University of Tehran
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Introduction to cognitive science

Homework 1 – Phase 2

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Abstract

In this project, we designed and implemented a psychophysical experiment using **PsychoPy** to investigate **perceptual sensitivity to morphed face identities**. Participants were shown face images generated from morph continua between two distinct identities, with images taken from four features. Each folder contained 100 images representing a smooth transition from one identity to another.

From each morph continuum, we selected **10 equally spaced morph levels**, and each image was presented **10 times in randomized order**, totaling 400 trials. In each trial, participants were asked to indicate which of the two original identities (e.g., Romeo or Juliet) the presented image resembled more, using keyboard responses. To ensure familiarity with the identities, each block began with a **training phase** that showed the two endpoint faces.

After collecting the responses, we analyzed the data by computing the **proportion of "Face A" responses** at each morph level. We then fitted **psychometric functions**—specifically **sigmoid curves**—to the response data for each condition. From these curves, we estimated the **Just Noticeable Difference (JND)** as a measure of perceptual sensitivity for each feature and folder. The resulting psychometric plots and JND values reveal how finely participants could discriminate between morphed facial identities under different shape and appearance transformations.

Question 1 – Coding the Experiment in PsychoPy

In this part of the project, we designed and implemented a face identity discrimination task using **PsychoPy**. The original experiment design was extended in two key ways:

1. **Expanded Feature Coverage**: Instead of focusing on only one feature dimension, we incorporated four distinct morph continua by selecting two features (fX and fX+10) from both the app/ and sha/ folders. This allowed us to test perceptual sensitivity across a broader set of visual transformations (appearance and shape).
2. **Training Phase for Each Block**: To improve the clarity of the task for participants and ensure that they could accurately associate each morph continuum with its two endpoint identities, we added a **training phase before each of the four experimental blocks**. In the training phase, the two original faces used to generate the morphs were shown clearly and labeled, helping participants to form a mental template before starting the trials.

