Crowdsourced visual design feedback through designers' eyes

David A. Robb

School of Mathematical and Computer Sciences, Heriot-Watt University, Scotland

dar14@hw.ac.uk.

Britta Kalkreuter

School of Textiles and Design, Heriot-Watt University, Scotland

B.Kalkreuter@hw.ac.uk.

Stefano Padilla

School of Mathematical and Computer Sciences, Heriot-Watt University, Scotland

S.Padilla@hw.ac.uk

Mike J. Chantler

School of Mathematical and Computer Sciences, Heriot-Watt University, Scotland

M.J.Chantler@hw.ac.uk

Abstract

Purpose

Evaluation of a new method for visual design feedback by crowds aimed at encouraging intuitive perceptual and emotional responses.

Methodology

Semi-structured interviews and grounded theory qualitative analysis.

Findings

Designers received new image based forms of feedback about emotional responses to their designs. They found inspiration for design changes in the visual feedback formats produced using this new method. Visual responses using abstract imagery were perceived to be useful as perceptual mood boards confirming that designers' intentions had actually been realised. When contrasting text feedback with image feedback, differing views were expressed about communication of emotion: one view being that images encouraged focus on emotions while text had lead the crowd to stray away from their emotions into a conventional design critique.

Eleven out of the twelve participating designers desired to use a service offering the new visual feedback formats.

Research limitations/implications

The group of participants were student interior designers.

Practical implications

An image based channel for crowd feedback suited to visual and intuitive thinking has been developed and evaluated.

Social implications

If crowds can be engaged by the new image based feedback method, design feedback cycles using fast intuitive image selection rather than text could democratise participatory design.

Originality/value

This paper reports results from an evaluation of a new method of crowdsourced design feedback based on images.

Keywords

Computer mediated design feedback; crowdsourcing; image summarisation; qualitative research; participatory design; intuition and imagery in design.

Article Classification

Research paper

Introduction

"Head Crowd" is a collaboration between the Schools of Textiles and Design, and Mathematical and Computer Sciences at Heriot-Watt University. The aim is to develop a service which enables designers and crowds to engage in a series of co-design cycles, using images as the medium. The intention is to democratise design feedback and co-design beyond design professionals and enthusiasts in a way that is engaging and useful in today's digital social world.
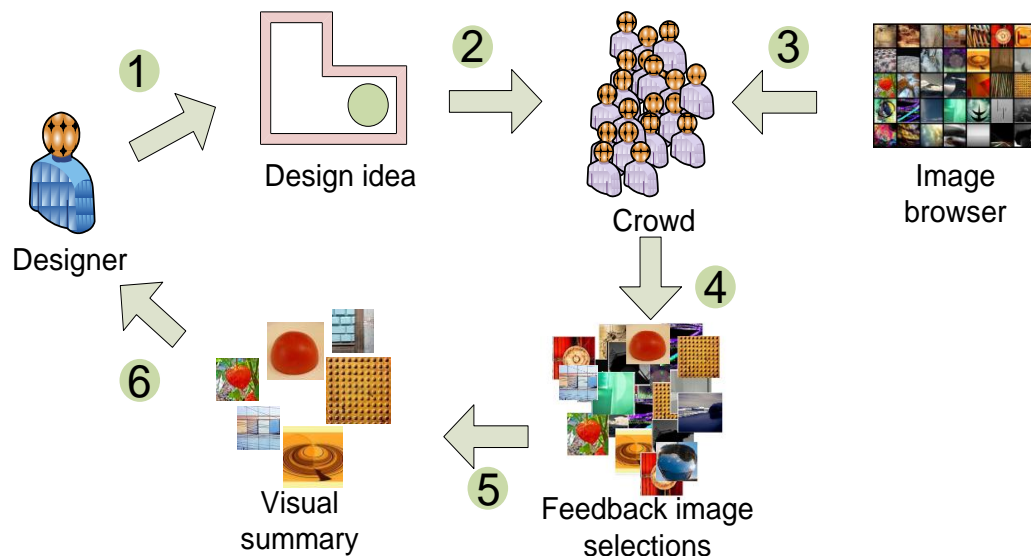

Figure 1 - The crowdsourced visual feedback method: 1-Designer presents design; 2-Crowd views design; 3- Crowd responds by selecting images from browser; 4- Image selections collated; 5-Automated summaries generated; 6 Designer views feedback.

In previous work we have proposed the new communication method (Figure 1), described the creation of an intuitive image browser for feedback and an automated way of summarising massed image selections made from the browser (Kalkreuter & Robb 2012). We have shown that these visual summaries communicate the intended meaning of those who selected the images as effectively as the full image selections (Kalkreuter et al. 2013). In this paper we report a study to evaluate the visual feedback method. *Designer participants*, a group of interior design students, put forward their designs. *Feedback participants* viewed each design and responded to the question "How did the design make you feel?" using three formats: an abstract image set, a second, emotional image set, and text. Image summaries (abstract and emotive) and lists of text responses were generated and shown to the designers during semi-structured interviews. The designers were asked about the status of their design (prototype or

finished) and whether they were considering changes. They were then shown the feedback summaries, and their own reactions to the feedback were probed. After receiving their visual feedback all but one of the designers revealed that they would be enthusiastic users of a service which allowed them to continue receiving design feedback in these visual formats.

In the remainder of this paper, in *Background* we describe aspects of semiology, communication, psychology, emotions and imagery in design, and discuss how these relate to our novel method of crowdsourced design feedback. Then, in *Imagery for feedback,* we describe the image sets we have used to evaluate the method, and how they are organised to enable intuitive use. In the *Evaluation of the feedback method* and *Findings* sections we describe the methods used in the evaluation study and the results which flowed from it. Finally, in *Discussion and conclusions,* we discuss the implications arising out of the study and the future application of the new visual feedback method.

Background

Semiology and communication

A major part of this project is to establish a visual medium for fast intuitive visual feedback. Therefore, a brief examination of semiotics is appropriate. Semiology is usually taken to be the study of signs and symbols. Chandler (2002) defines semiotics as:

> *"...the study... of anything which 'stands for' something else."*

An important aspect of any conversation between a designer and a crowd will surely be whether or not the designer will be able to understand what the crowd has said in images. Part of our previous work addressed this issue by evaluating the communicative effectiveness of a set of mainly abstract images. By having participants use images to communicate terms our study showed that the abstract images were better for communicating material properties than for emotion terms (Kalkreuter et al. 2013). However, the semantics of a message is not the only reason for a conversation. Guiraud (1971) when listing the aspects, or as he labels them "functions", of communication, points out that there is often much more to communication than simply the substance of the message in terms of its overt meaning. A message can have its own intrinsic artistic or poetic meaning. Also, a message can be aimed to illicit a logical or an emotional response from the recipient. Furthermore, an important function of many instances of communication is simply to continue the conversation. i.e. the semantic content can be entirely superfluous to its purpose. We argue that the non-semiotic properties of the visual feedback conversations, that our method will enable, may be as important as the purely semantic message content of image based crowd feedback. Indeed, some of the visual

feedback summaries themselves may well possess their own intrinsic artistic meaning, and if so, designers receiving them would surely benefit.

