point validation test. Once achieved the .5 degree of X and Y variation, the mapping stimulus were presented. Each visual was displayed for 20 sec; participants were then instructed to verbally state their choice, which were documented by a team member. This process was repeated until all of the visuals had been viewed. In total the experiment took from 12 to 15 minutes depending mainly on the rate at which calibration and validation were repeated and accomplished.

The surveys were entered in a spreadsheet using MS Excel and subsequently processed and analysed using IBM SPSS Statistics 23. Charts were generated in both MS Excel and SPSS. Each respondent was given a participant number and the names were kept separately. The two sets of answers given by the respondents were reviewed to see if any had answered differently for the reversed sheet and analysed using the Wilcoxon Signed Rank test for ordinal, paired data. The SD scale would provide a defined boundary between two images where the technology/blanked-out areas were seen more than the person. A consensus of which two images were chosen was analysed using the statistical software package IBM SPSS Statistics 23.

The fixation pathways and descriptive statistics for the points of interest from the eight participants were processed using the SMI 'BeGaze'™ software. The sequence of eye fixations during the choices made were reviewed, along with a summary of fixations. These were shown as 'heat maps'.

Results

The results of the statistical analysis of the modified Semantic Differential scale and subsequent eye tracking test are shown below. Figures 1, 2 and 3 show the images from pages 3, 5 and 4 respectively in the survey sheets. (Torrens *et al.* 2018) The images were reversed and mirrored for the second attempt at choosing the image where more technology than person may be seen.

The descriptive analysis of the ordinal data shows a clear preference for image 3 in all three series of images. This is shown in clustered bar chart, Figure 4. There is a notable 'tail' for both wheelchair and person image series towards image 7. This was the opposite for the for the head images, where almost 20% of participants chose image 1, where there was no technology present.

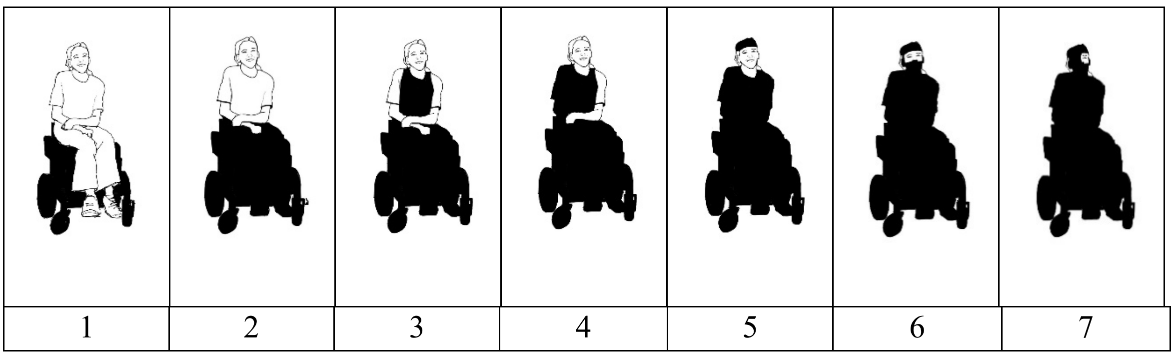

Figure 1. Person in Wheelchair series with sections blacked out to represent technology.

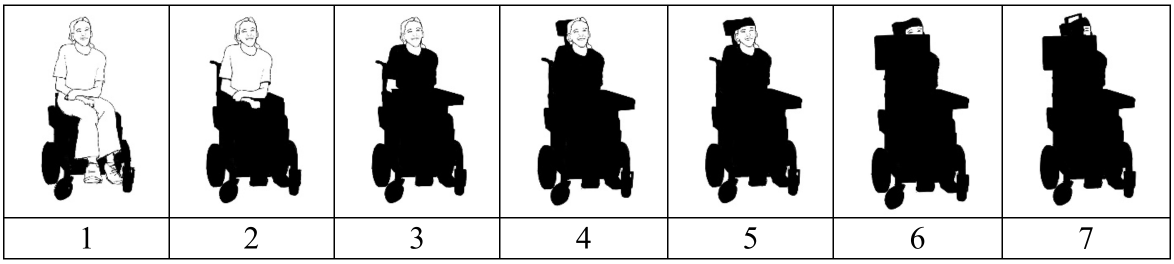

Figure 2. Person in Wheelchair series with sections blacked out, but broken person outline.

