

EarthPal: An Anthropographic Visualisation of Environmental Data

Benjamin McKitterick

Lancaster University
Lancaster, UK
b.mckitterick@lancs.ac.uk

Ross Neacy

Lancaster University
Lancaster, UK
r.neacy@lancs.ac.uk

Garry Charnley-Fisher

Lancaster University
Lancaster, UK
g.chnley-fisher@lancs.ac.uk

Andreea Burcin

Lancaster University
Lancaster, UK
a.burcin@lancs.ac.uk

Ziling Xie

Lancaster University
Lancaster, UK
z.xie3@lancs.ac.uk

Xiangyu Meng

Lancaster University
Lancaster, UK
x.meng1@lancs.ac.uk

ABSTRACT

Data visualisation holds an important role in helping people better understand and perceive information. In this paper, we explore the emotional affect that anthropomorphised graphics, formed from an ecological dataset, have on people in comparison to standard charts. Additionally, we inspect a specific set of chosen attributes to determine which elicit more emotion. Our experiments were conducted in a moderated online environment, consisting of a series of surveys measuring participants' emotional attitudes based on the environmental anthropographic and charts shown. Concurring with other findings, we find that neither anthropographics nor standard charts are more effective than the other. Moreover, we discover that a combination of attributes that induced a greater positive emotional response from participants.

Author Keywords

Data Visualisation; Anthropographics; Emotion; Climate Change; Visual Embellishment; Feeling; Interactivity

INTRODUCTION

As social media proliferates information on a massive-scale and exacerbates the rate of assimilation with society [1, 2], information designers and data journalists have found opportunity to spread graphic visual representations of data. Developments in enhanced cognition through graphics to improve the human optical system's ability to perceive patterns and trends have been made permissible through the efficacy of said visualisations [3]. The illustration of *anthropomorphised data graphics* is the practice of representing data about people in such a way that it creates an immediate connection that helps an audience relate; the term *anthropographics* was

coined by J. Boy and colleagues [4], to encapsulate this meaning. Reflecting on this and the opinions of critics [5, 6, 7], we believe anthropographics can be utilised as a tool for leveraging societal awareness in the pursuit of public change.

However, what truly stimulated this research was a desire to alter the public's viewpoint towards climate change and ramifications due to ensue. A plethora of scientific papers highlighting these critical conditions [8, 9, 10, 11, 12] show that if we do not take swift and dramatic action over the next decade, we could face the collapse of civilisations, the formation of uninhabitable regions, and a forceful climate-driven exodus [13]. Seemingly, widespread coverage of environmental decline has resulted in many people becoming desensitised to the matter [14]. It is crucial that this information is widely received and not disregarded because of its ubiquity; our hope is to more transparently make individuals aware of their influence, and thus, alter their environmental propensity.

Currently, literature investigates anthropomorphised visualisations within subject areas centralised on data about people [4, 15, 16]—this study, however, aspires to bring something unconventional and unexplored to the design space of anthropographics established by L. Morais and associates [15] by experimenting with environmental data that directly affects people. In addition to this, the same researchers put forth further concepts we wish to investigate—"Customisation and targeting for compassion", suggesting efficacious user symbiosis with data when the graphic incorporates personal information. There is also an apparent demand for empirical studies that examine the effects of anthropographic design dimensions [15] to discern

in what manner users are affected, be it detrimental or beneficial.

A combination of motivation towards tackling climate change, an effort to embellish existing data gathered by J. Boy *et al.*, and gaps of knowledge presented by L. Morais *et al.* have fashioned our study and research questions into the following:

- Do anthropographics elicit more of an emotional response towards environmental data in comparison to traditional graphing methods, and,
- Which anthropographic attributes elicit more of emotional response towards environmental data?

Alongside this, we inspect the aforementioned unapproached techniques to determine their functionality and to extrapolate new empirical evidence.

A brief outline of the subsequent sections of this paper are as follows: we begin with an overview of previous related work accompanied by our resulting experimental and anthropographic designs. Next, we present the implementation, conducted experiment, and our findings. To finalise, an evaluation and analysis of the gathered data are composed, closing with a discussion of their implications.

RELATED WORK

In this section, we discuss preliminary work in the field of anthropographics. We motivate our experiments' general design with prior research on emotion and aesthetic while examining pragmatic approaches for measurement. Following that, we discuss anthropographic attributes, their implications on this study, and issues with existing approaches.

Design Space of Anthropographics

Anthropomorphism in data representation has long been a subject of study [17, 18]. Visualisation designers have often sought to utilise it as an instrument for illustration to improve viewer perception of abstract data. The idea of the *anthropographic assumption* [4], is the rationale that such visualisations have the immediate effect of creating a connection between the abstract data and viewer [6]. Many have nourished this concept, albeit, without evidence that proves or disproves it. Research is, overall, unclear on whether anthropographics really do induce empathy, compassion or inherently increase awareness of the data they represent [16, 4]. However, the extent to which anthropomorphised data has been

empirically tested with has mainly been 'silhouettes', or vague implications of the human form [4, 19]. Consequently, there is much ambiguity into terminology and design considerations in this sector.

A recently published paper by Morais *et al.* seeks to reconcile divergent ideas by proposing an amalgamation of design dimensions through a new 'design space' [15]. However, the paper stresses the incompleteness of this space and highlights the need for further research. This study, then, aims to expand the design space and provide concrete data about the effects of a portion of design dimensions.

Emotion and Aesthetic

Aesthetics and emotion are often considered to be linked, in that it can bring about satisfaction and fulfilment and a connection to people's own lives in the context of data [20, 21]. Aesthetics play an essential role in the perception of data and what people take out of it, wherein attractive graphs can prove more effective in communication, and provide higher levels of 'user patience' [22, 23]. In this way, if an emotional link can be established between the anthropographic and the viewer, we could suppose that they would be more inclined to think retrospectively about the data it represents and the broader implications. While these papers focus on more general representations of data, the idea that aesthetics and emotion do play a vital role was something to extend upon in our anthropographic study.