Cognition, decision making and intuition

It is recognised that some people are more visual and others more verbal. It is work in psychology on cognitive styles which has led to this being generally accepted. Cognitive styles have been used to inform teaching and learning (Coffield et al. 2004) and are often used to predict people's performance in different circumstances (Kozhevnikov 2007). Research in this field of cognitive styles produced several models (Rayner & Riding 1997). However, two main dimensions were identified by Riding & Cheema (1991) in a review. Those two major cognitive style dimensions are visual-verbal and analytical-holistic. The analytical-holistic dimension identifies some individuals as preferring to break down problems or situations into segments or stages, while others prefer to think of them as a whole. The visual-verbal dimension provides for there being some people who, when they conceptualise, do so in imagery, whereas others do so verbally i.e. in language. While cognitive styles are independent of gender, intelligence, and age (Riding 1997), differences between visual and verbal people have been measured in brain activity patterns. These have been observed to be different in visual and verbal individuals when engaged in certain tasks (Gevins, A. and Smith 2000). In terms of information consumption, visual people learn better when consuming information pictorially rather than verbally (and textually) (Riding and Ashmore 1980). A new image based feedback format should open up a new channel which appeals especially to visual people.

Another field of psychology has addressed the issue of how we approach decision-making. The importance of intuition is recognised in Dual Process theory (Evans 2003) which describes that we use two parallel "systems" when arriving at decisions. The theory names our fast intuitive decision-making process as *system 1* and the slow deliberative process as *system 2*. It is thought that our intuitive *system 1* remains with us from ancestor species deep in our evolutionary past, while we have more recently evolved the distinctively human, logical *system 2*. Knowing that the two systems exist one might question the quality of intuition when compared to deliberative, logical decision-making. However, Evans (2003) points out that, experts in given domains are actually thought to use their intuitive system 1, as it rapidly exploits previous experience, rather than spending time on slow analysis. It has been shown that the quality of the answers arrived at through the fast system 1 can equal and sometimes better those produced via the slow system 2 (Witteman et al. 2009, Sherbino et al. 2014). We all actually deploy our intuitive system 1 to take care of most of our every-day decision-making (Evans 2013) and even when we might think we are carefully and logically

analysing a situation, in fact, our intuitive system 1 is unconsciously biasing our supposedly deliberate thought processes (Evans 2003).

Evans (2008) describes system 1 as automatic, low effort, rapid, holistic, *perceptual*, *nonverbal* and independent of working memory. Whereas he characterises system 2 as controlled, high effort, slow, analytic, reflective, *linked to language*, and limited by working memory capacity. Our goal is to encouraging intuitive, *perceptual and nonverbal* feedback responses by providing a *perceptual and nonverbal medium* as a way of exploiting the intuitive side that we all possess. What we know about the dichotomy of our thinking processes and the pervasiveness of intuition makes this goal a valid one.

Imagery and emotion in design

Emotions are closely implicated in human information processing, decision-making, and intuitive thinking (Tiedens & Linton 2001, Lerner et al. 2004). Approaches such as Kansei engineering (Nagamachi 1995) factor consumer emotions into product design. With regard specifically to imagery, mood boards are a well-established creative and analytical tool used by designers when creating a design idea. Mood boards use images and objects to develop a perceptual and emotional theme. Abstract images are often used for this to avoid specific figurative connections (Garner, S. & McDonagh-Philp 2001). However, figurative images can access emotions in a more specific way than can abstract images (Bradley et al. 2001). Mikels et al. (2005) categorized images according to their emotional affect. There is a good prospect of emotive images being suitable for fast intuitive feedback because it has been shown that people rapidly and reliably interpret the emotion content of images (Junghöfer et al. 2001).

With all these considerations in mind we decided to use two types of imagery in the evaluation of the crowdsourced visual feedback method: 1) a relatively abstract image set to provide a wide ranging and non-specific image pool with which designers would already be comfortable; and 2) an emotive image set built specifically to provide images communicative of emotions relevant to design discourse.

Imagery for feedback

In this section we describe how the two image sets used for the evaluation are constructed and how selections of many images chosen from each can be summarised by a small number of representative images.

Abstract image browser

A collection of 500 mainly abstract Creative Commons licenced images was assembled as described by Kalkreuter & Robb (2012). The human perceptual similarity judgements which were also gathered for the image collection allow it to be organised in an intuitive browser. The images are arranged in stacks as defined automatically by a self-organising map (SOM) (Vesanto et al. 1999) based on the perceptual similarity between the images. The resulting browser makes finding images highly intuitive (Padilla et al. 2013). See Figure 2. An evaluation of the effectiveness of the abstract image set for communicating terms revealed that it was, relatively, much better for communicating material properties e.g. "smooth" or "brittle" than it was at communicating emotions e.g. "embarrassment, shame" (Kalkreuter et al. 2013).
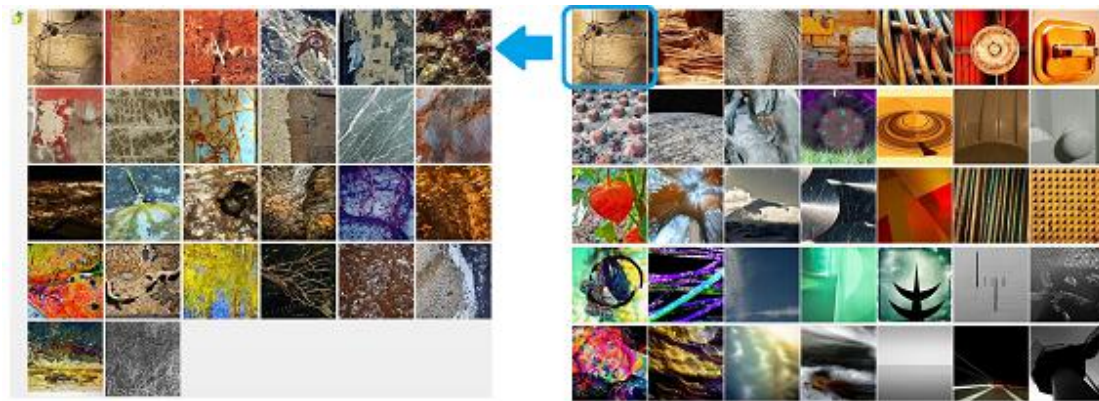

Figure 2 –Abstract image SOM browser. Right: Top level showing stacks. Adjacent stacks contain quite similar images. Stacks far apart contain dissimilar images. Each individual stack contains highly similar images. Left: the top corner stack is opened to show it contains similar texture images.

Emotive image browser

To build a further image set, designed to better facilitate emotion communication, a model of emotion which incorporates several basic emotions, derived emotions, and an intensity dimension was selected (Plutchik 2002). A survey of staff and students at a design institution identified 19 of the emotion terms from the model as being relevant to a design feedback. E.g. 'joy' and 'pensiveness' were among the chosen terms, while 'ecstasy' and 'loathing' were among those terms rejected. 2000 Creative Commons licenced images associated with the 19 *design feedback terms* were gathered from Google and Flickr. These 2000 images were then tagged with terms from the Plutchik model by crowdsourced particpants using a drag-and-drop web interface. The resulting categorisation produced an emotion term profile for each image. Figure 3 shows one of the images and Figure 4 shows its emotion profile.
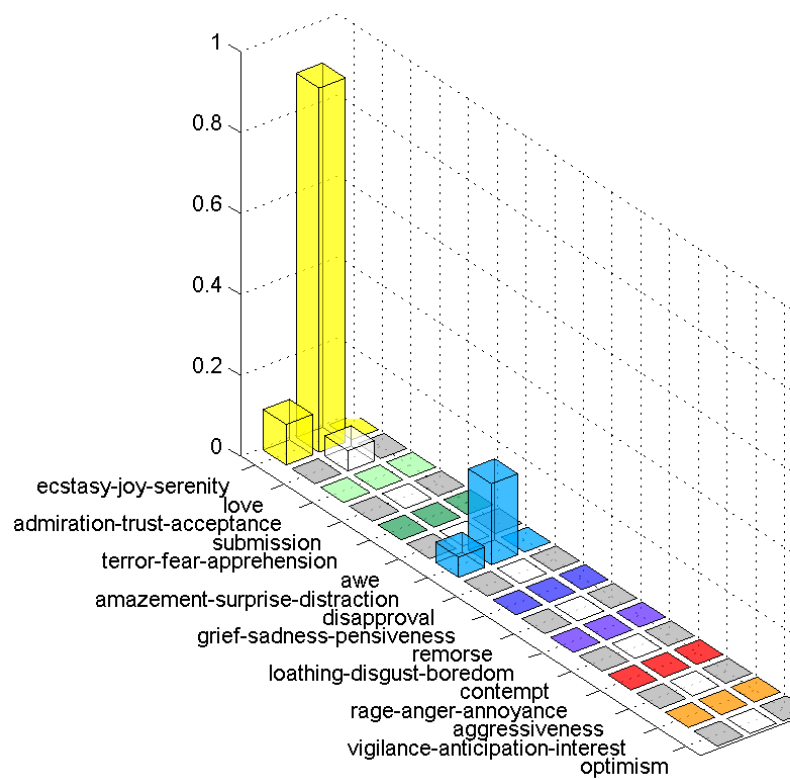
Figure 3 - Emotive image ID10993