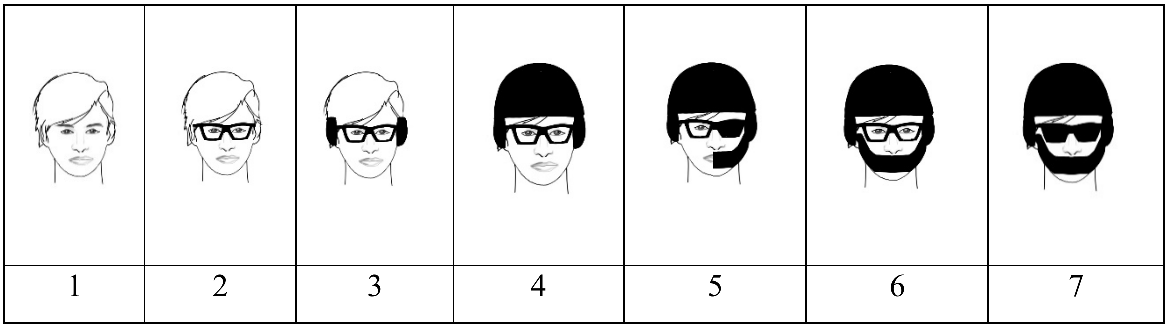

Figure 3. Head series with sections blacked out to represent technology.

Figure 4 Distribution of image choices where tech is first seen more than person

Considering the original ordering of the images for each series, in each case the most common response was 3 (figure 4). Comparing the original to the reversed and mirrored sequence of images there was a statistically significant difference (95% confidence level) in the image chosen as the point where technology was first seen more for the chair with the broken profile outline images (figure 2) according to the Wilcoxon Signed Rank test ($z=-.489$, sig $p<.05$). There was no significant difference for the head or the chair profile images however the result for chair profile could be considered marginal. Although the magnitude of change between the respondents varied considerably, a subsequent Spearman's correlation showed that generally if a respondent changed their image choice in a particular direction and by a specific number of places for the chair with a broken person profile outline, then they made a similar change for the chair unbroken person profile ($rho=.036$, sig $(p) < .05$) (figure 5).

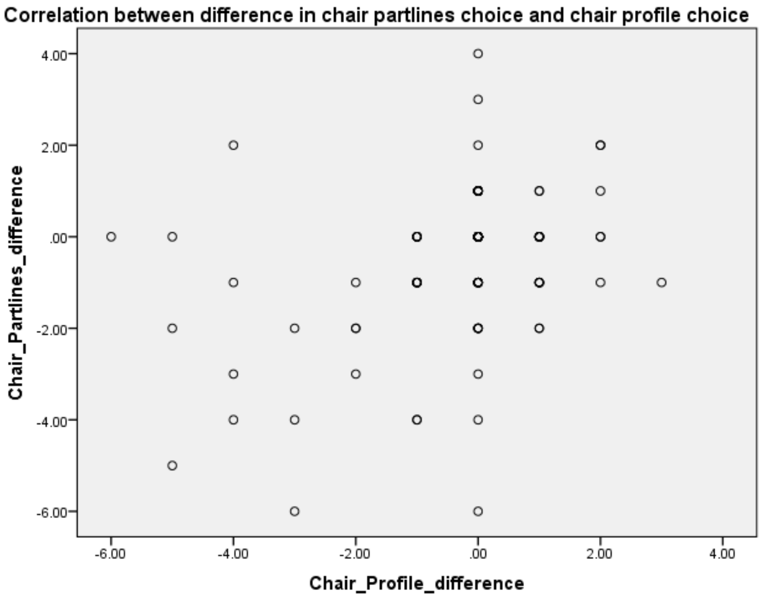

Figure 5 Correlation between magnitude and direction of difference in image choice (original – reversed/mirrored for chair profile and chair with broken outline profile)

Despite the differences in the overall distribution of image chosen, for each wheelchair profile, visual boundaries and head, the most frequently chosen image in the reversed mirrored series remained as 3.