Papers show that 'cute' images have a positive effect on a viewer not just as an improvement to their general mood, but also in their subsequent actions [24, 25]. Affection for, or just an aesthetic like of the anthropographic, then, can be very useful in the promotion of the environmental problems we would represent through the anthropographic; in this manner, we could expect that a cute anthropographic will alter and improve user response in our study.

Measuring Emotion

Scientific literature covering emotional phenomena is vast and discombobulating; there exists no commonly agreed-upon consensus to define the features of these different types of affective phenomena [26]. We can discern at least that emotional response can be measured using three different systems – affective reports, physiological reactivity, and overt behavioural acts [27]. In 1896, Wundt discovered that differences in affective meaning among words, events, and objects can fittingly be encased by three basic dimensions

labelled pleasure, tension, and inhibition [28]. Following this discovery, much empirical work has confirmed Wundt's findings [29, 30, 31], certifying that these words are ubiquitous in categorising judgements for a broad range of perceptual and symbolic stimuli. One instance of this is Mehrabian and Russel's construction of a set of 18 different bipolar adjectives pairs known as the semantic differential scale, whose purpose is to assess the three-dimensional structure of objects, events, and situations [32].

A non-verbal pictorial assessment technique known as the Self-Assessment Manikin (SAM) provides a means of adequately measuring the physiological, emotional response of subjects through the use of graphical representations [33]. Being well-established, affective, and conventional, the method facilitates comparability between other research results in a multitude of fields. The SAM graphics consist of representations of the human body, which correlate with a nine-point scale to assess for pleasure, arousal and dominance. The study by M. Bradley et al., [34] compares the effectiveness of this technique with the aforementioned semantic differential scale. Resultingly, it is discovered that the SAM scale encapsulates holistically said adjectives, thus, illuminating an easy, inexpensive, and quick method for assessing reports of affective response [34].

Anthropographic Attributes

In this section, we explore existing strategies used to design anthropographics. We select three specific attributes that we believe to be most influential on user emotion compared to contemporary approaches [4, 35, 36, 16], in order to deduce their capabilities with empirical testing.

Visual Embellishments

Anthropographics themselves are often considered a form of visual embellishment; wherein data visualisations are given additional features to make data 'stand out' [36]—in this case, adding human qualities. A common concept among representing data is that of 'chart junk': embellishments which are not necessary to the representation of data and therefore can act as more of a distraction, or in worse cases, dubiously misrepresent data and mislead viewers [36]. There is much debate on whether these embellishments affect interpretation, or 'chart imagery' provides benefit. Further studies have been conducted [35, 37, 38, 39] into the effects of visual embellishments; many concur that higher levels of

embellishment may prefer or respond better to higher levels of embellishment in some form or another; however, most do not come to any concrete conclusion, or rather say that visual embellishments should not be any worse than standard charts, which alludes to the complexity of the subject. Our study in this respect aims to extend these studies into an empirical measurement in an anthropographic perspective, in that we aim to see to what effect embellishment of the anthropographic affects user response.

Interactivity

Previous studies confirm through their findings that the visual aesthetics and animation possess a potential of encouraging curiosity and involvement and, applying the animated feature to the visualisations, can have a "persuasive effect" on the users. Valkanova *et al.* support the idea that visualisations are made more vivid and understandable when incorporated with dynamic visual cues [40]. As Newell *et al.* [41] affirm in their study, the interactive visualisations come out as being "powerful tools" for both retaining interest and transmitting complex information to the various users. Consequently, we could reasonably expect that if the anthropographic had some form of interactivity, it would promote the user again to think about the data it represents.

Feeling

Studies show that people are more likely to '*expend greater resources*' to help singular, identifiable victims rather than a whole group, regardless of whether victims in this group are themselves identifiable or merely represented through statistics [42, 43]. Hence, we could expect that the use of the single anthropographic would incite a user to think more retrospectively. In addition to this, the emotion depicted on the graphic, henceforth described as 'feeling', is very important. In studies by Morris *et al.* and Whalen *et al.*, pictures of happy faces have been shown to activate reward-related areas of the brain, and by contrast, sad faces can also activate 'threat'-related areas [44, 45]. For example, if the graphic was depicted as 'sad', we could suppose a viewer could feel sympathetic towards it, and therefore allow reflection to the data it represents [46], but also that a user be rewarded when depicted as 'happy'.

Secondly, adding human-like qualities such as 'feeling' can promote attachment, on the grounds that people subconsciously have a tendency to 'be attracted' to things that they consider similar to

themselves, according to a paper by Berger *et al.* [47]. It affirms that a sense of familiarity can improve relationships between humans and devices. Therefore, we can assume that adding the very human quality of emotion, or ‘feeling’ in this study’s case, would lead to an increase of attachment toward the anthropographic, and therefore potentially a larger impact as to what it represents.

GENERAL METHODS AND DESIGN

In this section, we introduce the design of our anthropographics and the general study setup. We describe the structure of the experiment, which consists of an initial environmental questionnaire and experimental phases composed of eco-scenarios, emotional surveys, and sample grouping structure.

Anthropographic Design

For the total 45 anthropographics we designed, 27 were used for experimentation for reasons of practicality. The anthropographics we devised were classified ‘EarthPals’, the term by which it will be referred to for the remainder of this paper. We tailored our designs according to the design space proposed by L. Morais *et al.* [15] hoping to cover a broad range of different attributes to test. We produced the three-dimensional design scale shown below in figure 1: **interactivity**, **feeling**, and **visual embellishment**.