Figure 4 - Emotion profile for emotive image ID10993.The height of each column represents the normalised frequency with which participants categorising the image tagged it with a given term. i.e. this image was mainly being tagged with the term, 'joy' with fewer participants tagging it as 'ecstasy', 'love', surprise' and 'amazement'. The arrangement of the emotion terms on the profile chart reflects the basic and derived emotions and their relationships from the Plutchik (2003) model.

These emotion profiles allowed images to be filtered based on the term they best represented. Applying this filtering produced around 10 images for each of the 19 design feedback terms, forming a balanced set of 204 images with which to communicate emotion for design

feedback. The emotion profile data held for each image allowed the images to be organised in a SOM browser in a similar fashion to the abstract image browser. Each stack contains images with similar emotion profiles (Figure 5).
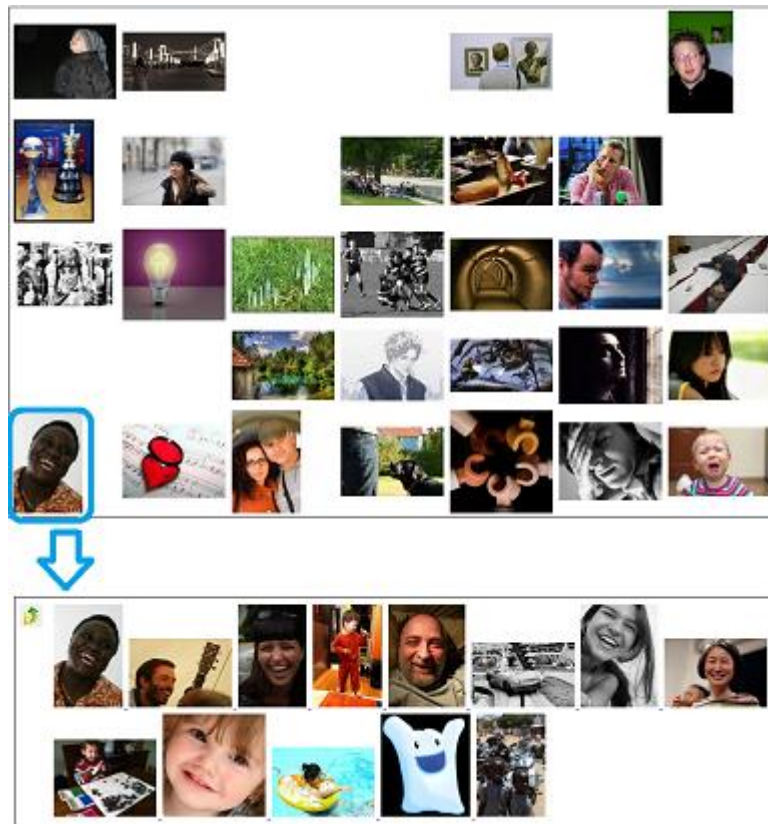

Figure 5 – Emotive image browser showing bottom left stack open. The images in that stack all have emotion profiles associating them with the term 'joy'. The self-organising map algorithm has dictated that, with 35 available stack spaces (5 rows x 7 columns) and 204 images, not all the available stack spots are needed; hence the gaps in the top level of the SOM.

Summarisation of massed image selections from the browsers

Selections of images from the abstract image browser can be summarised automatically by clustering the images based on the similarity data held on each image. Images at the centre of each cluster are selected to represent their cluster and thus, a selection of many images from the browser is reduced to ten representative images. In a study of image selections made from the abstract browser, the communicative effectiveness of the summaries was shown to be as good as that of the full image selections (Kalkreuter et al. 2013). The same summarisation algorithm is applied to selections from the emotive image browser making use of the emotion profiles held on each image as the basis for clustering.

Evaluation of the feedback method

We evaluated the visual feedback method with 12 student interior designers (*designer participants*) who were enrolled on a contextual studies course. Another 32 students on the course were recruited to act as the crowd (*feedback participants*) who would view the designs and give feedback. All the participants received course credit for taking part.

Each designer provided a design image to the project. A web application was created to allow the *feedback participants* to view the designs and react to them. The feedback participants would be asked to respond using three different answer formats:

    A. Choosing 3 abstract images

    B. Choosing 3 emotive images

    C. Typing some text

An image response required 3 images in case, for example, a feedback participant felt a combination of emotions when viewing a design.

During the task each feedback participant did the following:

    1. Viewed a design

    2. Viewed this question: "How did the design make you feel?"

    3. Responded using the three response formats. (For each participant these response formats were presented in a random order).

Each feedback participant did this for 6 designs (at random from the 12 available). Their responses were recorded in a database. With each of the 32 feedback participants responding to half of the 12 designs, we were able to collect 16 sets of responses for each design. Therefore the responses for each design consisted of 16 text responses, 48 abstract image selections, and 48 emotive image selections. The responses to each design were collated. The text responses were compiled into a randomly ordered list. The abstract image responses were summarised using the automatic summarisation algorithm producing an abstract image feedback summary. The emotive image responses were processed in the same way producing an emotive image feedback summary.

During semi-structured interviews (Kvale and Brinkmann 2009) lasting around 45 minutes, each designer was shown their three feedback formats. The interviews started with a warm-up during which designer participants were shown the image sets and shown how summaries can be made of selections of images from each image set. The designers were asked to talk about their design so as to establish the design status. During the rest of each interview designer

participants were shown their feedback formats (in random order) and asked prepared questions about the feedback. Follow-up questions were asked when necessary and as the opportunity arose. The interviews were recorded using a digital audio recorder. Transcriptions were made and analysed following a grounded theory approach (Corbin and Strauss 2008).

In addition to the designer interviews, each feedback participant was asked, in a post-task questionnaire, to rank the feedback formats in order of overall preference (forced ranking).

Findings

In this section we first describe in detail each of the themes which arose out of the analysis of the designer interviews. We then report the preference rankings of the feedback participants. We conclude this section with a summary of the themes from the interviews.

Theme 1 - Inspiration to change

Designers were motivated to consider improving their designs after viewing the image feedback summaries. We describe examples of three designs which the designers revealed to be at different stages, a prototype, a transitional design, and a final proposition. For each, we show the design image put forward for feedback, one of the associated feedback image summaries, and details of the interview discussion, including some of the component images from the summaries which were highlighted by the designer participants.

