Critical Review: Improving the Efficacy of Games for Change Using Personalization Models

Introduction

Persuasion is the act of influencing or reinforcing certain attitudes and behaviours [Khaled et al., 2008]. The use of technology for encouraging behavioural change to benefit its users or the wider community is a long-term area of research [Fogg, 2002]. This review summarises and critical analyses Orji et al. [2017] whose paper explores the use of personalisation models as a persuasive device for improving the efficacy of games which are designed to change user behaviour, as well as putting forward a set of suggestions for future work in this domain of Persuasive Technology.

Summary of Contributions

Orji et al. [2017] highlight the rising prominence of *games for change*[1] that are designed for purposes other than entertainment, to effectively educate players about certain topics in a way that influences their behaviour [Busch et al., 2015]. The authors raise the issue that many such games are designed with a "*one size fits all*" philosophy whereby the design of the game itself (and its adopted persuasive *strategies*) are not tailored to the *type* of the player. Orji et al. [2017] therefore seek to answer two main research questions to understand the observed efficacy of certain strategies in existing games [Peng, 2009, Kaipainen et al., 2012]. Firstly, whether tailoring games for change to a specific player type increases their persuasiveness. Secondly, if beneficial effects of tailoring are observed, whether these effects are mediated by an improved play experience. By answering these, results could inform the future decisions of games designers in which persuasive strategies they adopt to maximise efficacy in certain player types.

Treating user groups in a monolithic way is generally considered dangerous, especially in the domain of games for health [Berkovsky et al., 2010]. To further justify the need to investigate tailoring, the authors then reviewed the persuasive strategies adopted in a range of existing domains of games for change: healthy eating [Kaipainen et al., 2012, Orji et al., 2013b], physical activity [Fujiki et al., 2008] and disease management [Brownson and Kumanyika, 2007]. The authors, by their own admission, comment that this list is not exhaustive which gives great scope for future research in other domains. However, as the authors highlight in their review of existing systems, there is little work on isolating the persuasive strategies employed in these games to study their effects on specific types of gamer. This makes a strong case for their research in this respect.

To evaluate their research questions, Orji et al. implemented two versions of a custom model-driven

[1] An annual festival exists for workshops and design classes on games for change: `www.gamesforchange.org`

online game called *Junk Food Aliens* (Figure 1) which targets the domain of healthy eating - players control an avatar and search for fruits and vegetables to save the planet from an invasion of junk foods. The reward-based version (JFA-R) adopted persuasive strategies such as achievement badges (Figure 3) whereas the competition-based version (JFA-C) adopted comparative strategies such as leaderboards displaying fictional scores of opponents (Figure 2).

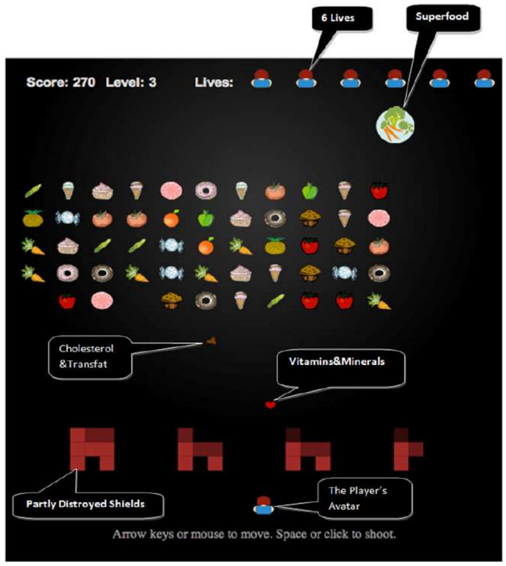
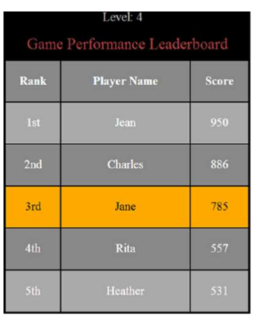


Figure 1: "Junk Food Aliens" (JFA): A persuasive game designed to change gamer behaviour towards healthy eating.



Level: 4

Game Performance Leaderboard

Rank	Player Name	Score
1st	Jean	950
2nd	Charles	886
3rd	Jane	785
4th	Rita	557
5th	Heather	531

Figure 2: JFA-C: Competition-based version of JFA.