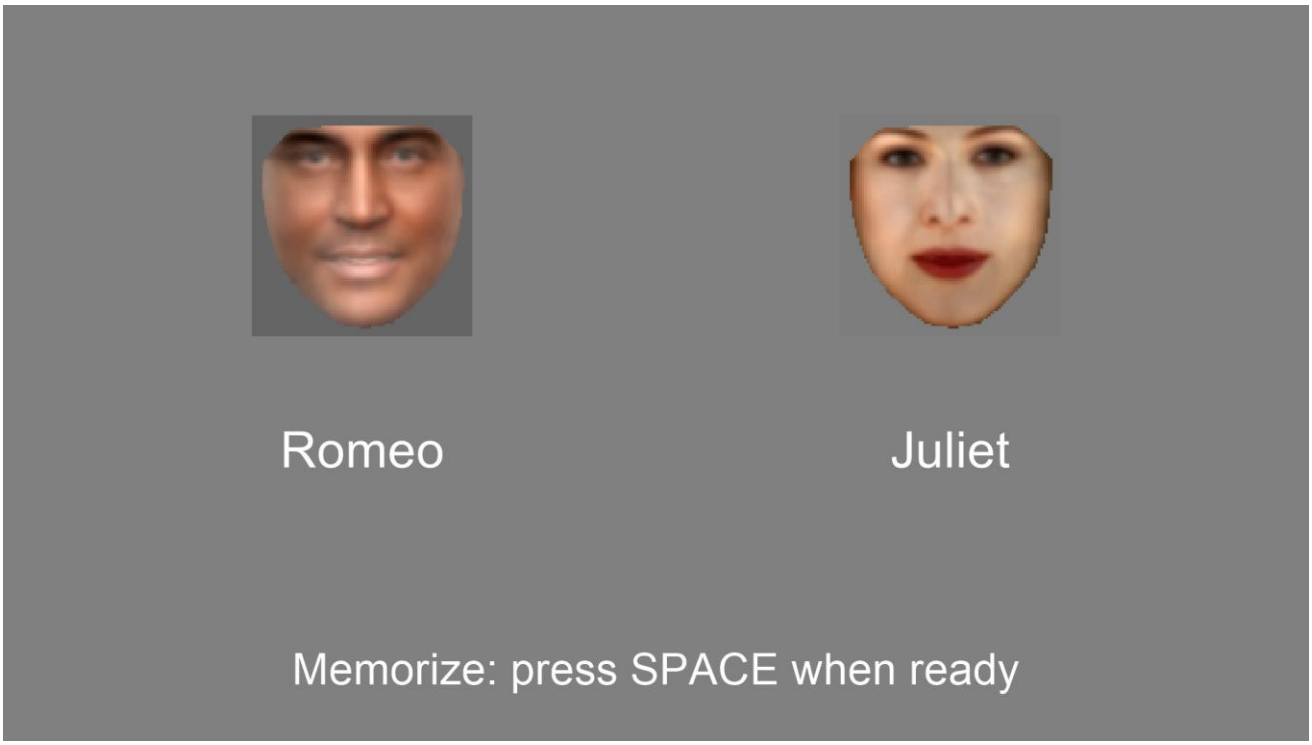

Figure1 - Training

The main task presented each selected image 10 times in a randomized order. In every trial, the participant was asked to judge whether the image looked more like identity A or B, using left and right arrow keys for responses. All components, including randomization, response collection, feedback structure, and logging, were implemented in a custom PsychoPy script. This setup ensured a controlled yet flexible design for exploring identity sensitivity across multiple facial dimensions.

folder	feature	morph_level	response_	rt	participan	session
app	9	9	left	2.818644	farzaneh	1
app	9	59	right	1.285378	farzaneh	1
app	9	9	left	1.973813	farzaneh	1
app	9	49	right	1.176375	farzaneh	1
app	9	9	left	0.764893	farzaneh	1
app	9	19	left	0.606145	farzaneh	1
app	9	79	right	1.080816	farzaneh	1
app	9	49	right	0.867008	farzaneh	1
app	9	39	right	2.959451	farzaneh	1

Figure 2 - Data recieved from one of the subjects

Question 2 – Psychometric Curves and JND

In this section, we analyzed the participants' responses by fitting **psychometric functions** (specifically sigmoid curves) to the proportion of "Right" responses across different morph levels for each block. The **Just Noticeable Difference (JND)** was computed from each fitted curve to quantify perceptual sensitivity. Lower JND values indicate higher sensitivity to identity changes.

2.1 *Comparison of Results Across Participants and Blocks*

- ✓ **Farzaneh** showed relatively consistent performance across blocks, with JNDs ranging from **2.7 to 15.8**. The lowest JND (2.7) was in Block 2, indicating high sensitivity to the morphs in that condition(appearance feature 19). Block 3 had the highest JND (15.8), possibly due to greater perceptual difficulty or confusion between identities (Shape feature 9).
- ✓ **Mohammad** displayed moderate to high sensitivity across blocks. His JNDs ranged from **3.3 to 15.4**, similar in pattern to Farzaneh. Block 1 (JND = 3.3) suggests precise discrimination(Appearance 9), while Block 4 (JND = 15.4) again indicates a more challenging condition or possible attentional lapses (Shape 19).
- ✓ **pr11** had three blocks with usable data. JNDs varied from **3.9 to 10.5**, with a good curve fit in Blocks 2, 3, and 4. Block 1 failed to fit.

- ✓ **Parsa** experienced curve fitting issues in Blocks 1 and 2, but Block 3 and Block 4 had very **low JNDs (3.5 and 3.2)**, indicating strong perceptual performance in those conditions. (Shape 9 and 19)