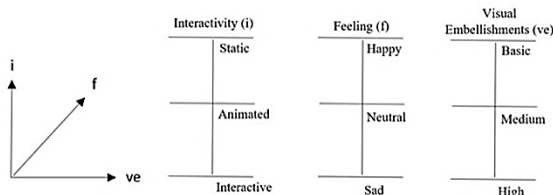


Figure 1. 3-dimensional anthropographic design scale

Interactivity

The interactivity design dimension is composed of static, animated, and interactive levels. The purpose of the static level was to act as a tool of contrast for comparison with interactivity and animation. As discussed earlier, interactivity can be used to retain interest and convey complex data [15, 41]. Figure 2 shows separately the general idea for variations in the interactivity scale, as these would be dependent on their real-time display. A similar system designed in a



Figure 2. Example permutations of EarthPal, ‘Interactive’ emphasis

project by Tanyoung *et al.* [48] discovered that users wanted “more elaborate transitions” when switching states. Figure 3 shows various animation ideas like orbiting flies, rotating clouds, twinkling stars, and other general movements like twists and turns. Animations are believed to add more “visual fun at a visceral level”, increasing engagement [48].

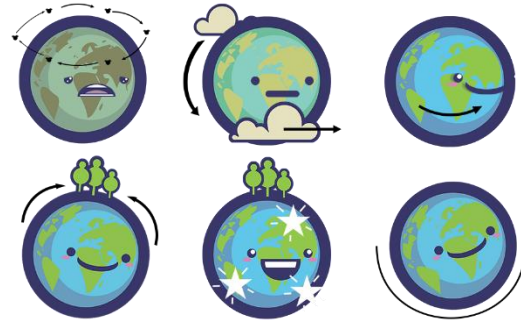


Figure 3. Ideation for animation level of interactivity dimension.

Feeling

The feeling design dimension consists of happy, neutral, and sad levels. EarthPal coincides with the ‘face chart’ anthropographic designs presented by L. Morais *et al.* [15], who describe a face as a highly distinctive attribute with high information specificity. The EarthPal was designed to be ‘cute’ in accordance with the papers by Sherman *et al.* and Nittono *et al.* [24, 25] in order to take advantage of the emotional predisposition for attachment to such images. Figure 4 shows a matrix of EarthPal graphics, over the Feeling and Visual Embellishment dimensions.

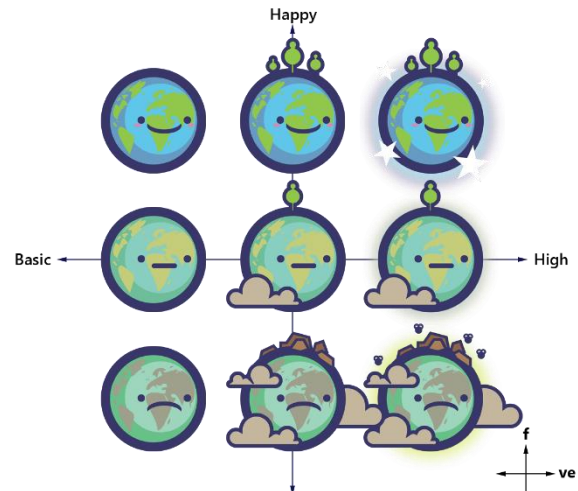


Figure 4. Matrix of EarthPals, ‘Feeling’ (f) and Detail / ‘Visual Embellishment’ (ve)

Visual Embellishment

The visual embellishment dimension is divided into basic, medium, and high levels. As we move across this dimension, more detail and decoration is placed onto the graphic; when the value is ‘high’ in particular, each graphic is inundated with respective embellishments, for example, the stars when feeling is ‘happy’, or the trash bags when feeling is ‘sad’. In line with the design dimensions constructed by L. Morais *et al.* [15], the EarthPal designs show partial authenticity because of said synthetic attributes from a non-existent dataset. Moreover, because of distinguishable and distinct embellishments, maximum granularity and specificity (ranging from low to high), show how EarthPal further reflects L. Morais’ design dimensions template.

Standard Charts

Graphs are inherently static and do not conform with the anthropographic design space we designed; it would therefore be illogical and unfair to retrofit these qualities on to the graphs. In this sense, a static, basic-detail EarthPal will be used for comparison against a basic bar-chart to answer the first research question.

General Study Design

Here, we detail the structure of the study and its components. To commence, we designed an environmental questionnaire to form a dataset of personal information unique to each individual. Following this, we devised emotional surveys, eco-scenarios and an overall experimental phase plan.

Environmental Questionnaire Design

To amass our participant’s personal data, we constructed a questionnaire on environmental consciousness in daily activities. Based on four behavioural tendencies we found in research [49], we catered our questions to their likeness. Thus, we organised them into four categories: environmental aesthetics, health-related, natural resource, and environmental protection. These mentioned classifications of environmental issues are a guideline for studying human behaviour in the environment, provided by J. Krajhanzl [49].

Most conducted questionnaires on environmental consciousness use positively phrased questions, however, based on a large-scale survey conducted by Hiramatsu *et al.* [50] it was discovered that people tend to automatically answer ‘yes’ to questions phrased in this manner. Correspondingly, we design our questions with consideration of the “yes-bias” tendency by using negatively phrased questions;

examples are shown in Table 1. All questions were made to be multiple-choice on a Likert scale from one to five; one being positive and five being negative. We generate a “palcode” for each participant based on their answers to the questionnaire, which would later be used to construct their EarthPal.

Classification	Question
Environmental Aesthetic	“How many times did you participate in environmental protection activities last year?”
Health-Related	“How often do you eat animal-based products a month?”
Natural Resource	“How much is your monthly electricity bill for your household?”
Environmental Protection	“How often do you use disposable products (e.g., a takeaway coffee cup)?”

