

# Pattern Separation Contributes to Categorical Face Perception

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## INTRODUCTION

### Background

- **Pattern separation:** neural encoding of non-overlapping memory representations  
→ Brain region: dentate gyrus (DG) subfield of the hippocampus
- **Pattern completion:** neural reinstatement of memory representations from partial cues  
→ Brain region: CA3 subfield of the hippocampus
- **Categorical perception (CP):** the brain's propensity to a) generalize categorically; and, b) differentiate perceptually between inputs that lie along a sensory continuum  
→ Brain region: depends of the modality of the input  
→ Evidence that face discrimination depends on the hippocampus/medial temporal lobe

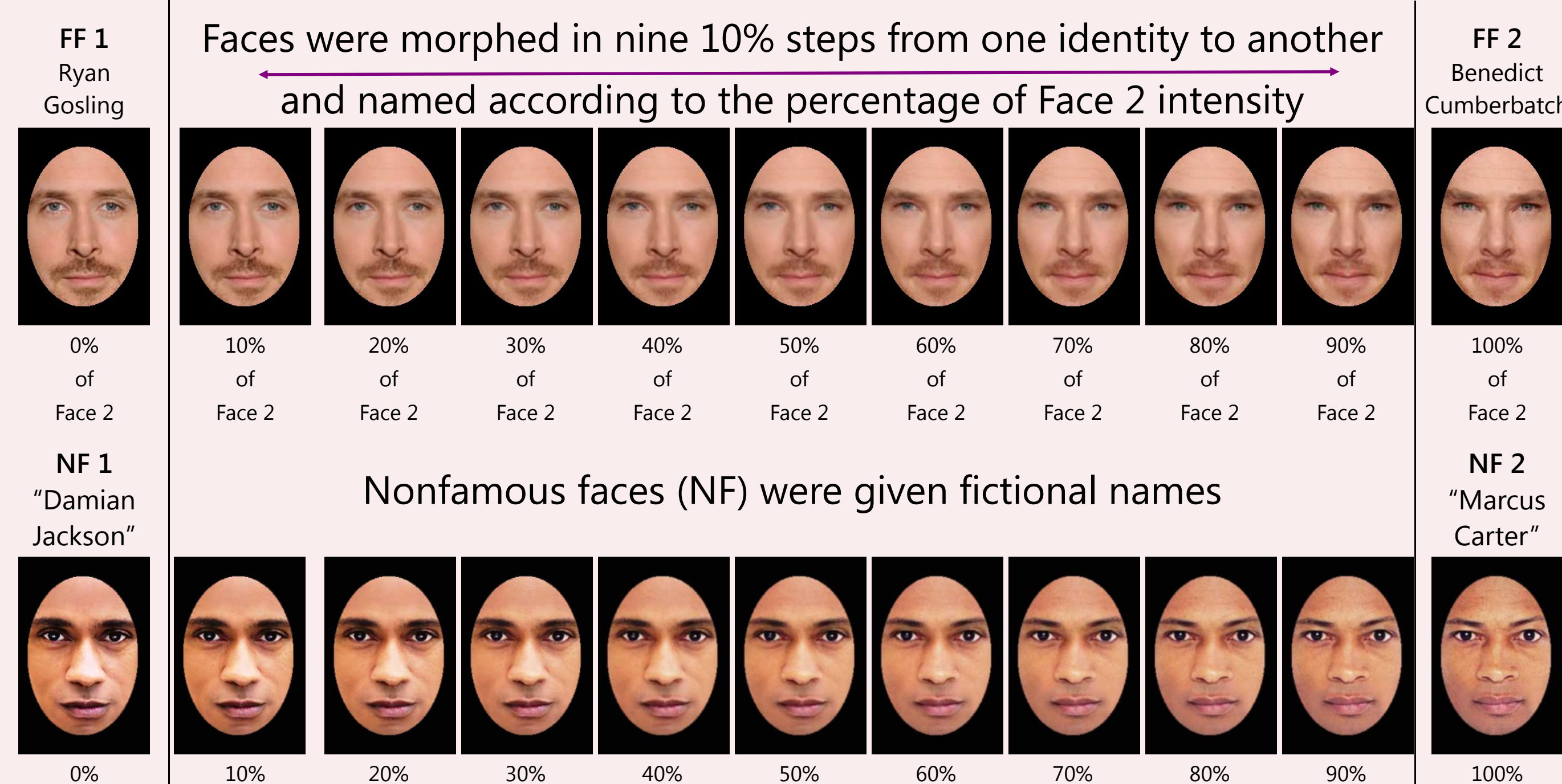
### Theory

- Pattern separation function of the DG and pattern completion function of CA3 — together with personal expertise — influence CP categorization and identification

### Questions

1. Does pattern separation support **identification** of nonfamous/famous faces?
2. Does pattern separation relate to **discrimination** of nonfamous/famous faces?
3. Are CP effects impaired in an individual with a pattern separation deficit?

As hippocampal involvement in CP of faces is thought to be mediated by existing face memories, we used **famous (FF)** and **nonfamous (NF)** face morphs



## METHODS: Participants & Stimuli

### Participants

- Patient BL: 56 years old, memory-impaired male with DG lesions
- Healthy controls: 35 middle-aged individuals, age range 50–64, 20 females

### Stimuli

- Four pairs of famous faces (FF) and four pairs of nonfamous faces (NF)