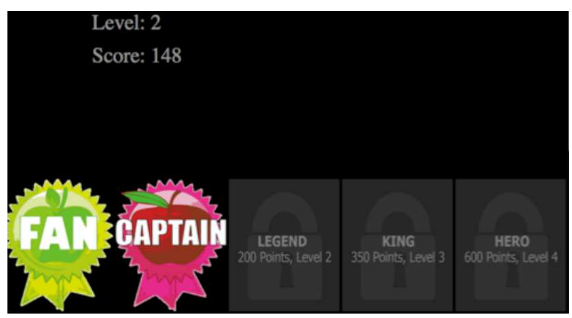


Figure 3: JFA-R: Reward-based version of JFA.

Main contributions of Orji et al. [2017] are fourfold. First, it is important to tailor games for change in order to observe any efficacy as the main experiment demonstrates by measure of change in attitude, self-efficacy, and intention. Second, tailoring can be achieved by modifying the persuasive strategies adopted, rather than the mechanics of the game which will surely minimise the tailoring costs involved. Thirdly, the resulting positive effect of tailoring was not seen to be mediated purely by an improved player experience which, if it remained untested, would be a very strong potential confounding factor. Finally, the adoption of a single persuasive strategy is sufficient to observe these effects - combining additional strategies is unpredictable and may be somewhat counter-productive.

Justifications for Conclusions

Initial work by the authors suggested that a strategy shown as effective for one type of gamer could be detrimental to another [Orji et al., 2013a] (Table 1). This table of results sets out a well-founded taxonomy which maps 7 independent gamer types defined by the BrainHex model of Nacke et al. [2014] against 8 commonly adopted persuasive strategies selected by Gerling et al. [2014] based on a large-scale online survey of 1108 gamers. Participants responded to the survey to indicate how likely each of 10 selected strategies would influence eating decisions, using a validated scale [Drozd et al., 2012] before completing the BrainHex questionnaire to indicate their gamer type. After careful statistical analysis (Exploratory Factor Analysis and PLS-SEM modelling) 8 strategies were chosen which were pairwise distinct. The data collected from this initial experiment therefore forms as valid justification for the later comparison between Achievers (motivated by Reward) and Conquerors (motivated by Competition).

Table 1: β values confusion matrix: Strength of motivation of different players that result from different strategies. Positive β values indicate that gamers of this type are motivated by the corresponding given strategy. Negative β values indicate demotivation, whilst an empty value indicates neither motivation nor demotivation [Orji et al., 2013a].

Strategies / Gamer type	CMPT/ CMPR	COOP	CUST	PERS	PRAS	SEMT/ SUGG	SIML	REWD
Achiever	-	.15	-	-	-	.10	-	.10
Conqueror	.25	-	-	.12	-	.12	.14	-
Daredevil	-.10	-	-	-	-	-.14	.11	-
Mastermind	.12	-	.10	.12	-	.14	.12	-
Seeker	.10	-	.19	.11	.10	-	-	-
Socializer	.11	.17	-.12	-	-.12	-.13	-	-
Survivor	.17	-.20	-.13	-	-	.27	-	-.14
CMPT/CMPR = competition and comparison, COOP = cooperation, CUST = customization, PERS = personalization, PRAS = praise, SEMT/SUGG = self-monitoring and suggestion, SIML = simulation, REWD = reward.								

As a way of empirically evaluating this model, for the rest of the paper the authors focus on the domain of games for healthy eating and restrict their considerations towards the effects of two persuasive strategies (Competition and Reward) on two types of gamers (Achiever and Conqueror). Whilst somewhat limiting in scope, this approach allowed direct comparison between types of gamers shown empirically to be significantly-distinct in their response to these strategies [Orji et al., 2013a]. Furthermore, these strategies are also common to existing games [Bell et al., 2006] and these player types are equally dominant [Bartle, 1996].

Participants were recruited online via Amazon's Mechanical Turk (AMT) using Mason and Suri [2012] as a reference. The authors recognise this as a trade-off between having a large selection pool in return for greater difficulty ensuring participant motivation or attentiveness, leading to a potential loss of some generalisability in results. After two pilot studies ($N = 40, N = 4$) had verified experimental and instrumental validity, a large-scale randomized controlled online study of 272 valid participants (117 female, 155 male - 50% Achievers and 50% Conquerors, all game-players) was carried out to investigate the effects of tailoring and contra-tailoring on these two types of gamer in a between-subjects design. In this sense, half of Achievers played JFA-R (tailored) and the remaining half played JFA-C (contra-tailored), and vice versa for the Conquerors (tailored played JFA-C and contra-tailored played JFA-R). Participant selection was therefore weakened by its focus on self-selected experienced gamers who are not the prime target audience for games for change [Brox et al., 2011].

