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Title: Empirical Data from Judgments of Achromatic Color Differences

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Empirical Data from Judgments of Achromatic Color Differences

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1 Introduction

Color perception has been studied for decades. Psychologists have developed several empirical tasks to measure how differently colors are perceived to be. One such task, which has been widely used, is the two alternative forced choice (2AFC) task where participants are asked to make judgments about two pairs of colors [2, 3, 5]. Participants are shown three stimuli in a row and are asked to judge whether the left or right stimulus is more different from the middle. The binary responses can be aggregated to determine the magnitude of perceived color differences.

2 Methods

2.1 Materials

This data set comes from a study of perceived differences of shades of gray. The triads were comprised of shades of gray, quantified by their L^* value in the CIELAB color space. The center gray, referred to as the *standard*, took on values of $L^* = 30, 40, 50, 60, 70$. The left and right grays, referred to as *test 1* and *test 2*, were defined by their difference in L^* units. The *test 1* gray is defined to always be darker than the *standard* while the *test 2* gray is always lighter than the *standard*.

The values of the differences between the *tests* and *standards* are described in Figure 1. There are 64 combinations of differences, which result in a total of 320 total triads tested. These triads were presented on a dark blue background, similar to that used in a study of small and large color differences that spanned chromatic colors along the visible wave lengths [3]. A screenshot of the presentation of stimuli is seen in Figure 2.

2.2 Procedure

Participants were shown a subset of triads and asked to judge which of the *tests* was more different from the *standard*. Participants indicated their selection by

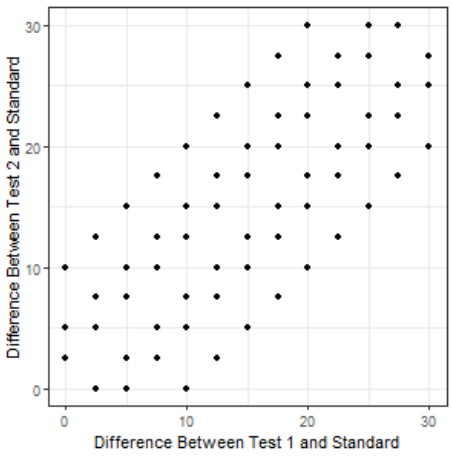

Figure 1: Each point represents combinations of the difference between the darker gray (*test 1*) and the *standard* and the difference between the lighter gray (*test 2*) and the *standard*. Every combination results in five triads, one per standard.

pressing the "q" button to indicate the left gray and the "p" button to indicate the right. The order of triads were randomized and the left/right position of the darker (*test 1*) and lighter (*test 2*) grays were randomized. Participants had unlimited time to make their selection. After each trial, participants were provided feedback on whether or not they were correct. This design decision was made to increase participant engagement. Participants were also guided through three training triads before completing the experimental task. This study was completed on individual laptop or desktop computers. The study was implemented using Qualtrics survey software [4].

2.3 Participants

Approximately 1400 participants completed the study. Participants were recruited through Amazon Mechanical Turk (MTurk) [1]. Participants were asked to attest to their non-CVD status and given an online Ishihara plate test to minimize the impact of CVD participants. All participants were United States-based MTurk users.

3 Data Description

The csv file of the data contains 91896 rows and 5 columns. Each row corresponds to an individual response. The columns contain information about the trial and response:

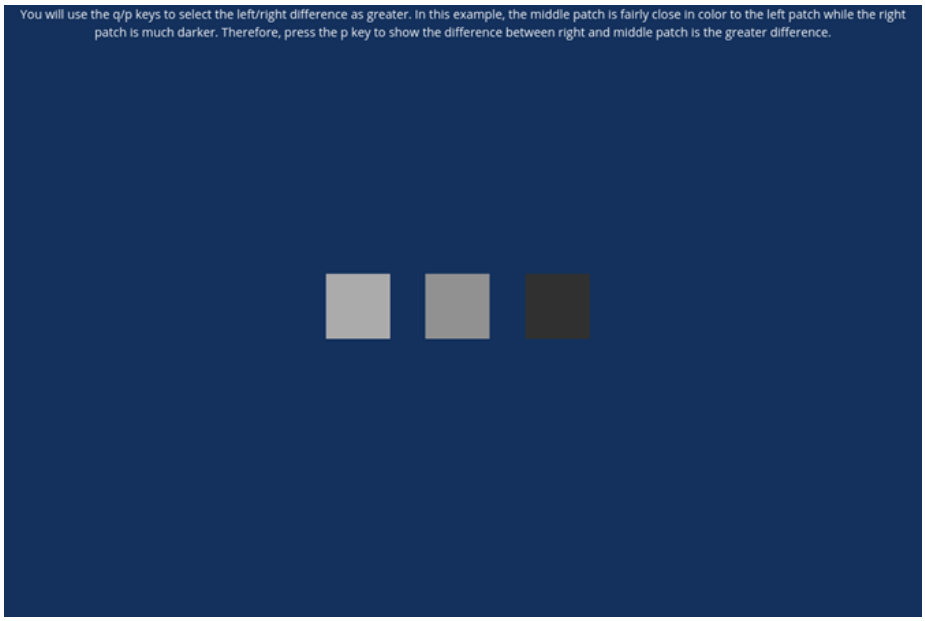

Figure 2: An example triad presented to participants.

- **trial**: The trial number indicates whether the specific triad was shown first, second, third, and so on
- **Ls**: This is the L^* value of the *standard* in the triad. This value only takes on values of $30, 40, 50, 60, 70$.
- **Lt1**: This is the L^* value of the *test 1* in the triad, regardless of the left/right position. This value will always be less than the corresponding Ls value.
- **Lt2**: This is the L^* value of the *test 2* in the triad, regardless of the left/right position. This value will always be greater than the corresponding Ls value.
- **R**: This is a binary variable indicating the participant's response to the triad described by the Ls, Lt1, and Lt2 values. $R = 0$ indicates that the participant selected *test 1* as more different. $R = 1$ indicate that the participant selected *test 2* as more different.

This data set contains the responses from all participants to all triads they were shown, however there is no way to assign a given triad to a particular participant. The data are ordered first trial, then Ls, then Lt1, then Lt2. The same participant did not necessarily respond to the first Trial 0 and the first Trial 1 and so on. This data set has been completely scrubbed of any personal identifiable information (PII) and has been completely de-identified.

4 Subset of Data

Below is the first 25 rows of the data.

```
"trial","Ls","Lt1","Lt2","R"
0,30,0,50,1
0,30,0,50,0
0,30,0,50,0
0,30,0,50,1
0,30,0,50,0
0,30,0,55,0
0,30,0,55,0
0,30,0,55,0
0,30,0,55,1
0,30,0,57.5,0
0,30,0,57.5,0
0,30,0,57.5,0
0,30,0,57.5,0
0,30,2.5,47.5,0
0,30,2.5,47.5,1
0,30,2.5,47.5,0
0,30,2.5,47.5,0
0,30,2.5,47.5,1
0,30,2.5,47.5,0
0,30,2.5,47.5,0
0,30,2.5,47.5,0
0,30,2.5,47.5,0
0,30,2.5,47.5,0
0,30,2.5,52.5,1
0,30,2.5,52.5,1
```

5 Acknowledgements

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References

[1] Amazon Mechanical Turk Website. www.mturk.com/mturk/welcome.

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[3] David H Krantz. Small-step and large-step color differences for monochromatic stimuli of constant brightness. *JOSA*, 57(11):1304–1316, 1967.

[4] Qualtrics Website. www.qualtrics.com.

[5] Warren S Torgerson. Multidimensional scaling: I. theory and method. *Psychometrika*, 17(4):401–419, 1952.