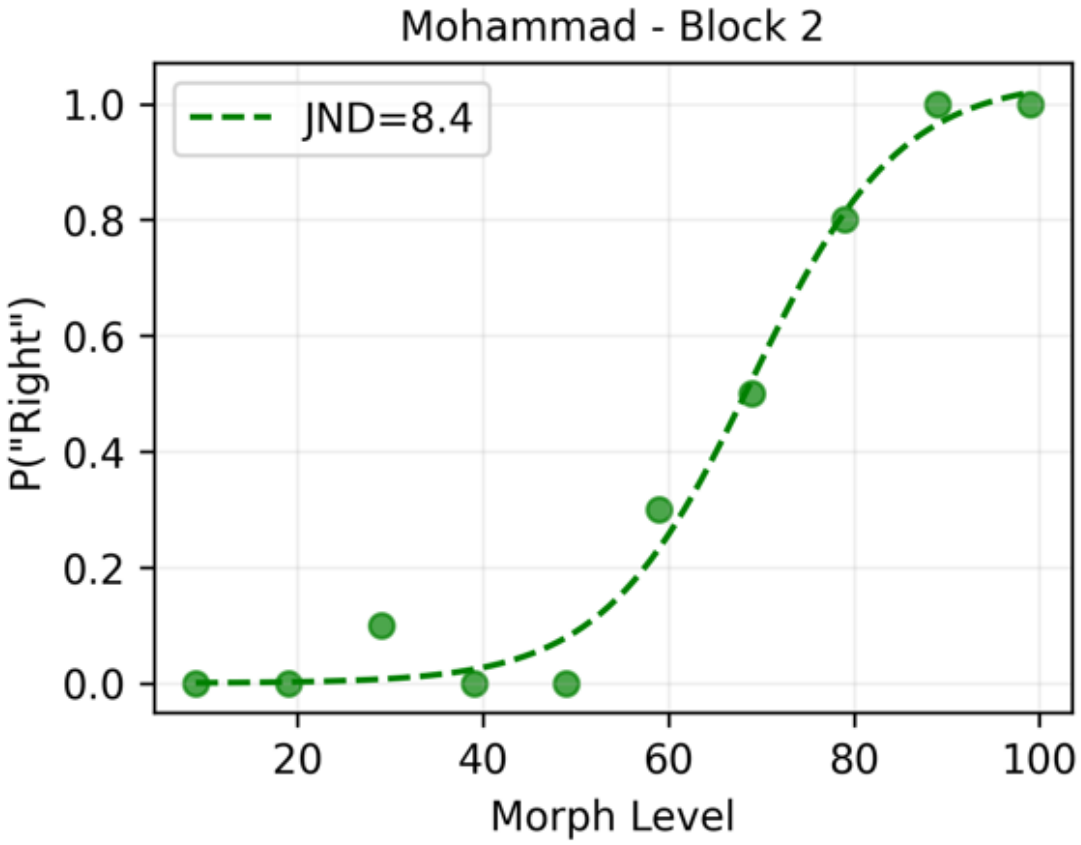

Figure 3 - Psychometric curve of subject Mohammad with feature Appearance 19

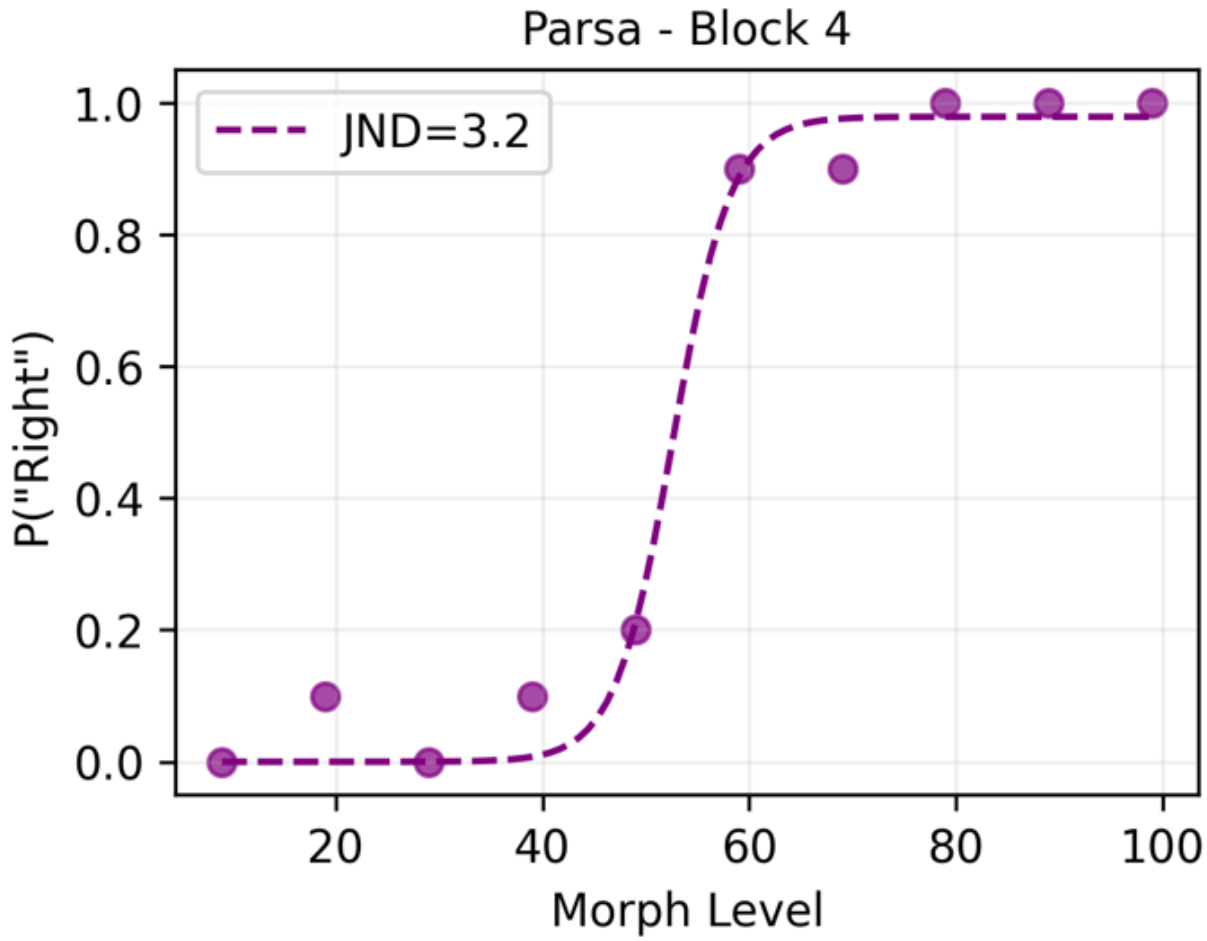

Figure 4- Psychometric curve of subject Parsa with feature Shape 9

2.2 *Curve Fit Failures and Linear Fit Explanation*

Three blocks (pr11-Block 1, Parsa-Block 1, Parsa-Block 2) resulted in **curve fit errors**. This occurred because the response data were too binary—participants responded with either 0 or 1 probability at all morph levels. Such data patterns do **not provide enough gradient** for a sigmoid to be fitted; essentially, the participant made the same choice consistently across all levels.

To still visualize the trend, we plotted a **linear model (or Step fit)** for these blocks instead of a sigmoid. While not ideal for computing JND, the linear plots show the overall response direction and indicate a **lack of perceptual ambiguity**—participants perceived the images as strongly resembling one identity regardless of morph percentage.