Before playing the game, participants completed a BrainHex survey [Nacke et al., 2014], demographic survey and responded to 3 scales designed to measure their baseline attitude, intention and self-efficacy towards healthy eating based on Ajzen [2002]. Once gameplay began, interruptions were displayed after each minute had elapsed, to show rewards or the leaderboard in JFA-R and JFA-C respectively. After participants finished playing their assigned version of JFA for 20 minutes, they responded to the same 3 scales to measure their post-task attitude, intention and self-efficacy towards healthy eating. Finally, they also assessed their experience (enjoyment, effort, competence and tension) [Ryan et al., 2006]. Results showed that tailoring the game to a specific gamer type increased effectiveness (measured by the positive changes in attitudes, intentions and self-efficacy towards healthy eating) while contra-tailoring did not (Figure 4).

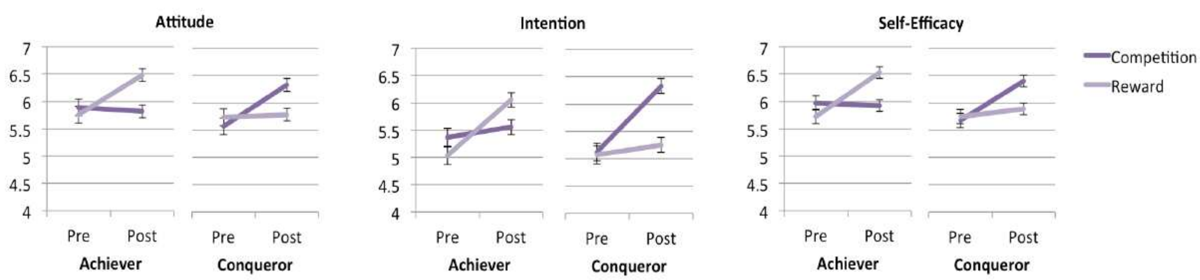


Figure 4: Mean values ± SE for Attitude, Intention, and Self-Efficacy by Gamer type (Achiever, Conqueror) and Game version (Competition, Reward).

Use of parallel mediated regressions [Hayes, 2013] showed that the positive effects of tailoring were not mediated by improved player experience which provides strong support in favour of tailoring games to player type (Figure 5).

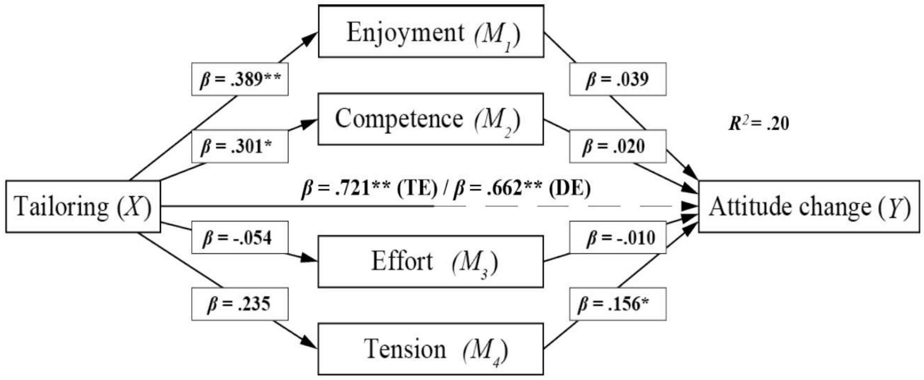


Figure 5: Parallel mediation model of tailoring on attitude change with play experience as mediator.

Overall, there is a respectable amount of evidence to support the authors' claims. The number and representativeness of the participant sample has been carefully considered, with the limitations of using AMT discussed.

Limitations and Suggested Further Work

Whilst the findings of the main experiment are convincing, well designed and validated with a good report on parametric data gathered, there are a series of limitations and unanswered questions that must be considered.

Orji et al. appreciate that the scoping of their original taxonomy by the main experiment to focus only on Achievers and Conquerors under Reward and Competition strategies respectively should encourage future research on different combinations of strategies and different gamer types. The authors recognise that their current research limits itself to the measure of change in attitude, intention, and self-efficacy toward healthy eating which immediately prompts questions about its effects on *tangible* changes in behaviour, rather than effects on *mediators* or precursors of behaviour change. Also, although purely illustrative, the domain choice of healthy eating should not limit investigations - by applying their model to other domains such as disease management and physical activity, it will be possible to decipher whether the effects of the persuasive strategy employed are domain-dependent.

