Individual Differences in Human Clustering

Shubh Goyal, Vijay Marupudi, & V.N. Vimal Rao

ILLINOIS

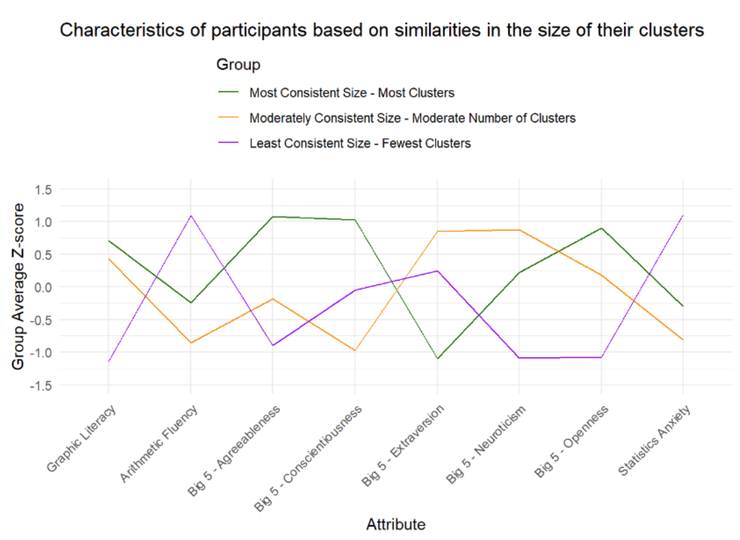
INTRODUCTION

- Human visual clustering is the process of dividing a set of points into "similar" groups.
- Marupudi et al. (2022) showed that people are reliable when clustering groups of points with even a slight degree of grouping (compared to random dispersion).
- Beyond differences in perception and strategies for clustering, we do not fully understand the variability present in people's clusterings.
- We suspect there may be group and individual differences in human clustering based on traits such as personality, graphic and arithmetic fluency, and statistics anxiety, in addition to perceptual factors.
- Here, we conduct a secondary analysis of the data collected by Marupudi et al. (2022) to quantify the similarities and differences in response patterns between individuals and groups across grouped stimuli.
- Additionally, we analyze data from new participants completing the same clustering task as used by Marupudi et al. (2022) as well as a survey measuring their graphic and arithmetic fluency and also personality traits associated with statistics anxiety to identify relationships between these factors.

METHODS

- N = 365 participants
- Each participant clustered 28 grouped stimuli, four stimuli each for 10 points, 15 points, ..., 40 points.
- Participants also completed a survey measuring graphic literacy, arithmetic fluency, their Big 5 personality traits, and statistics anxiety.
- Participants were grouped into 5 clusters using kmeans clustering, based on the number of clusters they created for each stimulus and the variance of their cluster sizes. Three groups with >100 participants were compared based on group average standardized scores on the survey measures.

Characteristics of participants based on similarities in the size of their clusters



RESULTS

- There do appear to be *some* differences between groups that are related to their clustering behaviour (MANOVA Approximate F Statistic = 1.565; $p = .095$).
- There is considerable individual variability in these measures, and future analyses will explore other methods of classification that may be more appropriate based on the data (e.g., latent classification analysis, other methods of clustering).

Possible Factors Related to Group Differences

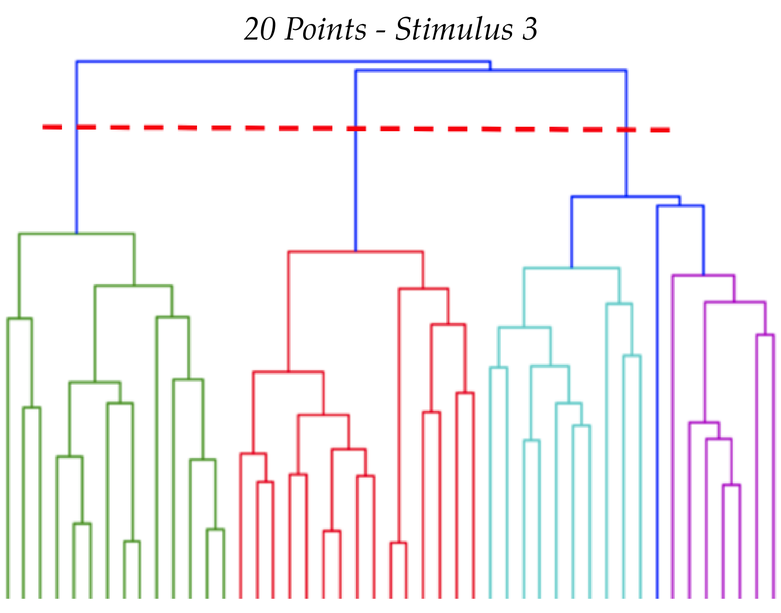
- Participants drawing *more* and *consistently sized* clusters appear to have:
  - higher agreeableness
  - higher conscientiousness
  - lower extraversion
- Participants drawing *fewer* and *inconsistently sized* clusters appear to have:
  - lower graphic literacy
  - higher arithmetic fluency
  - lower neuroticism
  - lower openness
  - higher statistics anxiety