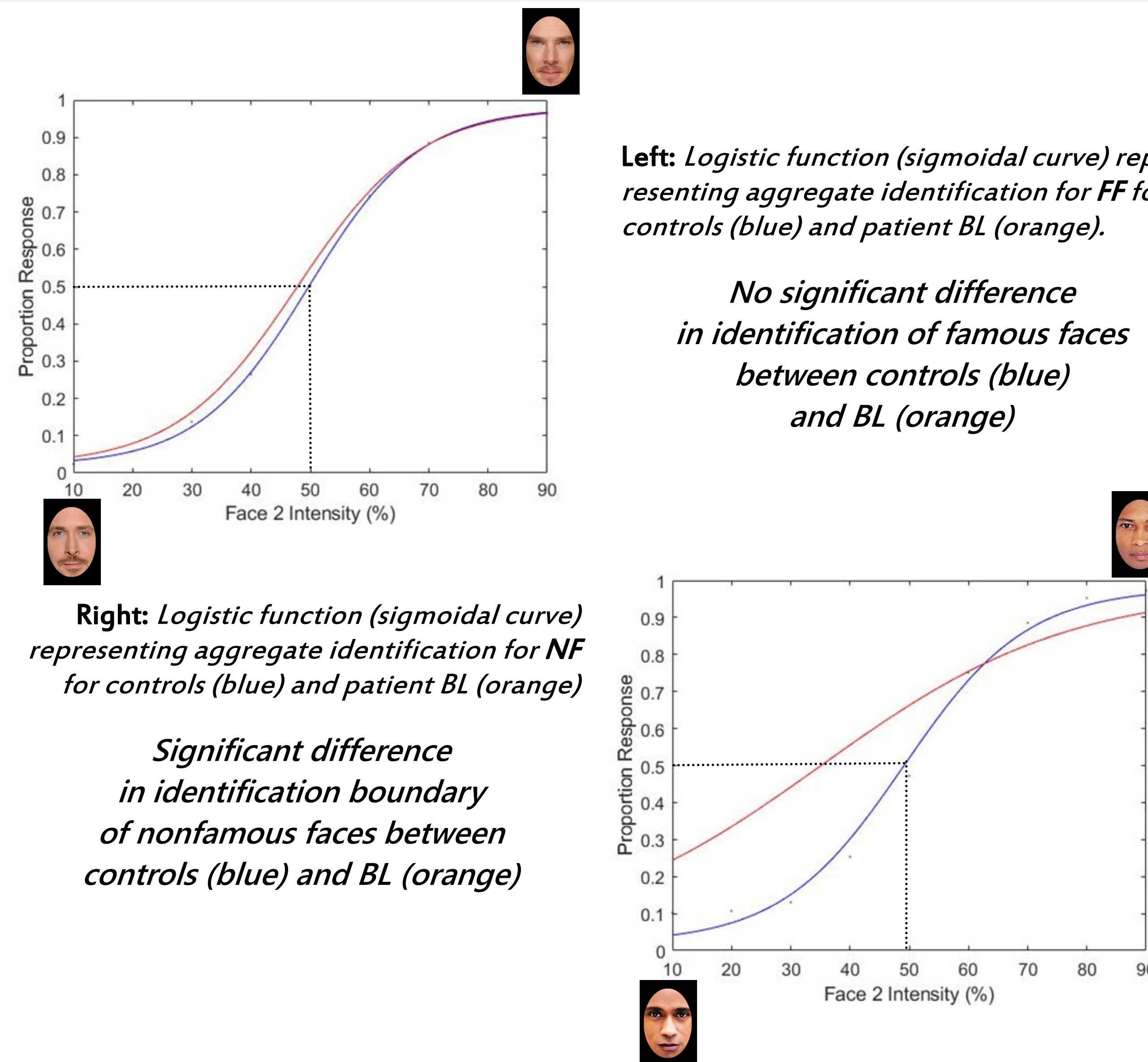
### Methods

- Standard CP identification and discrimination phases

## METHODS: Identification phase (one image presented)

- Participants specified whether the morphed faces (five of each morph pair per condition) were more like one face (e.g., Ryan Gosling) or another (e.g., Benedict Cumberbatch)
- Expectation of non-linear identification, e.g., responses would show a sigmoidal change in identification as contrasts moved stepwise from one endpoint to another
- We predicted that the sharpest change in classification would occur at a category boundary of approximately 50%