Table 1 - Example questions for environmental propensity questionnaire.

Eco-scenario Design

We carefully crafted three descriptive eco-scenarios to guide our data collection along each level of the feeling dimension. Respectively, they would describe a small, real-world storyline related to environmental propensity within which the participants could envision themselves. They have been structured in this way to prevent participant confusion about what to rate their feelings towards. All scenarios share a two-step narrative structure, to avoid the possibility of *narrative-structure-related* confounds [4]. The ‘happy’ scenario consisting of two positive actions, the ‘neutral’ scenario—one positive and one negative action—and finally, the ‘sad’ scenario being composed of two negative actions.

Emotional Survey Design

The emotional survey uses the Self-Assessment Manikin, in particular, the ‘valence’ and ‘arousal’ metrics. We felt that the ‘dominance’ metric was not relevant to the types of emotion we wanted to research; thus, it was disregarded. The SAM Manikin was used as it represents a combination of semantic values which can be compressed and represented by one, changing graphic.

In addition to SAM, we use six selected adjectives from Mehrabian and Russel’s extensive list of semantic adjectives [32]. The six adjectives are subdivided into two groups of three, one being

positive, the other negative. The positive emotions are pride, hope, and compassion. The negative emotions are anxiety, stress, and guilt. Our selection of these adjectives was motivated by the following interest points:

- *Pride*: Can EarthPal make people feel proud when they are helping the environment?
- *Hope*: Do people feel more hope towards a better future if EarthPal shows them they are doing well?
- *Compassion*: Can people feel compassion for EarthPal when it is suffering?
- *Anxiety*: Do people feel anxious when EarthPal shows them negative data?
- *Stress*: Will stress levels increase if EarthPal isn't doing well?
- *Guilt*: Do people feel responsible? Will they feel guilty if their EarthPal is not well?

Experimental Phases

The general procedure design of this experiment consists of two phases: a personal phase and a scenario phase, permitting us to study the effects of personalised data and generalised data. Both phases inherit from the following general procedure:

1. An EarthPal or graph is shown to the user in an arbitrary order.
2. The user records their emotional response through a survey.
3. Steps 1 and 2 are repeated 10 times.

For the scenario phase, the participant will be shown a graph or EarthPal according to the relevant level of the feeling dimension corresponding to the scenario. For the personal phase, the EarthPals shown reflect answers gathered by the initial environmental questionnaire taken before the experiment. Thereby, the participant is placed within one of three levels of the feeling dimension. The order of these phases will be randomised to minimise the effects of anthropomorphic carry-over [4].

Sample Selection & Grouping

Due to the ongoing COVID-19 pandemic and time constraints, our accessible population was limited to family or acquaintances. From previous findings [4], we found that women are more generally empathetic than men. Thus, we decided to split gender amongst the population evenly to draw a more fair sample.

As we expected to gather no more than 30 participants, we decided to perform a within-subjects study. This

would reduce the error associated with individual difference and solve the problem of not having a large pool of participants. Each participant is therefore required to be tested on all independent variables, allowing better generalisation of the population and increasing external validity.

TESTING THE ANTHROPOGRAPHICS

In this section, we introduce background into the development and running of the facilitating application used in the study. We detail the selection and distribution of questionnaires, problems that occurred before the study commenced, before finally highlighting our hypotheses for the experiment.

Expo Application

An *Expo* application was created to facilitate the purpose of survey distribution and anthropographic display; this consisted of a mobile application that can be run natively on phones through *Expo*, but without the requirement of it being uploaded to an 'app store'. In this way, the application assisted the display particularly of the interactivity dimension, where the user is able to touch the EarthPal at a time of their choosing, and it will react accordingly. The application was distributed to each participant through a QR code that could be scanned in-app. Then, the application simply allowed the user to input their Palcode and then execute the study as previously described. The results of the surveys undertaken are then sent via email (using Gmail's SMTP server) to a dedicated account, and compiled into a .csv file, ready for data analysis.

Participants and Procedure

In total, we gathered 24 participants, of which there was an even gender split (12 male, 12 female) in accordance with the sample grouping design; none of the selected participants identified outside of this binary. To prevent breaking country-wide restrictions, the participants were gathered through various communication methods, and the moderated experiment was conducted online using applications such as Microsoft Teams or Skype. Researchers were present during experimentation to provide answers to any participant questions.

The initial environmental questionnaire was created and distributed via Qualtrics prior to their participation in the moderated portion of the study. As mentioned previously, during the use of the app participants were shown, for both phases, each possible combination of the interactivity and the visual embellishment for the current value of feeling. Resultingly, for each

scenario, they were shown ten surveys: one for the graph, and nine for the various anthropographic forms. Each participant was therefore required to complete 40 surveys, wherein 10 were related to their personal EarthPal based on their answers to the original questionnaire, and 10 for each of the three eco-scenarios, totalling 30 for this phase.

Animation Constraints

Unfortunately, due to time constraints, we were restricted on the number of animations we could implement, reducing to two: a pop-in animation that played every time EarthPal was shown to the user, followed by a ‘bobbing’ animation in which the EarthPal moves in a slow up-and-down motion. Interactivity was unaffected, in that the user was still able to when applicable touch the anthropographic and it would ‘respond’.

Hypotheses

We propose the following hypotheses based on the research questions presented in the introduction section:

- **H1** – Anthropographics elicit a higher emotional response towards environmental data compared with graphs.
- **H0** - Anthropographics do not elicit more of an emotional response towards environmental data compared to graphs.

RESULTS

Results for participants’ feelings of valence, arousal, pride, hope, compassion, anxiety, stress, and guilt were successfully recorded through the application. However, the results for arousal were excluded from this stage of data analysis due to confusion around its definition, as well as its lack of any correlation with any of the other metrics/dimensions.