Ideally, participant selection should be via a source where intrinsically motivated rather than AMT where not all participants may be psychologically engaged in tasks affecting generalisability of results. It would also be novel to explore the adoption of a single persuasive strategy compared with use of multiple in a given game, to observe whether compounding effects are positive or negative on efficacy of behaviour change. Now that we are aware that player experience does not mediate the observed benefits, it would be wise to also consider whether game performance as a potential mediating factor as well - players who perform better in the game under a given strategy may experience more positive feeling towards the tailored game which could influence the observed results. Finally, the current approach is somewhat static in nature once participants are assigned to a given gamer type. Answers to the BrainHex questionnaire are what determines a player's type. Instead, it might be interesting to explore the avenue of determining a player's type in a more dynamic sense, perhaps during actual gameplay based on activity or game events.

Another novel suggestion to build on these findings is to experiment with existing gamification applications for physical exercise such as Apple Watch and Nike+ GPS, instead of focusing purely on games for change. By expanding into this area, this might require re-evaluation of the strategies originally selected by Gerling et al. [2014].

Conclusion

Orji et al. [2017] put forward a compelling and convincing case for personalising persuasive strategies employed in future games for change in order to observe effective change in behaviour. Whilst there are certain limitations to their work, it lays strong foundations for future work investigating tailoring games for change in other domains. These findings also have potentially wider consequences in the domain of Persuasive Technology - with recommendations on how to tailor to specific groups of users whilst minimising the efforts and costs involved in doing so, designers of these technologies could better-understand the considerations needed when matching a persuasive strategy to their specific user group.

Word count: 1641 words (not inc. Citations, Figures or References)

References

Icek Ajzen. Constructing a tpb questionnaire : Conceptual and methodological considerations september , 2002. 2002.

Richard Bartle. Hearts, clubs, diamonds, spades: Players who suit muds. 06 1996.

Marek Bell, Matthew Chalmers, Louise Barkhuus, Malcolm Hall, Scott Sherwood, Paul Tennent, Barry Brown, Duncan Rowland, Steve Benford, Mauricio Capra, and Alastair Hampshire. Interweaving mobile games with everyday life. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '06, pages 417–426, New York, NY, USA, 2006. ACM. ISBN 1-59593-372-7. doi: 10.1145/1124772.1124835. URL `http://doi.acm.org/10.1145/1124772.1124835`.

Shlomo Berkovsky, Mac Coombe, Jill Freyne, Dipak Bhandari, and Nilufar Baghaei. Physical activity motivating games: Virtual rewards for real activity. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '10, pages 243–252, New York, NY, USA, 2010. ACM. ISBN 978-1-60558-929-9. doi: 10.1145/1753326.1753362. URL `http://doi.acm.org/10.1145/1753326.1753362`.

Ross C. Brownson and Shiriki Kumanyika. *Obesity Prevention: Charting a Course to a Healthier Future*, pages 515–528. Springer US, Boston, MA, 2007. ISBN 978-0-387-47860-9. doi: 10.1007/978-0-387-47860-9_22. URL `https://doi.org/10.1007/978-0-387-47860-9_22`.

Ellen Brox, Luis Fernandez-Luque, and Torunn Tøllefsen. Healthy gaming – video game design to promote health. *Applied clinical informatics*, 2:128–42, 04 2011. doi: 10.4338/ACI-2010-10-R-0060.

Marc Busch, Elke Mattheiss, Rita Orji, Andrzej Marczewski, Wolfgang Hochleitner, Michael Lankes, Lennart E. Nacke, and Manfred Tscheligi. Personalization in serious and persuasive games and gamified interactions. In *Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*, CHI PLAY '15, pages 811–816, New York, NY, USA, 2015. ACM. ISBN 978-1-4503-3466-2. doi: 10.1145/2793107.2810260. URL `http://doi.acm.org/10.1145/2793107.2810260`.

Filip Drozd, Tuomas Lehto, and Harri Oinas-Kukkonen. Exploring perceived persuasiveness of a behavior change support system: A structural model. In Magnus Bang and Eva L. Ragnemalm, editors, *Persuasive Technology. Design for Health and Safety*, pages 157–168, Berlin, Heidelberg, 2012. Springer Berlin Heidelberg. ISBN 978-3-642-31037-9.

B. J. Fogg. Persuasive technology: Using computers to change what we think and do. *Ubiquity*, 2002 (December), December 2002. ISSN 1530-2180. doi: 10.1145/764008.763957. URL `http://doi.acm.org/10.1145/764008.763957`.