- This boundary is where a concomitant change in identification from one category to another typically occurs

## RESULTS: Identification phase



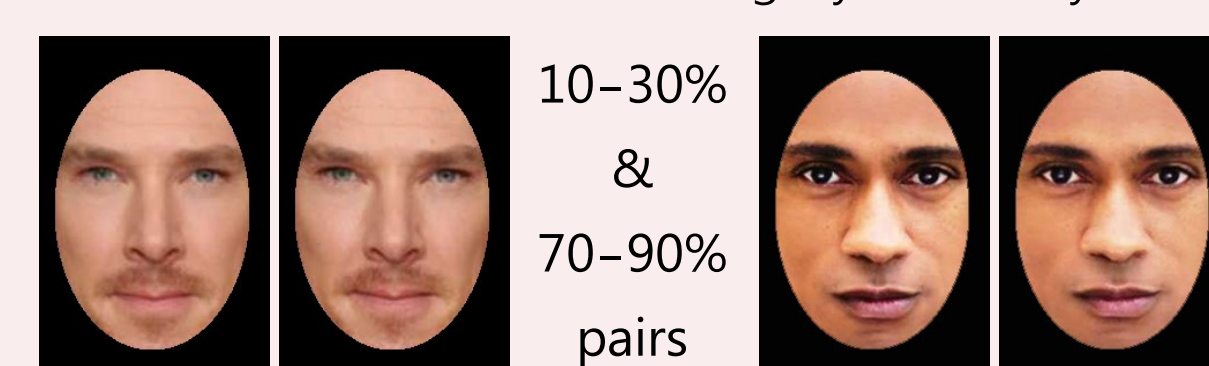
## Methods: Discrimination phase (two images presented)

### Same-Different Discrimination task

- Participants were presented with 62 trials per face pair: 10-10%; **10-30%**; 20-20%, 20-40%, 30-30%, 30-50%, 40-40%, **40-60%**, 50-50%, 50-70%, 60-60%, 60-80%, 70-70%, **70-90%**, 80-80%, 90-90%
- Participants focused on the two images presented in each trial and responded if the images presented were the *same* or *different*