Example 1 – A prototype

D9's design (Figure 6) was a prototype for a particular space in a college. He explained it was:

> *"… a kind of an image wall so the students can show their work in a sort of abstract way so it gets the person that is looking at it to move around the space so that they are not seeing everything as that flat [gestures flatness] surface."*
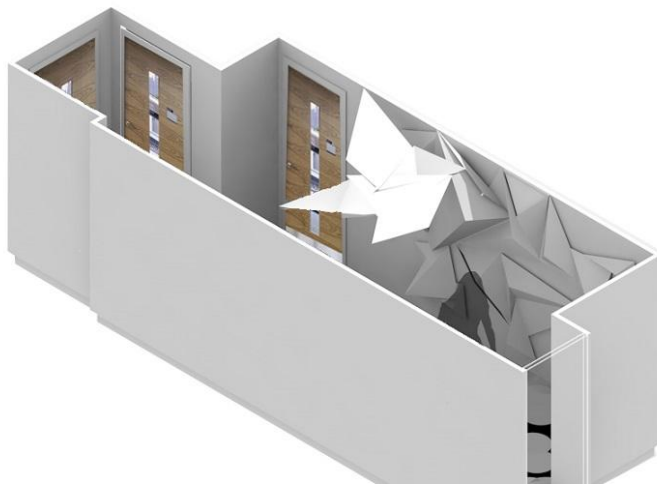
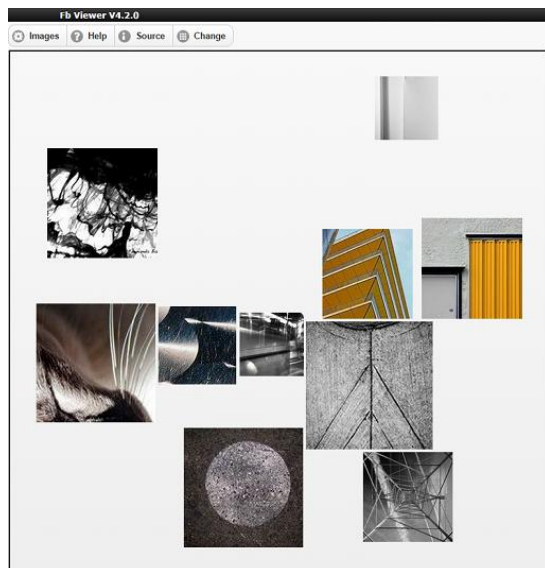*Figure 6 – The prototype design (with permission D9)*

Figure 7 – D9's abstract image feedback summary.

When the abstract image summary (Figure 7) was revealed the following discussion ensued:

> **Researcher** – *…does that give you any ideas do you think?*
>
> **D9** – *Absolutely yes!*
>
> **Researcher** – *So what in there [indicates abstract summary, Figure 7] is suggesting something to you to do with your design and if you could pick something out?*
>
> **D9** – *Oh, there's a few!*
>
> **Researcher** – *Yeah?*
>
> **D9** – *This one for a start [indicates image ID10475, Figure 8]*
>
> **Researcher** – *Why are you drawn to that one?*

D9 – I think colour more than anything… It's quite a good colour. Quite a bold colour"

Figure 8 – Abstract image ID10475

D9 went on to draw inspiration on lighting from other images in his abstract image feedback:

Figure 9 - Abstract image ID10302

D9 – Lighting is the next one. So that one [indicates image ID10302, Figure 9]… I think it's cat whiskers or something. The lighting behind it… I suppose I could use that one for lighting as well [indicating image ID10031, Figure 10].
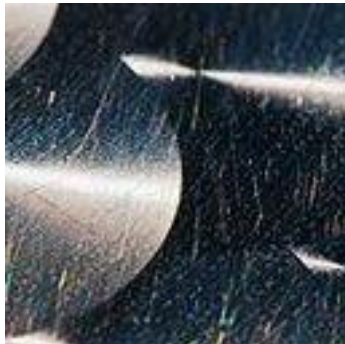

Figure 10 - Abstract image ID10031

Researcher – Ok. And when you say "lighting", are you thinking of making some change to the lighting or is it giving some specific ideas?
D9 – Eh, the way the light is projected across that sort of sculpture [indicating the sculptural part of his own design image (see Figure 6)].

Example 2 – A transitional design

D6 when asked whether her design, featuring a modular shelf system (Figure 11), was finished or a prototype described it thus:

> **D6** – *Somewhere in between because I mean, it is a prototype really. I always kind of do that though, but then I developed it a little bit further, but in a different kind of way. It wasn't a shop any more it was a watch cabinet. I mean there was another shop in it, but em…*
>
> **Researcher** – *So that design was midway between prototype and finished and so far with that idea you have done something else since then?*
>
> **D6** – *Yes.*

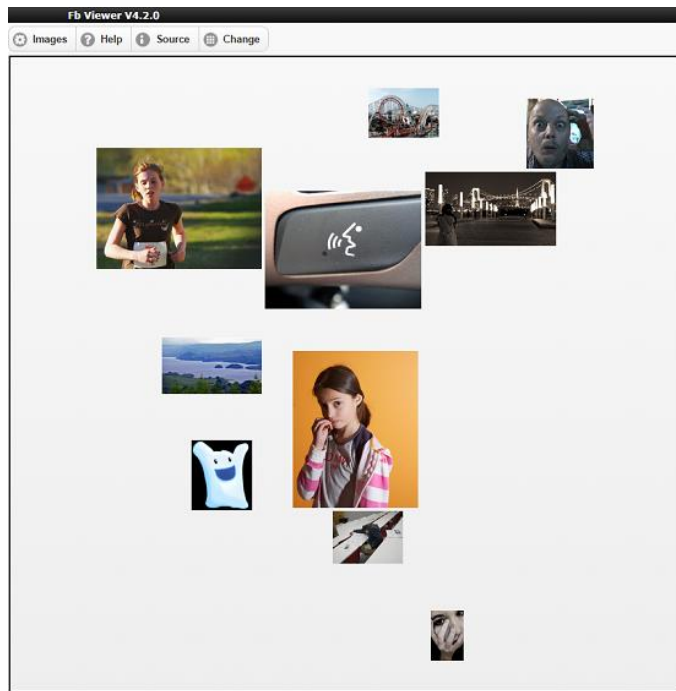*Figure 11 - A transitional design (by permision D6)*

Figure 12 – D6's emotive image feedback summary

When the emotive image summary (Figure 12) was revealed to D6 her immediate impressions were as follows:

> **Designer6** – *Em. Bored.*
>
> **Researcher** – *So which one is that?*
>
> **Designer6** – *That one and that one [indicating image IDs 10227 and 11581 ,Figure 13], and that guy looks confused [indicating image ID 11541, Figure 13].*

This interpretation, after viewing just the emotive image summary motivated D6 to consider presenting her design differently:

> **D6** – *I'd make it a nicer visual. I'd make… I'd refine it a bit more. I'd put more detail into it. I think.*
>
> **Researcher** – *Uh-huh?*
>
> **D6** – *Because it is a bit boring [referring to her design image].*
>
> **Researcher** – *So you are taking that from the images that you've interpreted from this as indicating "boring"?*
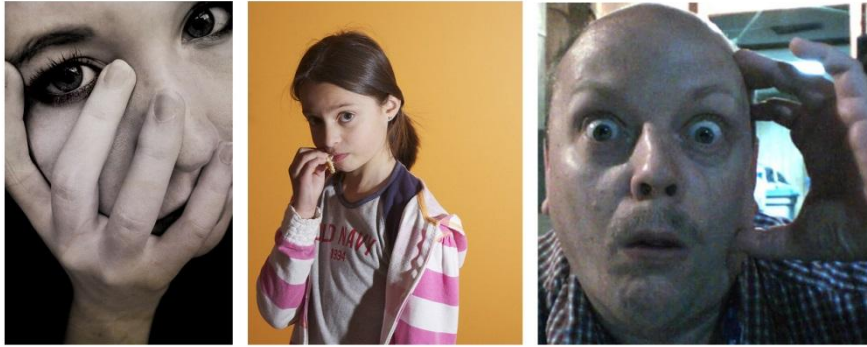>
> **D6** – *Yeah.*

Figure 13 – Left to right: Emotive image IDs 10227, 11581, 11541, interpreted by D6 as "bored", "bored", and "confused" respectively.