Yuichi Fujiki, Konstantinos Kazakos, Colin Puri, Pradeep Buddharaju, Ioannis Pavlidis, and James Levine. Neat-o-games: Blending physical activity and fun in the daily routine. *Comput. Entertain.*, 6(2):21:1–21:22, July 2008. ISSN 1544-3574. doi: 10.1145/1371216.1371224. URL `http://doi.acm.org/10.1145/1371216.1371224`.

Kathrin Maria Gerling, Regan L. Mandryk, Max Valentin Birk, Matthew Miller, and Rita Orji. The effects of embodied persuasive games on player attitudes toward people using wheelchairs. In *Proceedings of the 32Nd Annual ACM Conference on Human Factors in Computing Systems*, CHI '14, pages 3413–3422, New York, NY, USA, 2014. ACM. ISBN 978-1-4503-2473-1. doi: 10.1145/2556288.2556962. URL `http://doi.acm.org/10.1145/2556288.2556962`.

Andrew F. Hayes. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*. The Guilford Press, 01 2013. ISBN 9781609182304.

Kirsikka Kaipainen, Collin R Payne, and Brian Wansink. Mindless eating challenge: Retention, weight outcomes, and barriers for changes in a public web-based healthy eating and weight loss program. *Journal of medical Internet research*, 14:e168, 11 2012. doi: 10.2196/jmir.2218.

Rilla Khaled, Ronald Fischer, James Noble, and Robert Biddle. A qualitative study of culture and persuasion in a smoking cessation game. In Harri Oinas-Kukkonen, Per Hasle, Marja Harjumaa, Katarina Segerståhl, and Peter Øhrstrøm, editors, *Persuasive Technology*, pages 224–236, Berlin, Heidelberg, 2008. Springer Berlin Heidelberg. ISBN 978-3-540-68504-3.

Winter Mason and Siddharth Suri. Conducting behavioral research on amazon's mechanical turk. *Behavior Research Methods*, 44(1):1–23, Mar 2012. ISSN 1554-3528. doi: 10.3758/s13428-011-0124-6. URL `https://doi.org/10.3758/s13428-011-0124-6`.

Lennart E. Nacke, Chris Bateman, and Regan L. Mandryk. Brainhex: A neurobiological gamer typology survey. *Entertainment Computing*, 5(1):55 – 62, 01 2014. ISSN 1875-9521. doi: https://doi.org/10.1016/j.entcom.2013.06.002. URL `http://www.sciencedirect.com/science/article/pii/S1875952113000086`.

Rita Orji, Regan L. Mandryk, Julita Vassileva, and Kathrin M. Gerling. Tailoring persuasive health games to gamer type. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '13, pages 2467–2476, New York, NY, USA, 2013a. ACM. ISBN 978-1-4503-1899-0. doi: 10.1145/2470654.2481341. URL `http://doi.acm.org/10.1145/2470654.2481341`.

Rita Orji, Julita Vassileva, and Regan L. Mandryk. Lunchtime: a slow-casual game for long-term dietary behavior change. *Personal and Ubiquitous Computing*, 17(6):1211–1221, Aug 2013b. ISSN 1617-4917. doi: 10.1007/s00779-012-0590-6. URL `https://doi.org/10.1007/s00779-012-0590-6`.

Rita Orji, Regan L. Mandryk, and Julita Vassileva. Improving the efficacy of games for change using personalization models. *ACM Trans. Comput.-Hum. Interact.*, 24(5):32:1–32:22, October 2017. ISSN 1073-0516. doi: 10.1145/3119929. URL `http://doi.acm.org/10.1145/3119929`.

Wei Peng. Design and evaluation of a computer game to promote a healthy diet for young adults. *Health Communication*, 24(2):115–127, 2009. doi: 10.1080/10410230802676490. URL `https://doi.org/10.1080/10410230802676490`. PMID: 19280455.

Richard M. Ryan, C. Scott Rigby, and Andrew Przybylski. The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion*, 30(4):344–360, Dec 2006. ISSN 1573-6644. doi: 10.1007/s11031-006-9051-8. URL https://doi.org/10.1007/s11031-006-9051-8.

Critical Review: Exploring Interactions with Physically Dynamic Bar Charts

Introduction

Scientific studies investigating how data can be effectively presented to, explored and interpreted by users forms the core part of Information Visualisation ('InfoVis'). This research is under the guise of supporting users in the decision-making process. This review summarises and critical analyses Taher et al. [2015] whose paper explores the use of physically dynamic bar chart as a device for exploring user interactions with visualisations of data, as well as putting forward a set of suggestions for future work in this domain of Information Visualisation.

