Inter-subject hyperalignment of neural representational spaces

J. Swaroop Guntupalli, Andrew C. Connolly, and James V. Haxby
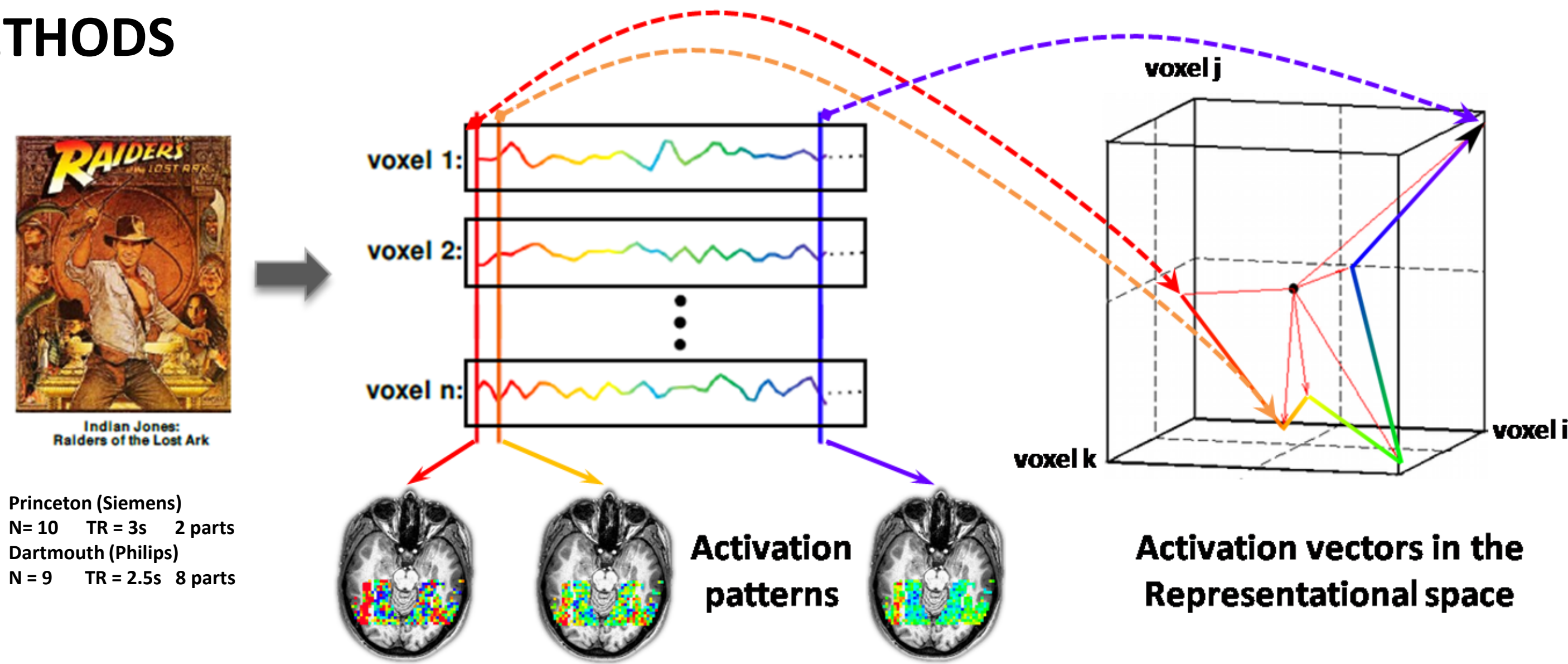
Dept. of Psychological & Brain Sciences, Dartmouth College, Hanover, NH, USA
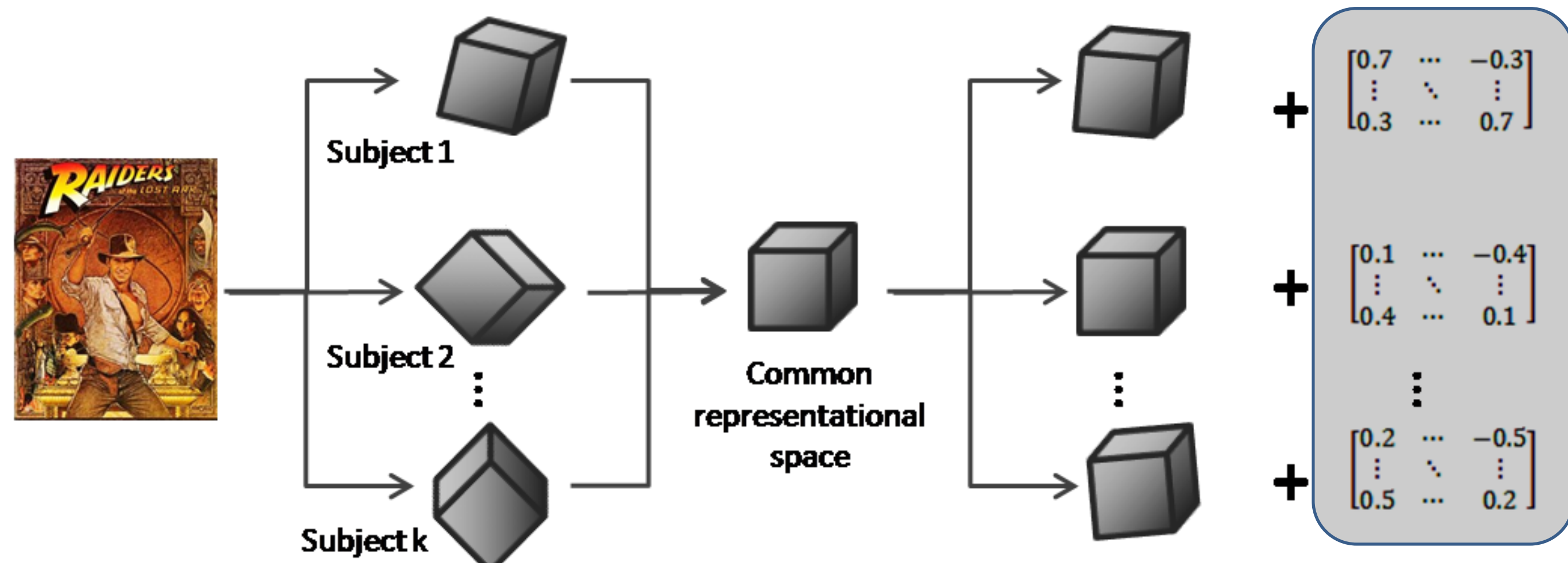
PyMVPA