This was also an example of a designer focussing on perceived negative feedback over positive and this is discussed below in "Negative feedback".

Example 3 - A final design proposition

Figure 14 – A final design proposition (by permission D10)

Prior to viewing the feedback D10 was not considering changes to her design (realised in a paper model, Figure 14) other than editing the image:

> **Researcher -** *Would you consider making any changes or modifications to your design at this stage?*
>
> **D10 -** *I think maybe it is a bit dark. I might have edited it [the image] and made it a little lighter.*
>
> **Researcher -** *But in terms of the actual design?*
>
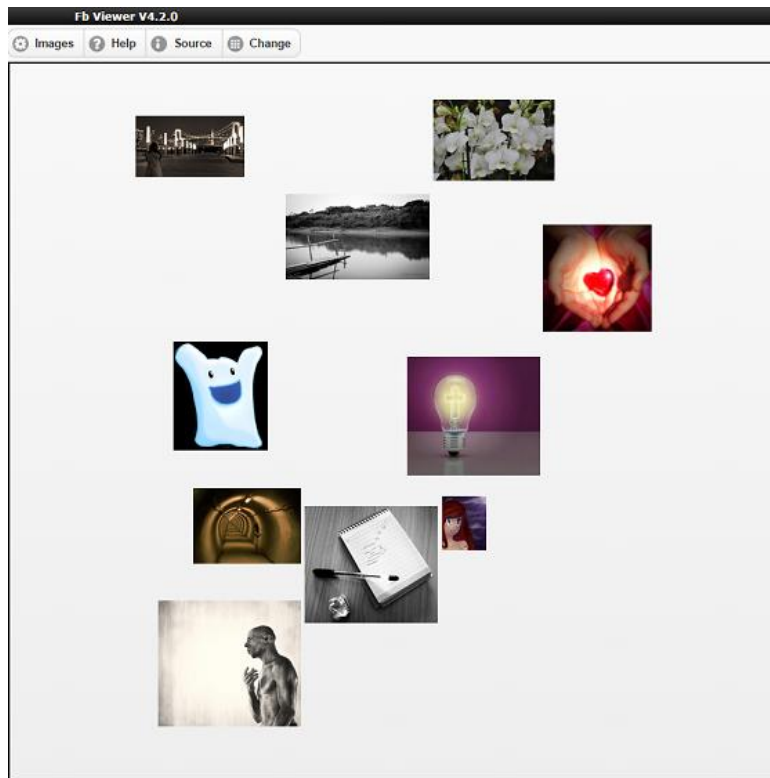> **D10 -** *The actual model? Em… I don't think so, no.*

Figure 15 – D10's emotive image feedback summary

Later after viewing her emotive image feedback summary, when asked if that had given her any ideas, D10 opened again one of the images (see Figure 16) from the emotive image feedback summary:

> ***Designer10 -*** *I quite like these forms in the flowers, maybe, do something with that.*

Figure 16 - Emotive image ID11365

Although her design was finished and had been realised in a mobile paper sculpture, D10 was open to taking inspiration for the future from her image feedback. Although the particular image she focussed on was from the emotive image set, D10 appeared to be reading it in the same way that other designer participants had read their abstract image feedback.

The level at which inspiration was taken by the designer participants varied depending on their own view of the status of their design. Those with prototypes were inclined to take ideas and directly relate them to the next stage of their design. Those with more developed or finalised designs were inclined to take on ideas to apply to future projects.

Theme 2 - Interpreting the feedback

When designer participants viewed and explored a visual feedback summary they would develop an interpretation of the feedback. While viewing emotive image feedback on her design for a bar interior, D5 successively expanded then closed individual component images by tapping them: *"Mmm. I think they are talking about the mood in this one. How, like, people here, socialising; they are happy. Something crazy going on here [little laugh]. And, [I] don't really understand this one here. Like you can just sit down by yourself and get lost in your thoughts. They are talking about the mood here, I think."*[D5]. Figure 17 shows the image summary and the specific component images to which D5 had referred.
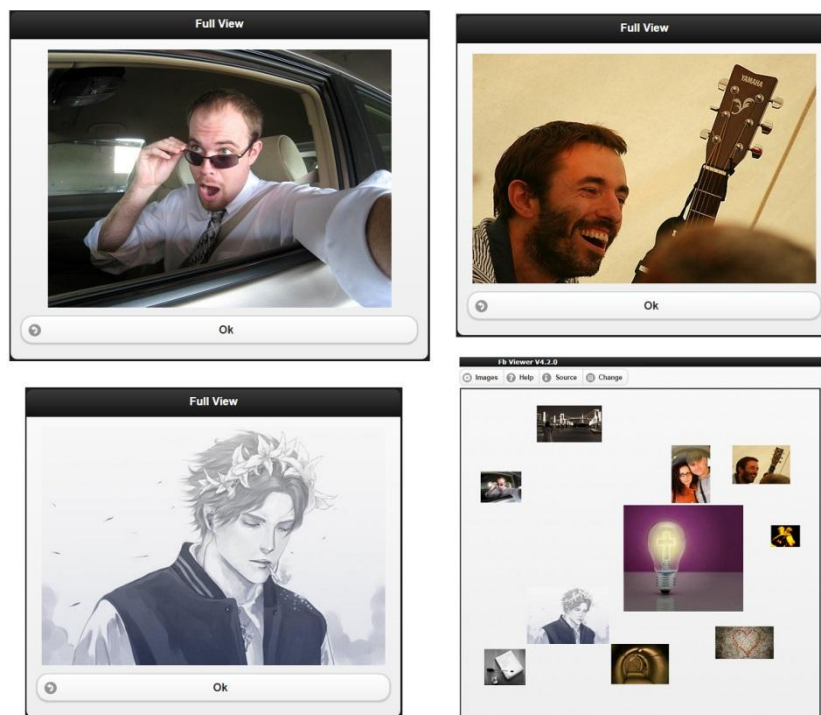

Figure 17 – D5 interpreting emotive image feedback as "mood". Three component images that D5 had interpreted individually are shown with the summary, bottom right. Top left, "something crazy"; top right, "socialising"; bottom left, "lost in your thoughts".

This development of an interpretation also seemed to be done when dealing with ambiguity in text feedback. Designer participants would assign messages to comments or groups of comments. E.g. here D12 starts by quoting from her text feedback: *"[quoting]'planning and*

organising, sense of group'. Yeah, because it's sort of the way that the chairs are laid out and stuff [referring to her design]."[D12]. Sometimes a designer could not assign a specific meaning to a given image but would still take something from it. Here D3 finds a message about colour in one of the images on her emotive feedback summary: "*When I look at the Lego hands [Figure 18], it's got basically all the colours that I've used.*" Then later: " *I didn't really understand what the hands meant, but the colours I understand.*"[D3].

Figure 18 – Emotive image ID11885

The designers dealt with ambiguity as they met it in the image summaries. They assigned a message to an image or group of images on a summary in a way analogous to the way they resolved ambiguity found in text feedback.

Theme 3 - Abstract feedback as mood board

One designer proposed using the abstract feedback as a mood board to confirm the intended mood was received.

Figure 19 – Courtyard design (by permission D12).