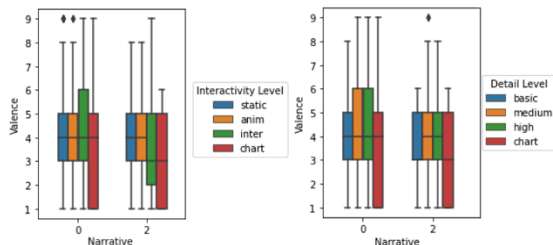


Figure 5. Box Plot showing the participants’ valence responses for their personal data (narrative 0) vs the neutral EarthPal (narrative 1)

Results were obtained from each of the participants regarding their emotional response to the visualisations of their personal data, generated from the initial questionnaire, as well as their responses to the three eco-scenarios (being “sad”, “neutral” and “happy” on the feeling dimension). Unfortunately, 92% of the people taking part in the study received a “neutral” EarthPal for their personal visualisation, and so we were unable to formulate any concrete conclusions regarding the effect of personal data on the participants’ emotional response. We believe the lack of any significant differences (which is noticeable in figure 5) between the personal visualisations and the narratives could be due to what we refer to as the “narrative identification confound”, whereby participants may not necessarily identify with the results, or due to the carry-over effect as almost all participants were exposed to the neutral EarthPal twice may have just attempted to answer as they did previously.

Research Question 1

Mean Valence of Charts vs Anthro

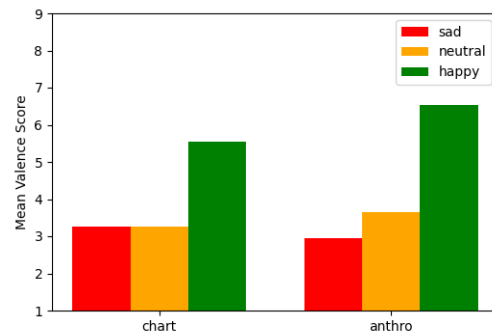


Figure 6. Bar chart showing mean valence for charts vs anthropographics

To answer the question “Do anthropographics elicit more of an emotional response toward environmental problems in comparison to traditional graphing methods”, we compared the mean valence for charts vs static, low detail anthropographics, to make a fair comparison, due to the static, low-level detailed nature of the charts. In figure 6, you can see that (based on the mean results) participants experienced slightly higher levels of valence when viewing the neutral and sad anthropographics when compared with the charts. However, upon performing the Wilcoxon signed-rank test (with a threshold of 0.05 for statistical significance), we found that there was less than a 5% probability that our results would be reproduced when assuming the null hypothesis (H0, detailed previously)

is correct. This was the case for all levels of the feeling dimension, so while there is a small difference it was not significant enough to confirm that anthropographics are more effective than traditional visualisation methods (graphs) at eliciting an emotional response, which corresponds with findings in the paper by Boy et al. [4]. Therefore, there is not enough evidence to support our hypothesis (H1) or reject H0, so we conclude that charts and anthropographics have similar effects on valence.

Research Question 2

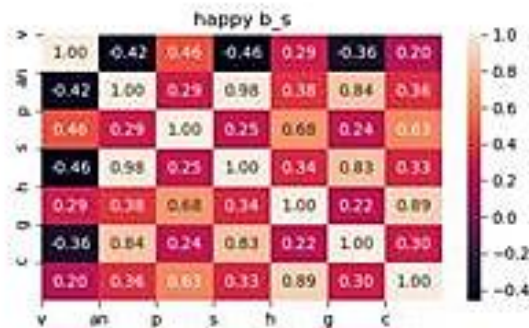


Figure 7. Example Spearman rho correlation matrix for data from the “happy” feeling dimension, “basic” visual embellishment and “static” interactivity

In order to determine whether “anthropographic attributes elicit more of an emotional response towards environmental data”, we plotted 27 Spearman rho (ρ) correlation matrices (an example of which can be seen in figure 7). After a careful analysis of these matrices for all detail and interactivity levels, we found the following for each feeling dimension:

- **Sad Dimension:** We found that there was a statistically significant positive correlation between anxiety and stress, with $\rho > 0.75$. This is to be expected; however, we also found an unexpected correlation with pride and hope for both the basic and medium levels of the detail dimension. This could be due to the narrative identification confound, as the participants’ may not have related to the actions taken by the character within the ‘sad’ narrative, and/or due to a semantic category misunderstanding.
- **Neutral Dimension:** There were no statistically significant correlations between any of the attributes for this feeling dimension, implying a large variation in results. This could be because the neutral EarthPal does not convey any inherent/obvious emotional information, which could have led to some ambiguity as to whether

this is a “good” or “bad” result – which would likely lead to highly varied results as we have observed.

- **Happy Dimension:** After cross-validating various charts, we found a statistically significant correlation (where $\rho > 0.75$) between anxiety, stress and guilt for the happy feeling dimension. This is as one would expect, as people would be less likely to feel negative emotions when shown the “Happy” anthropographic. We also found a significant correlation between hope and pride (where $\rho > 0.75$) specifically when the anthropographic had a high detail level coupled with “animated” or “interactivity” as its interactivity level, showing that these specific attributes do have an impact on the participant’s emotional response for the happy dimension.

So, to answer the research question: we can conclude that some specific attributes do indeed elicit more of emotional response. Namely, the attributes that were identified were a combination of high detail and either “animated” or “interactive” for the interactivity level, which cause a greater positive emotional response. However, this was only the case when the feeling dimension was “happy”.

Male vs Female

Our results showed that gender did not seem to impact the participants’ emotional response(s), as the differences for each of the measures were nearly identical, with some insignificant differences. The only measure that indicated a slight difference was compassion.