Eye tracking results are shown in external datasets and show some of the detail of fixation points on the outline profiles of the three series of seven images. Figures 6-11 illustrate the associated heat maps for fixations and indicate that some thinking about the choices was done by the participants; there are indications of fixations off to the top left-hand corner of the first three series of images. This indicates second phase cognitive processing; participants effectively not using eyes to see but using their minds to remember or associate.

Figures in all three image-series show that the participant's eye followed the boundary between the blocked-in technology sections and the illustration of the person. In series one, Figure 6, there appears to be an equally distributed proportion of fixations for both sets of images. In series two, Figure 7, where the profile of the person was disrupted there appears to be more fixations in the blacked-out middle images in the reversed and mirrored image series.

Figure 6 Heat map of fixations for series shown in Figure 1 and reversed series

Figure 7 Heat map of fixations for series shown in Figure 1 and reversed series

Figure 8 Heat map of fixations for series shown in Figure 3 and reversed series.

The head series appeared to be more clearly focused on specific images in Figure 8 than the reversed and mirrored series of chair and person series in Figures 6 and 7.

Discussion

The statistical analysis of the results from the three sets of images show that in terms of percentage, image 3 was chosen from all three sets of images. The Wilcoxon Signed Rank test indicated there were statistically significant differences in how the participants answered the reversed questions related to the wheelchair and person series. The same test did not show any statistically significant differences in the image series and reversed image series for the head profile vs technology or in the head vs technology series where the technology disrupted the profile of the head. The Spearman's rho correlation indicated a positive correlation in the magnitude of the difference in response (original – reversed response) between the wheel chair profile and the wheel chair with broken outer profile of the person. The person vs wheelchair technology series inferred perspective through the 'three-quarter view' positioning. In the first set, this was angled from left-back to forward-right and reversed in the second set of images. This may have influenced which image was chosen.

In the case of the person vs wheelchair technology series, it was at the point where the torso was being covered that the balance was exceeded. The distribution of the choices made relating to the two sets of chair and person images also show outliers that indicate some participants perceived the person still to be visible when only the eyes or even one eye was visible. This would appear to support a rationale that we recognise a person through their eyes, then head, then torso, which matches with child development as defined earlier in the article. The covering of the body below the waist appeared to be acceptable and to not interfere with the image of the person.

The participant's view of technology-person balance appeared much more sensitive when the head images were considered. Once ear-muff shapes were added, the level of technology vs persona was seen to have been exceeded. There were more outliers towards no technology or glasses only (images 6 and 7 or when reversed 1 and 2, Figure 3). The distribution may have been in part due to the way participants viewed the series, left to right. Reversed images produced a significant difference in answers in the direction of view; the difference in choices made has already been highlighted for the chair and person with technology coverage within the person's outline profile. However, there was no significant difference of choices between original and reversed head series. The wider distribution range of choices made relating to the head image series may be that the head was more symmetrical, and we focus on differences on facial symmetry as found in principles such as 'face-ism ratio', 'Attractiveness bias', 'von Restorff effect'.

The results of the eye-tracking provided a clear indication of where participants were looking, in all but one respondent. The boundary between the blanked sections, representing technology, and the illustration of the person was followed from each image to the next, right to left and then back along the same line of fixations. The heat map provides a clear focus for decision-making between two of the images. The one difference was in a male participant where their fixations were all off the top left-hand corner, suggesting they were using their memory, phase two cognitive processing to remember what they had answered in the hard copy version they completed a week earlier. The viewing process was the same when the image sequence and images were reversed.

The outcomes of the study were not unexpected. The emphasis for a viewer to identify another human being is on the face and upper body. The sensitivity of the participant group to placing any technology over the face was something worth further consideration. For developers and specifiers of Assistive Technology products it has been shown that it is important to consider how the person with multiple impairments can use combinations of these products, whilst maintaining their persona. The 'technology footprint' heuristic does appear to exist and is worth quantification to make the heuristic into a more robust predictive model. Further variables such as orthographic views, perspective, rendered, photographic, colour and moving images require quantification. Physical representations of a person using different levels of technology being viewed using eye tracking glasses would also be a worthwhile variable to explore and study.

The image-based semantic differential scale appeared to work well for the proposed questions. The use of memory (phase two cognitive processing), as shown by the one participant thinking about previous answers, is worthwhile to note for future studies.

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