### Within-category discrimination

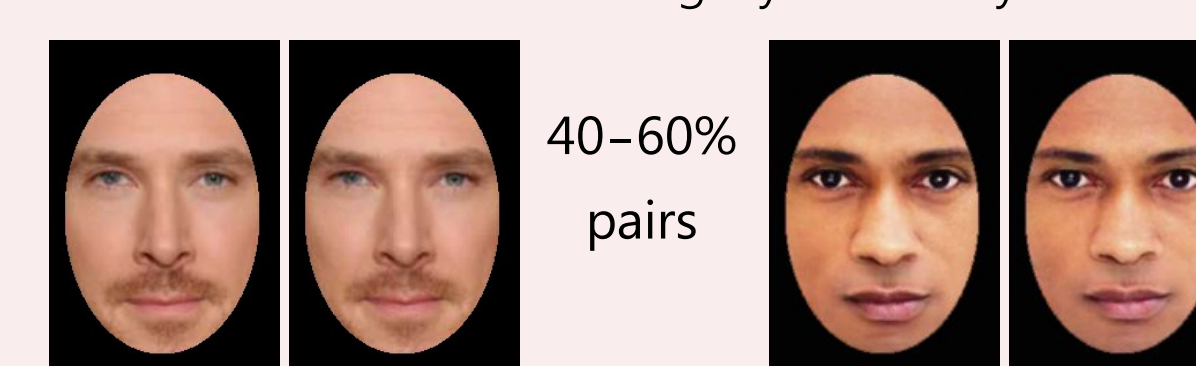
Prediction: accuracy lower for pairs which do not cross a category boundary



Same or Different?

### Between-category discrimination

Prediction: accuracy higher for pairs which cross a category boundary



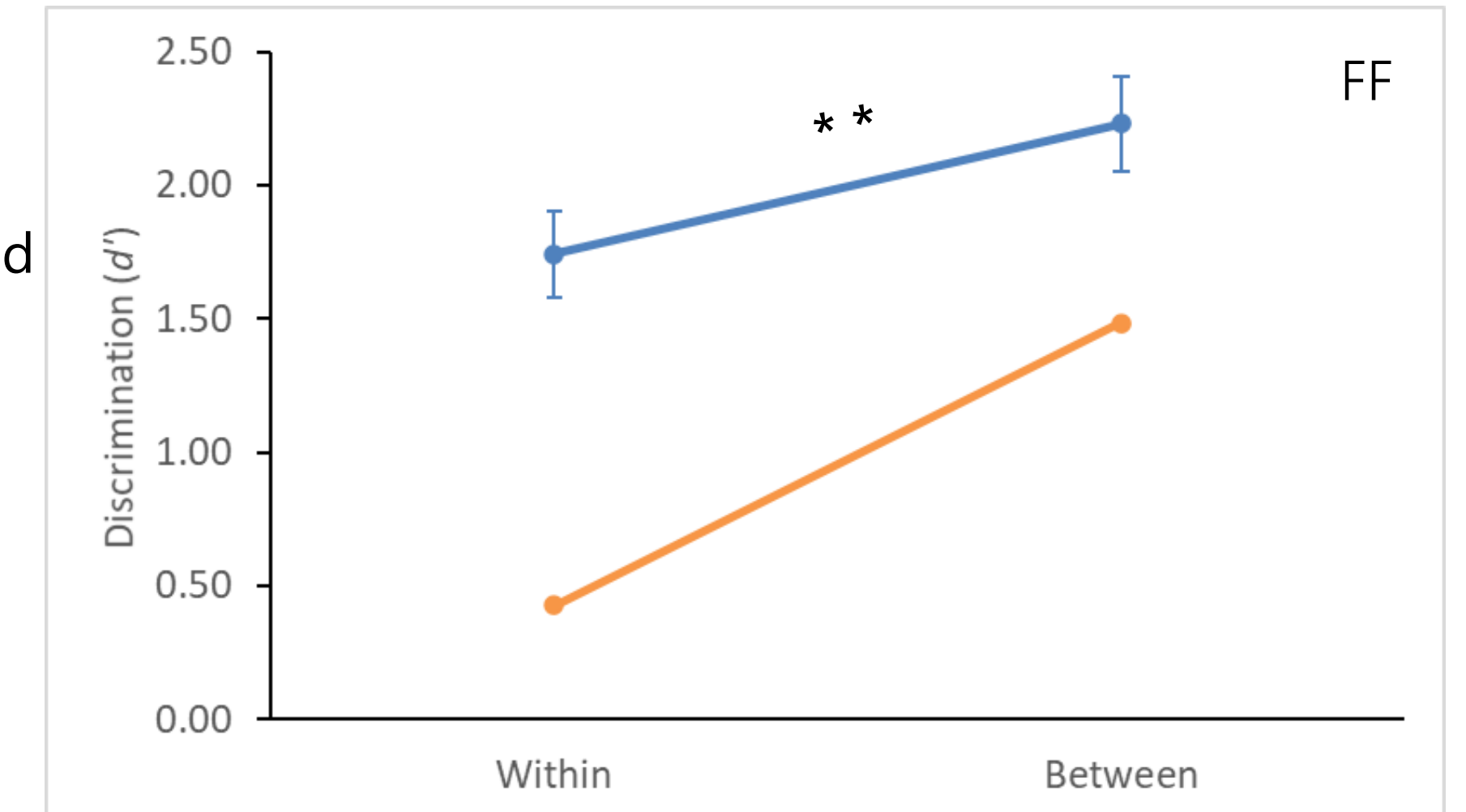
Same or Different?