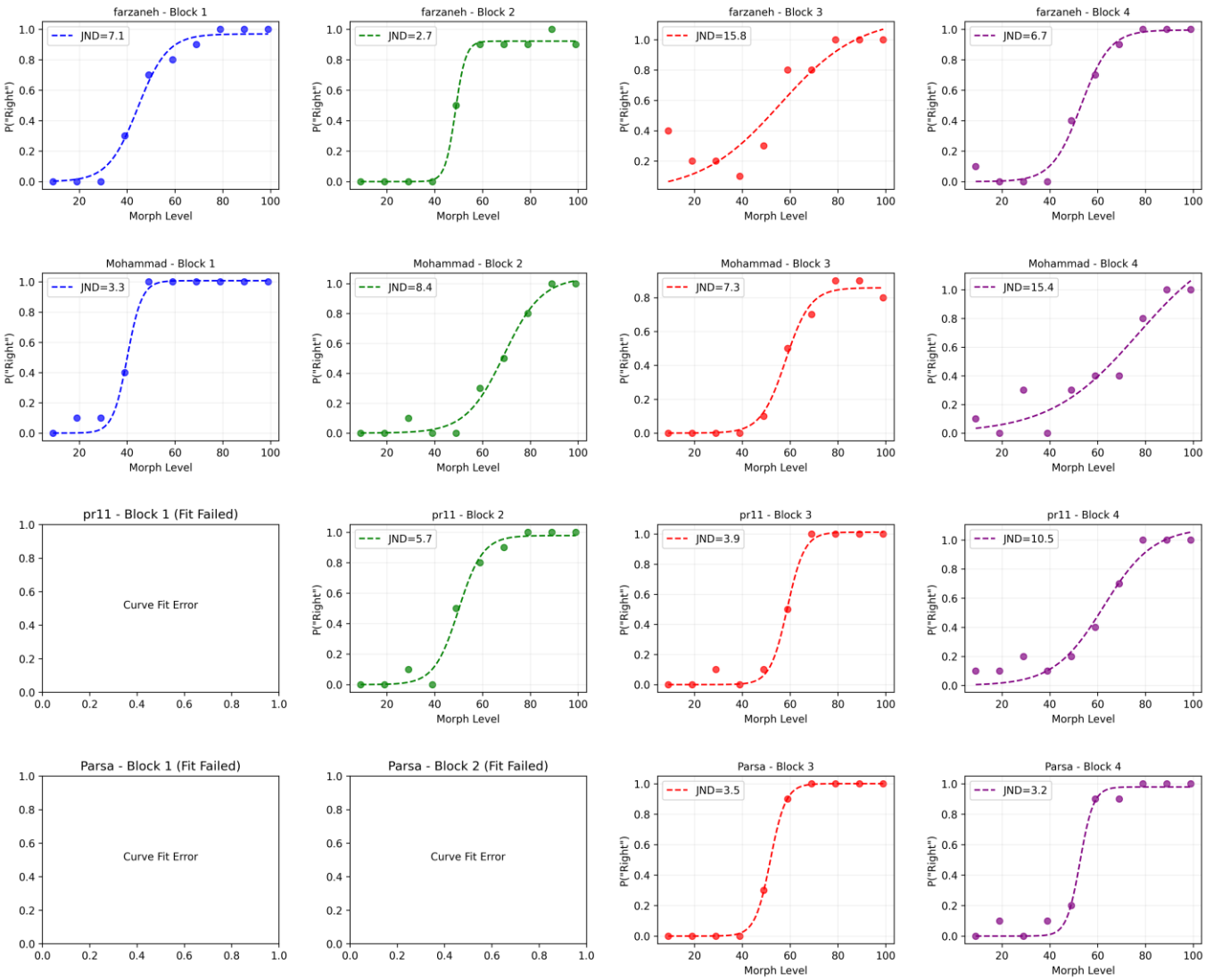

Figure 5 - All Psychometric Curves (each feature and subject)

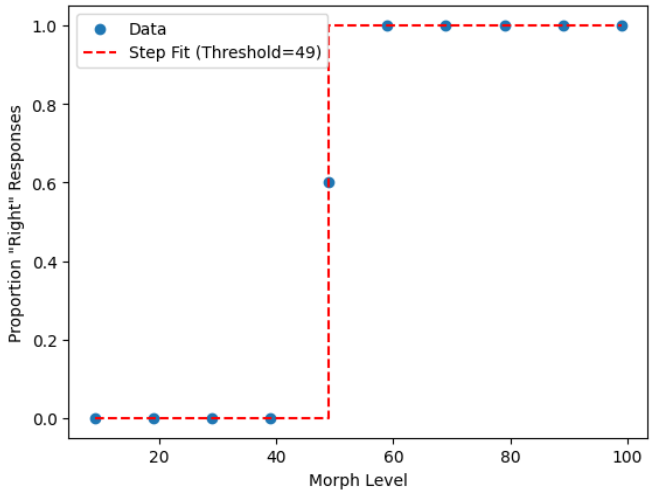

Figure 6 - Replacement of sigmoid for subject pr1 and block 1 due to impossibility of curve fit