Summary of Contributions

...

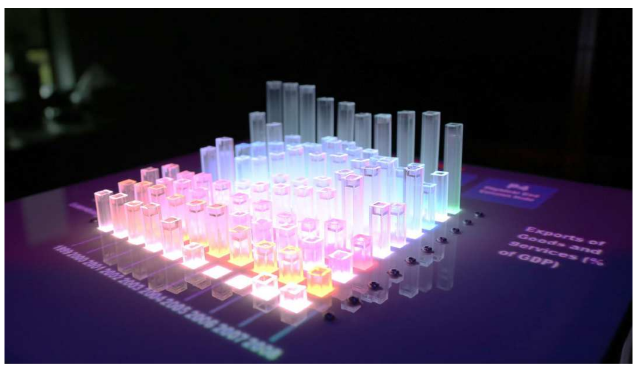


Figure 1: EMERGE: Exploring Interactions with Physically Dynamic Bar Charts using actuating physical rods and RGB LEDs to display international export data.

Table 1: Task-sets and interaction techniques explored during the user study.

Task	**Overview**	**Interaction Techniques**
Annotation ***(Process & provenance)***	Selecting and marking individual data points.	Point, pull, press.
Filtering ***(Data view & specification)***	Hiding and refining data for enhanced perception and comparison.	Swipe away, manual press, assisted press, press shortcut, and press to compare.
Organization ***(View manipulation)***	Data arrangement by moving rows and columns.	Drag and drop with immediate transition and hide-all with transition, press with instant transition and hide-all with transition.
Navigation ***(View manipulation)***	Controlling the view of large data sets.	Scroll, directional arrows, directional press, and paging.

Justifications for Conclusions

...

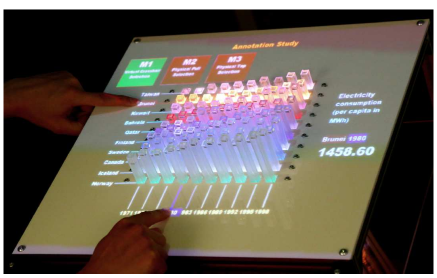


Figure 2: Annotation (Point technique).

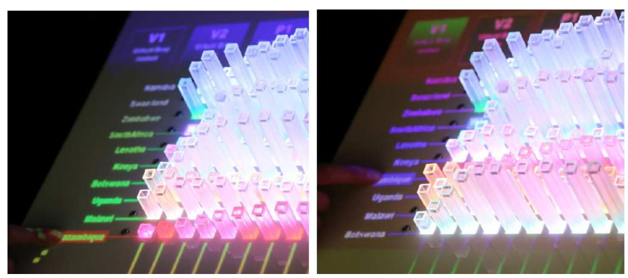


Figure 3: Organisation (Drag and Drop technique).

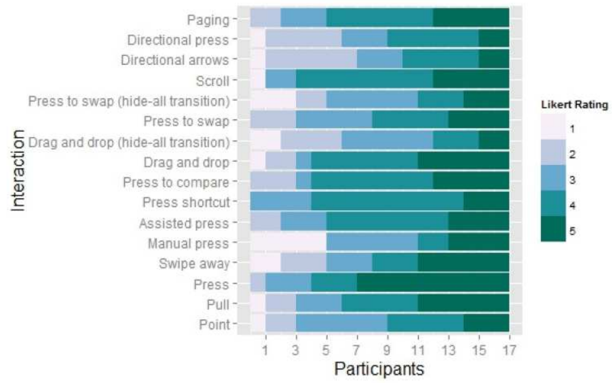


Figure 4: Likert scale ratings for helpfulness of interaction techniques. Range = 1: Strongly Disagree, 5: Strongly Agree.

Limitations and Suggested Further Work

...

Conclusion

...

Word count: 0 words (not inc. Citations, Figures or References)

References

Faisal Taher, John Hardy, Abhijit Karnik, Christian Weichel, Yvonne Jansen, Kasper Hornbæk, and Jason Alexander. Exploring interactions with physically dynamic bar charts. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, CHI '15, pages 3237–3246, New York, NY, USA, 2015. ACM. ISBN 978-1-4503-3145-6. doi: 10.1145/2702123.2702604. URL `http://doi.acm.org/10.1145/2702123.2702604`.