INTRODUCTION

- **Fine scale categorical information** is present in fMRI activation **patterns at fine spatial scale** which can be decoded using multivariate pattern (MVP) analysis[1].
- Anatomy-based alignment does an inadequate job of aligning these fine scale patterns across subjects..
- We developed *Hyperalignment* to align the underlying neural representational spaces across subjects.
- We further derived a common low-dimensional representational space that seem to capture the categorical information present in the VT cortex.
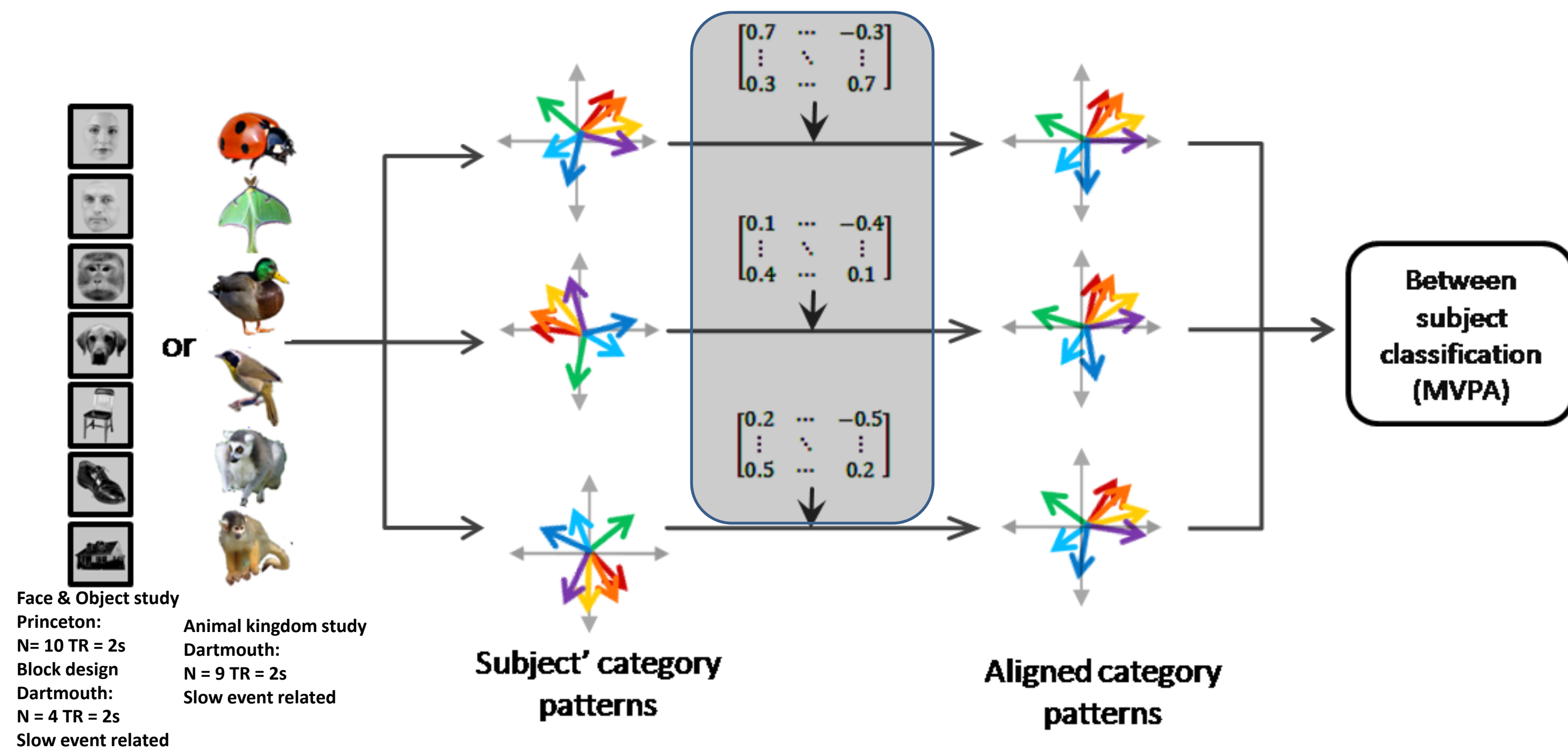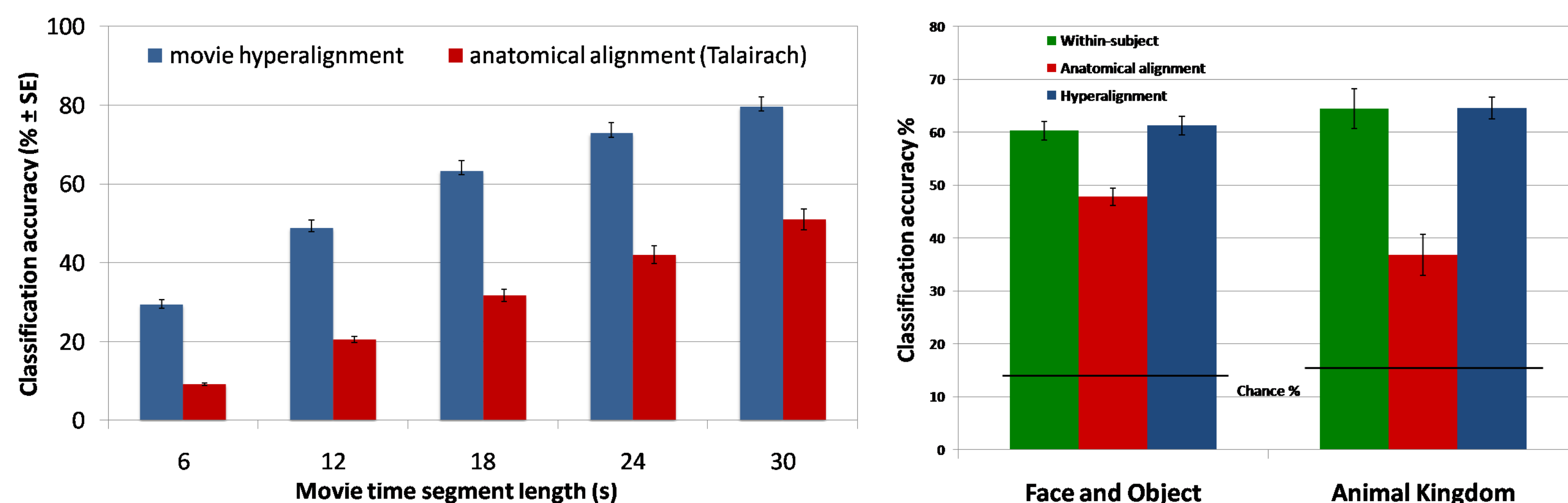
METHODS