D12 described her abstract image feedback summary (Figure 20) as: "*the look is similar to what my mood board would look like before it*" [D12].
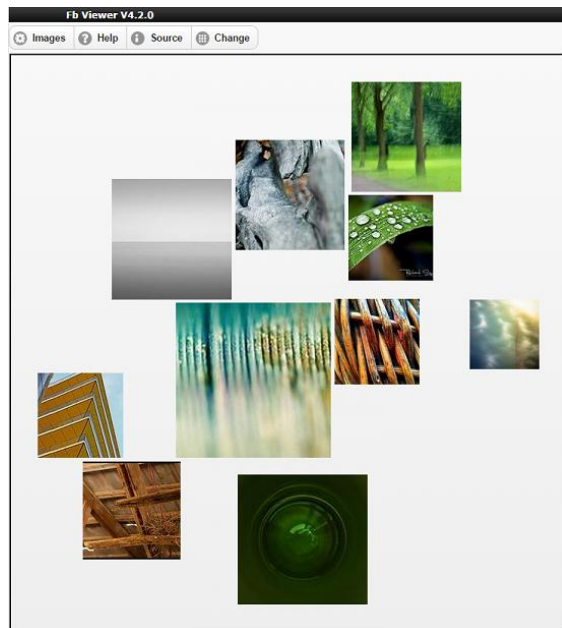

Figure 20 - D12's abstract image feedback summary.

She continued: "*It's showing that my design [Figure 19] is coming across how I wanted it to come across. Like, that's what I was going for and that's how it's come out.*"[D12]

D12 went on to describe how she would use abstract image feedback as a presentational tool to inform those who had commissioned the design how it was perceived by others. She said she would use it "*to show like if it was a presentation and you were then saying: "Well, I've actually surveyed all these people and this is what they thought of it", and then to show that [indicating the abstract image summary]. And that being similar to what I had done at first [referring here to her own original mood board]*" [D12].

Theme 4 - Negative feedback
This theme is divided into sub-themes:
Abstract image feedback viewed as non-threatening
The designer participants were able to read negative feedback in both the emotive image feedback and in the text list feedback. However, no participant mentioned this aspect in relation to their abstract image feedback. Actually, the abstract image feedback was able to suggest in a constructive way to a designer that something was wrong. Abstract image feedback was read in this way by D11: "*I was looking at [her abstract image feedback] and thinking that was earthy and very cold, it is not the environment I really wanted. So yes, it is making me think, definite change of textures, if that is how they see it: as cold and*

mechanical. I didn't think that would be the reaction you would get but that is good though. Good feedback" [D11].

This was an instance of a designer reading that her design was perceived in a way that was against her expectations, but she was taking this on board and was prepared to make changes as a result of the feedback. This is also an example of the mood board function of the abstract image feedback (see Theme 3) but instead of confirming the planned mood it was demonstrating the design was conveying some other mood.

A tendency to focus on negative feedback

The sub-theme above showed that abstract image feedback was not viewed as negative. However negative feedback was perceived in the emotive image feedback format e.g. the emotion, "boredom" was read by some designers in some component images in their emotive feedback. Negative feedback was also read in the text feedback. There was a tendency to focus on negative feedback to the extent that, proportionally, designers seemed to be giving more weight to negative feedback compared to positive. This tendency is illustrated by the following quantitative analysis of how participants chose to scan their list of text feedback during the interviews. Each participant was instructed to say what they were thinking when they viewed each of their feedback formats. As they read the text feedback (a simple list in random order), typically they would scan down the list stopping to read out loud some comments and discuss them. Only three of the twelve participants read out the first item on the list. Nine skipped one or more items to read out another they chose to focus on first. Eight of those who skipped comments chose to focus on a negative comment first, while only one skipped to a positive comment. (A negative comment was defined as a comment containing a clear negative element. A "positive" comment was defined as any comment not defined as negative, and so included neutral comments. The mean percentage of negative comments in the twelve participant's text feedback was 30.1%; Standard deviation 20.4%; Median 24.3%). This was acknowledged by designers in discussion. One participant was asked why she had stopped at a particular comment on her text feedback list: "*Just because the first two sounded quite positive [laughs]… I was enjoying reading it up to there [laughs]*" [D7]. It was pointed out to another participant that her text feedback list contained more positive comments than negative: "*You just can't help but read the bad stuff*" [D6]. Another described the same issue when talking about her text feedback: "*There's lots of nice comments on here though. I'm just picking out all the bad ones.*" [D2].

Negative feedback was also perceived by participants when viewing emotive image feedback. Participant D3's emotive image feedback summary contained only one negative image out ten. (The image was of a man covering his eyes with his hand). The size of the images on the summaries varied with the population of the feedback response cluster they represented, but the image that D3 chose to focus on only represented 20% of the total area covered by all the images on the summary.

This tendency to focus in on negative feedback can be interpreted as the designers valuing negative feedback over positive. As designers were able to read negative feedback in the emotive image format this would indicate that they would value the emotive image feedback.

The impact of negative feedback as text versus images
D3 felt that the negative feedback in emotive images had more impact than did the text feedback. D3 looked at the one negative image in her emotive image feedback and said the following*: "I think the emotive images are quite hard to look at because it is peoples' emotions towards your design. And if an image is that big, it does kind of pull you back … When you look at the images, they'll be stuck to you. Whereas the writing it doesn't really stick much to you. You just read it and you're like "Ok." But the images, you're like "Wow!" It's almost like you can see that person's emotion…when they are picking this image."* [D3].

Conversely, D6 was of the opinion that negative feedback in text was more impactful than in emotive image feedback: *"Looking at that [the emotive image summary]. I'd say I'm more relaxed looking at the images than the text. I'd say I'm more relaxed looking at them. Even though I've read this [her list of text responses] and this dude's bored and this wee girl's bored and that guy's confused [pointing to component images in the emotive summary]. It's just less threatening than the text because people have a way of…people have a way of putting things that might not be effective to whoever's getting criticised. Em. So the images is a good idea in that way."* [D6].

So there was disagreement between designers on whether negative feedback had more impact as text or as emotive images.

Theme 5 - Effectiveness at finding out how people felt
D6 was asked if the text feedback did a good job of answering the question "How did the design make you feel?". She pointed out that in her opinion the text comments had strayed into the realm of critique rather than talking about feelings. She began by quoting from her text feedback: *"[quoting] 'modern, young, cool, stylish, good interior for shoe display'. I*

think a lot of them have got the gist of it, because the flaws that they pointed out, I would also point out as well. Like the fact that it's not that big and it's a bit busy and stuff like that [referring to her design]. Em. But yeah. No-one's really said how they feel really. Well, [quoting again] 'I felt uninspired' There's one. But that's it... Yeah. I think the emotive images work better than the text...because it's fair enough if they were critiquing it, but they're not. They're meant to be saying how they feel and no-one's really [done that]" [D6]. Another participant stated: *"What they said in the text isn't exactly feelings"* [D8]. D2 also remarked on the effectiveness of images for emotion: *"I like that [emotive image summary]. Because it shows emotion as well, yes, mostly like emotions that people would feel...It's a good way of getting their understanding."* [D2].

Those designers though the emotive images permitted the feedback crowd to focus on emotions more effectively than when using the text format.

Theme 6 - A service offering the visual feedback formats

In the later stages of each interview, after designer participants had seen all the feedback formats, participants were asked if they would use an Internet service which allowed them to upload a design and receive feedback in the visual formats. Ten of the designers answered emphatically in the positive, one was neutral and one (D12) initially wished for text feedback but moved on to develop the idea of using the abstract feedback as a presentation tool. One participant was particularly animated and exclaimed: *"I'd love that! I'd absolutely love that yeah!"* [D8].

From this we conclude that, as a group, the designer participants valued the visual feedback formats and wanted more.