The male participants’ responses were quite dispersed, many picking options at either extreme end of the spectrum and there was no noticeable change in results when interactivity or detail was increased. Females’ responses differed in that they were more concentrated for both detail and interactivity, and whilst there was no noticeable change in compassion between detail levels there was a slight positive correlation between compassion and interactivity levels. These results simply indicate that females may be slightly more influenced by the interactivity level than with male participants when it comes to their feelings of compassion, however, there was not enough evidence to support the claim that any one gender is more compassionate than the other.

EVALUATION OF RESULTS

In summary, the results of this paper show that in this context, the use of anthropographics—in this case EarthPal—does not provide any real benefit over traditional graphing methods, except in specific contexts. In addition, when delving deeper into analysing the differences in the intermediate dimensional values (being ‘feeling’, ‘detail’ and ‘interactivity’) between anthropographics, we found the dimension that had the biggest influence on the participants’ response was the feeling dimension, particularly when looking at the valence. The ‘sad’ and ‘neutral’ narratives had similar responses, albeit with a slight negative tendency for the sad narratives, and the ‘happy’ narratives resulted in a significantly higher valence on average.

It is important to look retrospectively at the study to understand how these results may have arisen. 92% of people received a neutral EarthPal after completion of the survey, which meant that comparison of personal and non-personal data was made more difficult as it had restricted comparison to ‘neutral’ on both sides, it would not have been fair to observe valence for other values of the feeling dimension. This could explain the lack of observed difference, as the graph and the EarthPal do not differentiate between personal data and the spoofed narrative data resulting in the anthropomorphic carry-over effect.

The animations used in the study were limited to a simple up-and-down idle motion and pop-in motion that played while interactivity was ‘animated’ and above, as well as a change in expression when pressed for the ‘interactive’ EarthPal. This carries the notion that perhaps participants did not observe enough difference between the varying versions of the EarthPal for there to be a substantial change in their survey results for each.

GENERAL DISCUSSION

Contrary to our initial expectations, the findings of this study are similar to previous work that explores the same research area [4]. The difference in our results that could indicate that anthropographics would be a better visualisation tool to elicit a higher emotional response was not significant enough to build a strong statement. Although our study tried to overcome the limitations of related papers and implement suggestions from their recommended future work, the outcomes were somewhat similar, in that we could not support preliminary beliefs.

Limitations

The experiment was undertaken with limited participants known to the researchers due to the COVID-19 pandemic, which could have led to a selection bias wherein the participants may have answered differently due to a prior connection, thereby leading to results that may not be representative of how the general public would respond to visualisations shown. Additionally, the test could not be performed under a constant environment, regarding lighting, for example, which could have led to an environment bias wherein external factors may have influenced results. It is unclear if this had an impact on people’s responses.

We found that the experiment’s length was an issue, that could have been solved through a pilot-study if time permitted. With 40 surveys to complete, participants reported feeling ‘bored’ and increasingly ‘indifferent’ as exposure to the EarthPal and related surveys continued. In addition, a common confusion was that a user would have to complete surveys for the same value of the feeling dimension twice due to the separation of personal data and the narratives. During the monitored sessions, a few participants felt as if they were in an “infinite loop”, believing that they were being shown the same, or a very similar graphic repeatedly through each survey. This created lassitude and annoyance, which may have confounded the participants’ feelings.

On a separate note, some of the selected semantic adjectives were out of context and highly unlikely to apply to the shown anthropographic. For example, it would be unusual for participants to experience anxiety when shown the happy EarthPal. Some users misunderstood what the semantic adjectives applied to, for instance, stating that “they felt hopeful that the EarthPal would improve”, when rating their feeling of hope after being shown a ‘sad’ EarthPal.

Technical Challenges

Some users experienced technical difficulties during the installation and use of the EarthPal app, as it was not available on an ‘app store’ and required a third-party app to be downloaded. In addition, the application was not functional on iOS devices due to a foresight where it was not known that Apple did not allow the execution of uncertified apps; this required use of a browser version which was slow and buggy, which may have led to a frustration bias. We also found that some elements were not displayed correctly on smaller screen sizes, namely the text that indicates

that an EarthPal is ‘interactive’, which likely caused confusion when the interactivity dimension was ‘animated’ or ‘interactive’ as they both initially appeared the same. This may have affected the results from some of the participants if they were not explicitly told by the one supervising their study.

Future Work

There is a vast ocean of opportunity for further work in this growing field of anthropographics. To begin with, analysing a range of different ages could reveal disparities and bring forth interesting results. The age range of our study participants was widely distributed. It would have been interesting to see, for instance, whether younger aged participants felt more in tune with technology, and thus, responded to the anthropographics with more emotion than participants from older generations.

Under different circumstances, forthcoming extensions of this research project could explore how the proposed study performs with participants unknown to the researchers. Further, it would be interesting to measure user environmental attitude or propensity before participant recruitment, in order to analyse what emotions people with negative environmental propensity felt compared to people with positive environmental propensity.

Regarding the design of the EarthPal, the addition of different human-like attributes, such as arms and eyebrows, would be another interesting aspect to study. As mentioned earlier in the related work section, people subconsciously tend to be attracted to things that look like themselves [47]. It would be interesting to explore how effective each specific human-like attribute is towards affirming that sense of familiarity and increasing emotional response. It would have also been interesting to offer a wider variety of animations and interactions, particularly as we had designed many animations and interactions that could not be implemented due to time constraints. Additionally, other forms of media, such as sound effects could be applied to see how these affect participant emotional responses.