Same or Different?

## RESULTS: Discrimination phase ( $d'$ )

### Controls (blue)

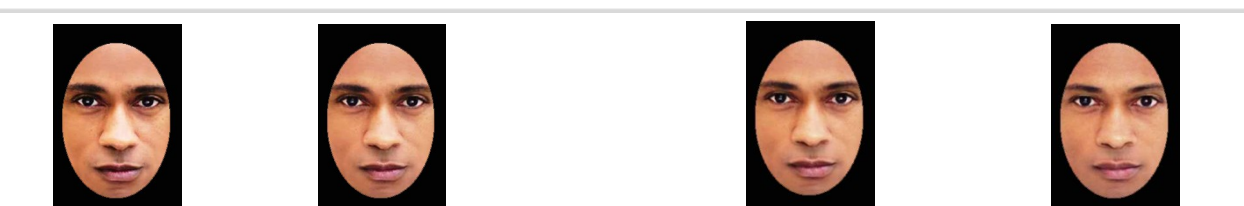
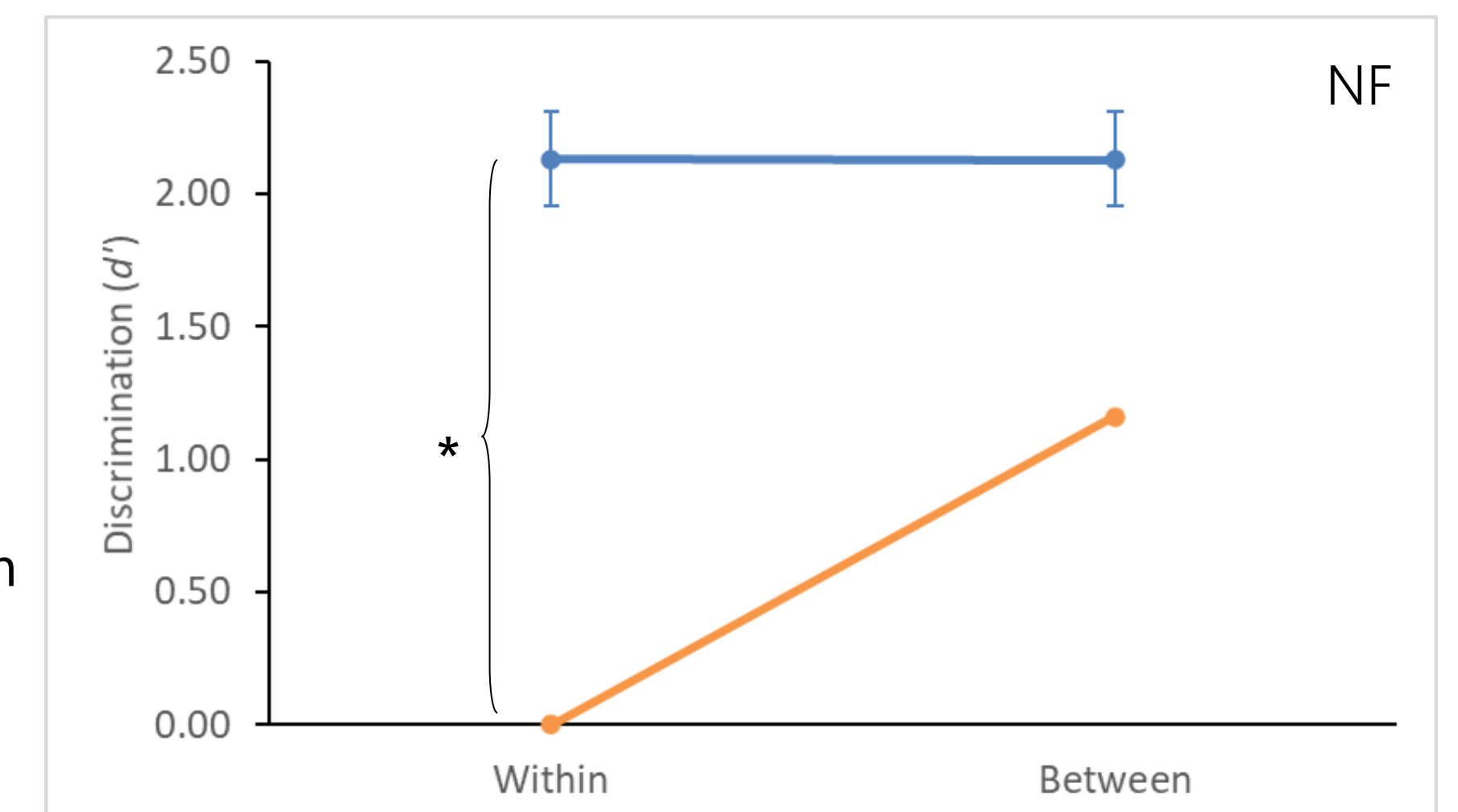
- **FF:** As predicted, within-category FF were discriminated at a lower rate than between-category FF, ( $p = .001$ )
- **NF:** within-category NF did not have a similar perceptual disadvantage relative to between-category morphs



- ∴ CP effects found for FF but not for NF

### Patient BL (gold)

- Within-category faces discriminated at a lower rate than between-category faces
- ∴ CP effects for FF and NF
- BL had a  $d'$  score of 0 (random responding) for NF within
- Difference between BL and controls for NF within was significant ( $p = .027$ )



## CONCLUSION

- We set out to determine if CP of faces, like pattern separation, is modulated by hippocampal DG integrity and is influenced by mnemonic familiarity
- Controls exhibited CP effects — successful categorical identification alongside within-category compression and between-category separation during discrimination — for famous, but not nonfamous faces
- These data suggest that personal familiarity influences the identification and discrimination of highly confusable face images
- BL, an individual with highly selective bilateral ischemic lesions of the DG, exhibited idiosyncratic identification of NF and significantly lower accuracy rates for within-category discrimination of NF
- Findings suggest that hippocampal integrity is necessary for supporting the discrimination of high-interference face stimuli — and that mediating this discrimination is pre-experimental familiarity with the faces
- **Our findings are the first to indicate that the perceptual act of CP and the mnemonic act of pattern separation are interrelated through underlying cognitive processes via a common hippocampal substrate**

## REFERENCE

Lee, Y., Smith, C.R., Grady, C.L., Hoang, N., & Moscovitch, M. (2014). Broadly tuned face representation in older adults assessed by categorical perception. *Journal of Experimental Psychology: Human Perception and Performance*, 40(3): 1060-1071.