Feedback participant's preference rankings

Although the main focus of the evaluation was on how the designers would receive the visual feedback formats, the opportunity was taken to seek the preferences of those who were giving feedback, acting as the crowd. During the feedback gathering phase of the evaluation, the feedback participants were asked in a post-task questionnaire to rank the three answer formats, text, abstract images, and emotive images, by overall preference (forced ranking). 31 of the 32 feedback participants responded and a quantitative analysis of their preferences is reported below. Table 1 shows the frequencies with which each ranking was awarded. The average rankings are calculated by giving the frequency of each ranking a weight equivalent to its rank and dividing by the total number of responses (e.g. for Abstract its average ranking of 1.81 = ((15x1)+(7x2)+(9x3))/31).

Rank / Format	1	2	3	Responses	Average ranking (1 is best; 3 is worst)
Abstract	15	7	9	31	**1.81**
Emotive	5	14	12	31	**2.23**
Text	11	10	10	31	**1.97**
Total	31	31	31		

Table 1 – The overall preference ranking frequencies of the three formats by the 31 feedback participants who responded. Abstract and Emotive were the two image formats.

These average rankings are illustrated by the bar chart in Figure 21. Note that a low value means a better ranking i.e. 1.0 would have been the best possible average ranking. Figure 22 compares text with images (either abstract or emotive) by showing the frequency with which participants ranked text as their first preference with those ranking one of the image formats as their first preference (i.e. 15 for abstract plus 5 for emotive totals 20 feedback participants who ranked one of the image formats as their most preferred answer format).
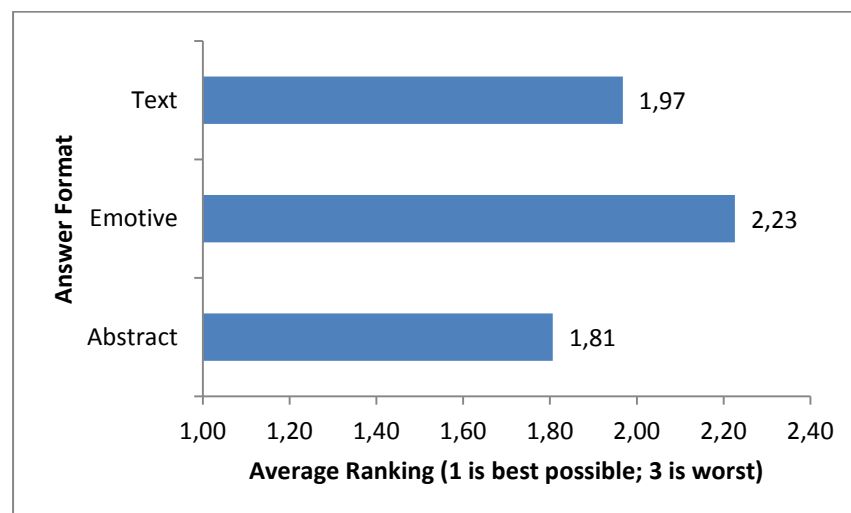

Figure 21 – Bar chart of average preference rankings for the three answer formats by the feedback participants. An average ranking of 1 would have been the best possible value; 3 would have been the worst possible. Abstract and Emotive were the image formats.
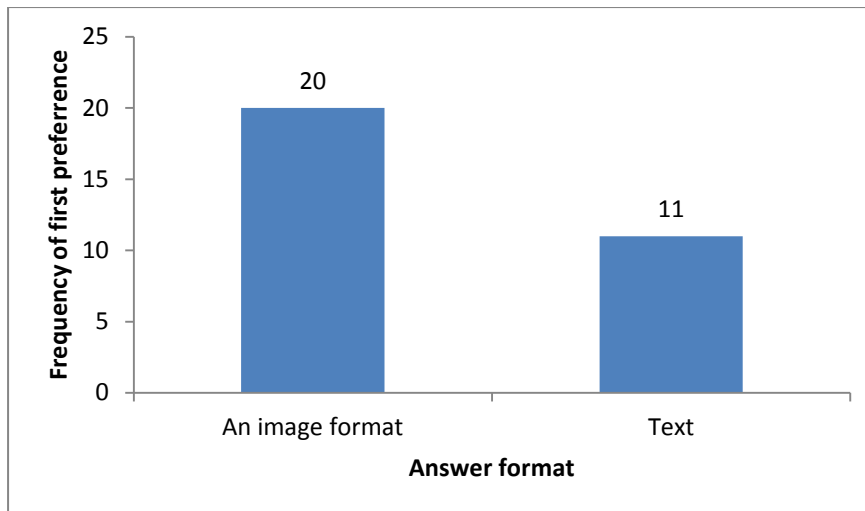
Figure 22 – Chart comparing the frequency with which one of the image formats and text were ranked as first preference by the 31 feedback participants who responded.

Cognitive styles theory would predict that, taking into account the visual-verbal dimension, some people are more visual and others are more verbal. This appears to be borne out in these results in that eleven of the feedback participants preferred to respond using text while 20 preferred responding with images.

Summary of themes

Theme1   The specificity of inspiration from the feedback depended on the design's status: directly applied ideas for prototypes; ideas for the future if the design was already more developed.

Theme 2   Participants assigned a message to an image or group of images on a summary when they initially perceived ambiguity.

Theme 3   Abstract image feedback summaries can act as 'reverse' mood boards to a) confirm a planned mood was being perceived and b) use as a presentational tool to demonstrate the perceived mood to others.

Theme 4   Abstract feedback was non-threatening while negative feedback was read in emotive image feedback. There was a tendency to focus in on negative feedback in text and emotive image feedback. There was disagreement between designers on whether negative feedback in emotive images was more or less impactful than in text.

Theme 5   Designer participants thought images helped feedback participants focus on emotions rather than straying into conventional critique with text.

Theme 6   Eleven of the twelve designer participants wished to use a service offering the visual feedback formats.

Discussion and conclusion

Firstly we make the point that one should be cautious about generalising based on our results due to the composition of the participant group for the evaluation. The feedback participants, as students on a contextual studies course might hold different views about communication with imagery. Similarly, our group of student interior designers may not be representative of all professional designers. The experience of the participants in our study does, however, give a picture of the probable appeal of this new method of crowd communication.

Images as a medium for responses

The feedback participants' rankings of the visual response formats compared to text show that, for many people, responding with images would be an enjoyable and engaging way of taking part in a design conversation. The fact that some preferred text and others preferred images, is something that would be predicted and supported by the visual-verbal cognitive style dimension. As the image sets can be presented in SOM browsers suited to different screen resolutions (Padilla et al. 2013), commenting by swiping a few images might well appeal to users of mobile devices.

The two types of imagery

Of the two image sets used for feedback, the abstract image set seemed to be the one that was embraced by the designers and feedback participants. It was seen as non-threatening by the designers. That the abstract image set offered 500 images compared to 204 in the emotive image set may well have been a factor. The reason for the lower number in the emotive set was the pursuit of a balance across the 19 design feedback terms (See "Emotive image browser" above). For some of the less clear-cut emotion terms such as 'anticipation' there were fewer images with clear emotion profiles. We had gathered 2000 images (about 100 associated with each of the 19 terms) and, following categorisation, there was no shortage of images with clear profiles showing they represented, say, 'joy'. However, images clearly representing other emotion terms such as 'anticipation' were less numerous. In retrospect we could have applied less strict filtering criteria and allowed more of our 2000 profiled images in. An unbalanced set of 500 emotive images containing, say, more 'joy' than 'anticipation' images may have provided more variety without necessarily biasing the feedback. Users would still have been able to browse the stacks for suitably expressive images. Whether or not the lower number of emotive images had an effect, the emotive set did seem to help the feedback participants focus on communicating their emotions rather than giving a conventional critique with text.