CONCLUSION

In summary, the main finding of our research was that we were not able to statistically prove that using anthropographic visualisations would overall elicit more of an emotional response when compared to more basic visualisations methods – bar charts in the current context. Therefore, regarding the first research

question, the study did not present enough evidence to confirm the anthropographic assumption or reject the null hypothesis. For the second research question, there was a slightly more clear answer. When studying the participants’ responses, the anthropographics that were placed at an “animated” or “interactive” level on the interactivity scale, in combination with the “high” detail dimension, resulted in eliciting more of an emotional response.

As previously mentioned in the results section of this paper, which addresses in more detail the implications of this study’s findings, neither the participant’s gender nor the personal data had any significant effect over the results. Personal data did not present any meaningful difference or advantage over the scenario data, but this could have been due to users having to see the same graphic twice.

The area of anthropographics will certainly constitute a subject of other future research; therefore, this study can serve as a template off of which to expand further. The results obtained in this study should not discourage future attempts in exploring the area of anthropographics.

ACKNOWLEDGEMENTS

We would like to acknowledge the support of our supervisors for their advice and valuable input during all stages of this project. We are also thankful to all participants that agreed to take part in our study.

REFERENCES

- [1] C. Ferguson, S. C. Inglis, P. J. Newton, P. J. Cripps, P. S. Macdonald and P. M. Davidson, Social media: a tool to spread information: a case study analysis of twitter conversation at the Cardiac Society of Australia & New Zealand 61st annual scientific meeting 2013., vol. 21, Collegian, 2014, pp. 89-93.
- [2] M. D. Vicario, G. Vivaldo, A. Bessi, F. Zollo, A. Scala, G. Caldarelli and W. Quattrociocchi, “Echo chambers: Emotional contagion and group polarization on facebook,” Scientific reports, 2016.
- [3] M. Smiciklas, The Power of Infographics: Using Pictures to Communicate and Connect with Your Audiences, Que Publishing, 2012.
- [4] J. Boy, A. V. Pandey, J. Emerson, M. Satterthwaite, O. Nov and E. Bertini, “Showing

- people behind data: Does anthropomorphising visualisations elicit more empathy for human rights data?," in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*, 2017.
- [5] S. Lambert, "And What Do I Do Now? Using Data Visualization for Social Change," 23 January 2016. [Online]. Available: <http://artisticactivism.org/2016/01/data-visualization-for-what/>. [Accessed 5 January 2021].
- [6] J. Harris, "Connecting with the Dots," *The New York Times*, 15 January 2015. [Online]. Available: <https://source.opennews.org/articles/connecting-dots/>. [Accessed 5 January 2021].
- [7] S. Slobin, "What If the Data Visualization Is Actually People?," 24 April 2014. [Online]. Available: <https://source.opennews.org/articles/what-if-data-visualization-actually-people/>. [Accessed 5 January 2021].
- [8] J. Hansen and M. Sato, "Regional Climate Change and National Responsibilities," *Environ. Res. Lett.*, New York, 2016.
- [9] R. T. Watson, M. C. Zinyowera, R. H. Moss and D. J. Dokken, "The regional impacts of climate change," IPCC, Geneva, 1998.
- [10] P. J. Beggs, "Impacts of climate change on aeroallergens: past and future," *Clinical & Experimental Allergy*, 2004.
- [11] C. Bellard, C. Bertelsmeier, P. Leadley, W. Thuiller and F. Courchamp, "Impacts of climate change on the future of biodiversity," *Ecology Letters*, 2012.
- [12] C. D. Harley, A. R. Hughes, K. M. Hultgren, B. G. Miner, C. J. Sorte, C. S. Thornber, L. F. Rodriguez, L. Tomanek and S. L. Williams, "The impacts of climate change in coastal marine systems," *Ecology letters*, 2006.
- [13] M. P. Gessellschaft, "Climate-exodus expected in the Middle East and North Africa: Part of the Middle East and North Africa may become uninhabitable due to climate change.," *ScienceDaily*, 2 May 2016. [Online]. Available: <https://www.sciencedaily.com/releases/2016/05/160502131421.htm>. [Accessed 5 January 2021].
- [14] B. Bloodhart, J. K. Swim and E. Diccico, "'Be Worried, be VERY Worried:' Preferences for and Impacts of Negative Emotional Climate Change Communication," *frontiers in communication*, 2019.
- [15] L. Morais, Y. Jansen, N. Andrade and P. Dragicevic, "Showing Data About People: A Design Space of Anthropographics," *IEEE Transactions of Visualization and Computer Graphics*, 2020.
- [16] L. Morais, D. Sousa and N. Andrade, "Evaluating a Situated and Physical Anthropographic: An In-the-Wild Study," CHI, 2020.
- [17] A. Joseph, "Anthropomorphism in science," *PhilArchive*, 1973.
- [18] J. A. Fisher, "Disambiguating anthropomorphism: An interdisciplinary review," *Perspectives in ethology*, 1991.
- [19] A. Ivanov, K. Danyluk and W. Willet, "Exploration & Anthropomorphism in Immersive Unit Visualisations," CHI, 2018.
- [20] P. Wright, J. Wallace and J. McCarthy, "Aesthetics and experience-centered design," *ACM Transactions on Computer-Human Interaction*, vol. 15, no. 4, 2008.
- [21] J. McCarthy and P. Wright, "Technology as experience," *Interactions*, vol. 11, no. 5, pp. 42-43, 2004.
- [22] N. Cawthon and A. Van de Moere, "The Effect of Aesthetic on the Usability of Data Visualization," in *2007 11th International Conference Information Visualization (IV '07)*, Zurich, 2007.
- [23] H. Kennedy and R. L. Hill, "The Feeling of Numbers: Emotions in Everyday Engagements