SECONDARY ANALYSIS METHODS

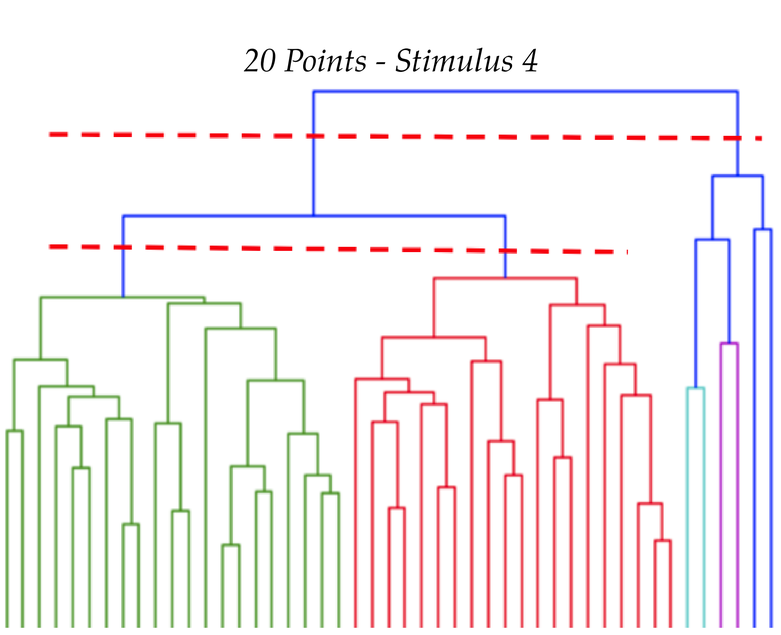
- N = 47 participants clustered 28 grouped stimuli, four stimuli each for 10 points, 15 points, ..., 40 points.
- We compared the similarity of participants' clusterings for each pair of participants for a given stimulus.
- We then clustered participants into groups for each stimulus using dendograms generated by a divisive hierarchical clustering algorithm.
- We examined the extent to which participant similarities extended across stimuli using Sankey diagrams, and the extent to which each stimulus discriminated between groups of participants.

Divisive Hierarchical Clustering Dendograms

20 Points - Stimulus 3

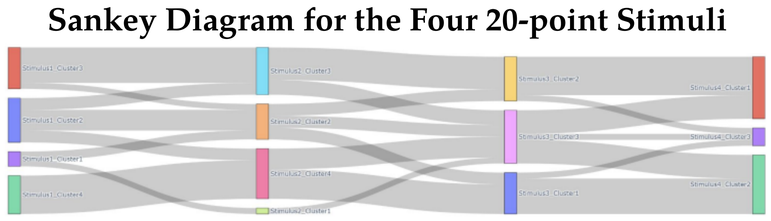


20 Points - Stimulus 4

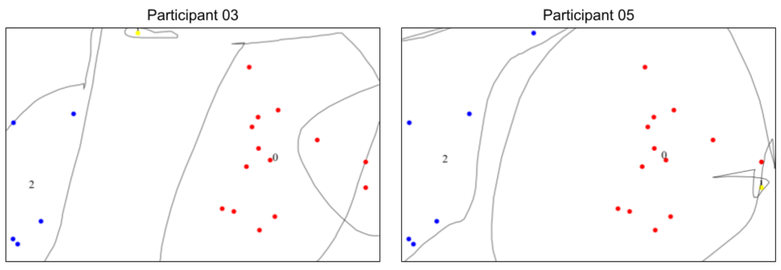


SECONDARY ANALYSIS RESULTS

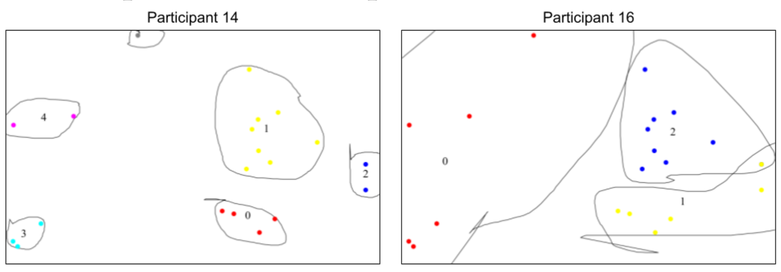
Sankey Diagram for the Four 20-point Stimuli