The designers' views of the feedback

The finding that the abstract image feedback could be used as a reverse-engineered mood board to confirm the perceived mood in a design was not one we were expecting. It seems that the abstract imagery in conjunction with the question "How did the design make you feel?" lends itself to capturing the perceived mood of a piece. The focus of designer participants on negative feedback was interesting. The size of each image on an image summary was proportional to the population of the feedback cluster it represented. However, one further measure to help designers keep negative feedback in perspective would be to provide additional information with each image on a summary. i.e. when tapping a component image the designer would see the feedback percentage represented by that image in a caption to the expanded image. All the participants found the image feedback made them think about their designs afresh even if they were already finished, but especially if the design was a current prototype. Designers found inspiration in forms, light, colour and mood from the visual feedback formats.

Possibilities for a new service

The finding that, overwhelmingly, the designer participants wished to use an internet service offering the new visual formats, demonstrates an appetite among them for this style of feedback. With such a service there are possibilities for successive cycles of feedback. This would allow a prototype to be developed through feedback stages. This suggested use was put to the designer participants and they were unanimous that this would be the way they would wish to use such a service. The method could also be used to build a following for a designer by segmenting the crowd. When this scenario was suggested to one designer participant she responded: *"That's a million dollar idea! You should get an app!"*[D1]. (Indeed one of Guiraud's (1971) "*functions*" of communication, namely, that a message can often be purely for continuing a conversation, might well be an aspect of the communication between designer and following). Records of co-design feedback cycles could be formed into a product design narrative. Such narratives add value to products in an environmentally sustainable way when consumers invest more value in fewer physical purchases (Sanders and Simons 2009). The more enthusiastic members of the feedback crowd could become engaged in adding to the image sets used for feedback. Activities associated with this will include gathering of further images and providing judgements to categorise and classify new images.

Cultural considerations relating to emotions and imagery

There are facets to emotional imagery which are universal and thus bridge cultures, such as some facial expressions (Plutchik 2003, Ekman 1984). However, colours for example, have different emotional associations depending on culture (McCandless 2009). Clearly images

allow language independent communication but intercultural differences may need to be taken into account. Further study of differences in the way different cultures interpret the image sets used for the evaluation would inform the creation of further image sets.

Conclusion

Our evaluation of the image-based design feedback method for use with crowds has shown that, for both designers and feedback givers, perceptually organised image banks can form the basis of a viable way of engaging in a design conversation. The method, which sets aside text, can tap into intuition and perception in a way that conventional text formats cannot match.

Bibliography

Bradley, M.M., Codispoti, M., Cuthbert, B.N., & Lang, P.J. (2001), "Emotion and motivation I: defensive and appetitive reactions in picture processing", Emotion, Vol.1 No.3, pp. 276.

Chandler, D. (2002), Semiotics : the basics (2nd ed.): Routledge. London.

Coffield, F., S.R., Moseley, D., Hall, E., Ecclestone, K. (2004). Should we be using learning styles?: what research has to say to practice. Learning & Skills Research Centre, London.

Corbin, J., Strauss, A. (2008), Basics of qualitative research: Techniques and procedures for developing grounded theory, Sage.

Ekman, P., (1984), "Expression and the nature of emotion", Scherer, K.R., Ekman, P., Approaches to emotion, LEA, New Jersey, pp. 319-344.

Evans, J.S.B.T, (2003), "In two minds: dual-process accounts of reasoning", Trends in cognitive sciences, Vol.7 No.10, pp. 454-459.

Evans, J.S.B.T., (2008), "Dual-Processing Accounts of Reasoning, Judgment, and Social Cognition", Annual Review of Psychology, Vol.59 No.1, pp. 255-278.

Evans, J.S.B.T, (2013), "Two minds rationality", Thinking & Reasoning, Vol.20 No.2, pp. 129-146.

Garner, S., McDonagh-Philp, D., (2001), "Problem interpretation and resolution via visual stimuli: the use of 'mood boards' in design education", Journal of Art & Design Education, Vol.20 No.1, pp. 57-64.

Gevins, A., Smith, M.E., (2000), "Neurophysiological measures of working memory and individual differences in cognitive ability and cognitive style", Cerebral Cortex, Vol. 10 No. 9, pp. 829-839.

Guiraud, P. (1971), Semiology. Routledge, London.

Junghöfer, M., Bradley, M.M., Elbert, T.R., Lang, P.J. (2001), "Fleeting images: A new look at early emotion discrimination", Psychophysiology, Vol.38 No.2, pp. 175-178.

Kalkreuter, B., Robb, D., (2012). "HeadCrowd: Visual feedback for design", Nordic Textile Journal, Sustainability and Innovation in the Fashion Field(1), pp. 70-81. Available at http://bada.hb.se/bitstream/2320/12351/1/NJ2012.pdf (accessed 13 Oct 2014)

Kalkreuter, B., Robb, D., Padilla, S., Chantler, M.J. (2013), "Managing creative conversations between designers and consumers", in Britt, H., Wade, S., Walton, K. (Eds), Futurescan 2: Collective Voices, Association of Fashion and Textile Courses, Sheffield, pp. 90-99.

Kozhevnikov, M., (2007). "Cognitive styles in the context of modern psychology: Toward an integrated framework of cognitive style", Psychological Bulletin, Vol.133 No.3, pp. 464-481.

Kvale, S., Brinkmann, S., (2009), Interviews: Learning the craft of qualitative research interviewing (Second ed.), Sage.

McCandless, D.,(2009), Information is beautiful, Collins London.

Mikels, J.A., Fredrickson, B.L., Larkin, G.R., Lindberg, C.M., Maglio, S.J., Reuter-Lorenz, P.A. (2005), "Emotional category data on images from the International Affective Picture System", Behavior research methods, Vol.37 No.4, pp. 626-630.

Nagamachi, M.,(1995). "Kansei engineering: a new ergonomic consumer-oriented technology for product development", International Journal of industrial ergonomics, Vol.15 No.1, pp. 3-11.

Padilla, S., Halley, F., Robb, D., Chantler, M., (2013), "Intuitive Large Image Database Browsing Using Perceptual Similarity Enriched by Crowds", Computer Analysis of Images and Patterns, Springer Berlin Heidelberg, Vol. 8048, pp. 169-176.

Rayner, S., Riding, R., (1997). "Towards a categorisation of cognitive styles and learning styles", Educational Psychology, Vol.17 No.1-2, pp. 5-27.

Riding, R.J., (1997), "On the nature of cognitive style", Educational Psychology, Vol.17 No. 1-2, pp. 29-49.

Riding, R.J., Ashmore, J., (1980), "Verbaliser-imager learning style and children's recall of information presented in pictorial versus written form", Educational Studies, Vol.6, pp. 141-145.

Riding, R., Cheema, I., (1991). "Cognitive Styles—an overview and integration", Educational Psychology, Vol.11 No.3-4, pp. 193-215.

Plutchik, R. (2002), Emotions and life: Perspectives from psychology, biology, and evolution, A.P.A. , Washington, DC.

Sanders, L., & Simons, G., (2009), A Social Vision for Value Co-creation in Design, Open Source Business Resource, (Value Co-Creation).

Tiedens, L.Z., Linton, S. (2001), "Judgment under emotional certainty and uncertainty: the effects of specific emotions on information processing", Journal of personality and social psychology, Vol.81 No.6, pp. 973.

Vesanto, J., Himberg, J., Alhoniemi, E., Parhankangas, J., (1999), "Self-organizing map in Matlab: The SOM Toolbox", in Matlab DSP Conference, Espoo, Finland, pp. 35-40.

Witteman, C., van den Bercken, J., Claes, L., Godoy, A., (2009), "Assessing Rational and Intuitive Thinking Styles", European Journal of Psychological Assessment, Vol.25 No.1, pp. 39-47.