- with Data and Their Visualisation,” *Sociology*, vol. 52, no. 4, pp. 830-848, 2018.
- [24] G. D. Sherman, J. Haidt and J. A. Coan, “Viewing Cute Images Increases Behavioral Carefulness,” *Emotion*, vol. 9, no. 2, pp. 282-286, 2009.
- [25] H. Nittono, M. Fukushima, A. Yano and H. Moriya, “The Power of Kawaii: Viewing Cute Images Promotes a Careful Behavior and Narrows Attentional Focus,” *PLoS ONE*, vol. 7, no. 9, 2012.
- [26] K. R. Scherer, “What are emotions? And how can they be measured?,” SAGE Publications, London, 2005.
- [27] J. L. Peter, “The mechanics of desensitisation and the laboratory study of human fear,” *Behavioural therapy: Appraisal and status*, New York, 1969.
- [28] W. Wundt, “Grundriss der Psychologie (Outlines of Psychology),” Leipzig: Entgelmann, 1896.
- [29] O. C, “The nature and measurement of meaning,” *Psychological Bulletin*, 1952.
- [30] C. Osgood, G. Suci and P. Tannenbaum, “The measurement of meaning,” University of Illinois, Urbana, 1957.
- [31] M. A, “A semantic space for nonverbal behaviour,” *Journal of Consulting and Clinical Psychology*, 1970.
- [32] A. Mehrabian and J. A. Russel, “An approach to environmental psychology,” MIT, Cambridge, 1974.
- [33] P. J. Lang, “Self-assessment manikin,” The Center for Research in Psychophysiology, University of Florida, 1980.
- [34] M. B. Margaret and J. L. Peter, “Measuring Emotion: The Self-Assessment Manikin And The Semantic Differential,” Pergamon, University of Florida, 1994.
- [35] A. Abdul-Rahman, R. Borgo, F. Mohamed, P. W. Grant, I. Reppa, L. Floridi and M. Chen, “An Empirical Study on Using Visual Embellishments in Visualization,” *IEEE Transactions on Visualization and Computer Graphics*, vol. 18, no. 12, pp. 2759-2768, 2012.
- [36] S. Bateman, R. L. Mandryk, C. Gutwin, A. Genest, D. McDine and C. Brooks, “Useful Junk? The Effects of Visual Embellishment on Comprehension and Memorability of Charts,” in *CHI 2010: Graphs*, Atlanta, 2010.
- [37] J. Kulla-Mader, “Graphs via Ink: Understanding How the Amount of Non-Data Ink in a Graph Affects Perception and Learning,” February 28 2019. [Online]. Available: <https://doi.org/10.17615/kfb3-2149>. [Accessed 5 January 2021].
- [38] J. D. Kelly, “The Data-Ink Ratio and Accuracy of Newspaper Graphs,” *Journalism Quarterly*, vol. 66, no. 3, pp. 632-639, 1989.
- [39] D. Skau, L. Harrison and R. Kosara, “An Evaluation of the Impact of Visual Embellishments in Bar Charts,” *Computer Graphics Forum*, vol. 34, no. 3, pp. 221-230, 2015.
- [40] N. Valkanova, S. Jorda, M. Tomitsch and A. Van de Moere, “Reveal-it! the impact of a social visualisation projection on public awareness and discourse,” in *CHI '13: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, Paris, 2013.
- [41] R. Newell, A. Dale and C. Winter, “A picture is worth a thousand data points: Exploring visualisations as tools for connecting the public to climate change research,” *Cogent Social Sciences*, vol. 2, no. 1, 2016.
- [42] A. Genevsky, D. Västfjäll, P. Slovic and B. Knutson, “Neural Underpinnings of the Identifiable Victim Effect: Affect Shifts Preferences for Giving,” *Journal of Neuroscience*, vol. 33, no. 43, pp. 17188-17196, 2013.
- [43] K. Jenni and G. Loewenstein, “Explaining the Identifiable Victim Effect,” *Journal of Risk and Uncertainty*, vol. 14, pp. 235-257, 1997.

- [44] J. Morris, C. Frith, D. Perrett, D. Rowland, A. Young, A. Calder and R. Dolan, "A differential neural response in the human amygdala to fearful and happy facial expressions," *Nature*, vol. 383, pp. 812-815, 1996.
- [45] P. J. Whalen, S. L. Rauch, N. L. Etcoff, S. C. Mclnerney, M. B. Lee and M. A. Jenike, "Masked Presentations of Emotional Facial Expressions Modulate Amygdala Activity without Explicit Knowledge," *Journal of Neuroscience*, vol. 18, no. 1, pp. 411-418, 1998.
- [46] S. Darwall, "Empathy, Sympathy, Care," *Philosophical Studies: An International journal for Philosophy in the Analytic Tradition*, vol. 89, no. 2/3, pp. 261-282, 1998.
- [47] C. R. Berger and J. J. Bradac, *Language and social knowledge: Uncertainty in interpersonal relations*, Hodder Education, 1982.
- [48] T. Kim, H. Hong and B. Magerko, "Design requirements for ambient display that supports sustainable lifestyle," in *DIS '10: Proceedings of the 8th ACM Confrence on Designing Interactive Systems*, New York, 2010.
- [49] J. Krajhanzl, "Environmental and proenvironmental behaviour," *Health Education: International Experiences*, 2010.
- [50] A. Hiramatsu, K. Kurisu and K. Hanaki, "Environmental Consciousness in Daily Activites Measured by Negative Prompts," MDPI, Tokyo, 2015.
- [51] M. Farrugia and A. Quigley, "Effective Temporal Graph Layout: A Comparative Study of Animation versus Static Display Methods," *Information Visualization*, vol. 10, no. 1, pp. 47-64, 2011.
- [52] N. Epley, A. Waytz and J. T. Cacioppo, "On seeing human: A three-factor theory of anthropomorphism," *Psychological Review*, vol. 114, no. 4, pp. 864-886, 2007.