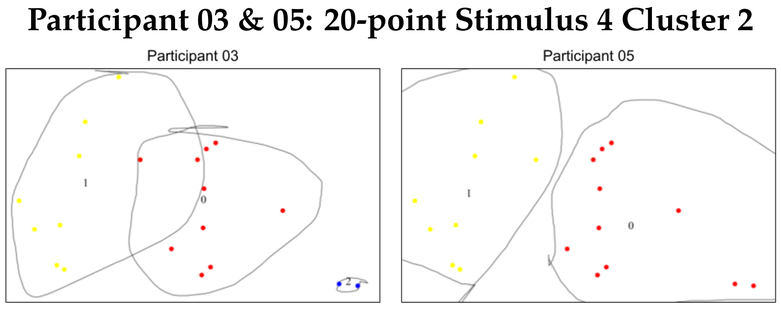
Participant 03 & 05: 20-point Stimulus 3 Cluster 1



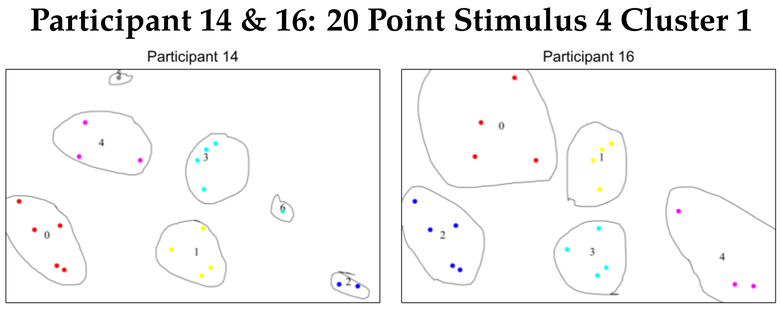
Participant 14 & 16: 20-point Stimulus 3 Cluster 2



Participant 03 & 05: 20-point Stimulus 4 Cluster 2



Participant 14 & 16: 20 Point Stimulus 4 Cluster 1



DISCUSSION

- There appear to be some consistent group similarities across stimuli as well as individual differences between participants who clustered very similarly.
- It appears that some of those differences and similarities may be related to personality factors that may underlie differences in perception (e.g. conscientiousness people really want clusters to be the same size). Similarly, there appears to be some relation to mathematical and statistical factors such as graphic literacy, arithmetic fluency, and statistics anxiety.
- However, this was not the case across all stimuli, nor for all groups identified in this analysis.
- **We believe this evidence supports the claim that individual differences in human clustering exist and are correlated to non-perceptual factors.**
- We did not analyze how variances within each stimuli may have led to increased individual differences. Certain point structures could increase or decrease the variability of clustering solutions.
- In future analyses, we plan to utilize more complex analyses to ensure our findings are robust.
- Most of our participants were freshmen and liberal arts majors. In future studies, we plan to collect data from students of different levels of seniority and varied areas of study.

REFERENCES

- Marupudi, V., Harsch, R., Rao, V. N. V., Park, J., Bye, J. K., & Varma, S. (2022). Use of clustering in human solutions of the traveling salesperson problem. In Proceedings of the Annual Meeting of the Cognitive Science Society (Vol. 44, No. 44).
- O'Keefe, D. F., Kelloway, E. K., & Francis, R. (2012). Introducing the OCEAN. 20: A 20-Item five-factor personality measure based on the trait self-descriptive inventory. Military Psychology, 24(5), 433-460.
- Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., & von der Heydt, R. (2012). A century of Gestalt psychology in visual perception: I. Perceptual grouping and figureground organization. Psychological Bulletin, 138, 11721217. https://doi.org/10.1037/a0029333
- Bimler, D., Kirkland, J., & Pichler, S. (2004). Escher in color space: Individual-differences multidimensional scaling of color dissimilarities collected with a gestalt formation task. Behavior Research Methods, Instruments, & Computers, 36(1), 69-76.
- Chew, P. K., & Dillon, D. B. (2014). Statistics anxiety update: Refining the construct and recommendations for a new research agenda. Perspectives on Psychological Science, 9(2), 196-208.