Princeton (Siemens)
N = 10   TR = 3s   2 parts
Dartmouth (Philips)
N = 9   TR = 2.5s   8 parts

Activation patterns

Activation vectors in the Representational space

Hyperalignment

Deriving common space and hyperalignment parameters

Subject 1
Subject 2
Subject k
Common representational space

Hyperalignment to common space using parameters

Between subject classification (MVPA)

Face & Object study
Princeton:
N= 10 TR = 2s
Block design
Dartmouth:
N = 4 TR = 2s
Slow event related

Animal kingdom study
Dartmouth:
N = 9 TR = 2s
Slow event related

Subject' category patterns

Aligned category patterns

RESULTS

Movie time segment length (s)

Face and Object   Animal Kingdom
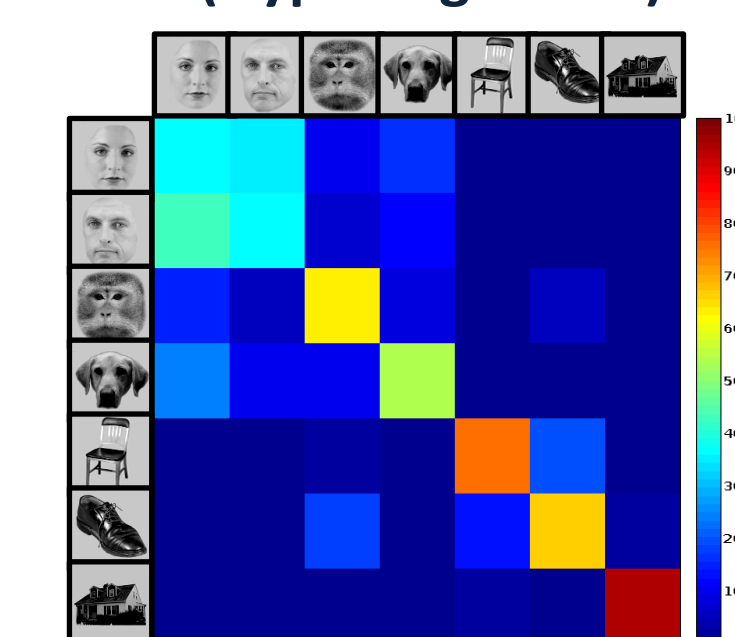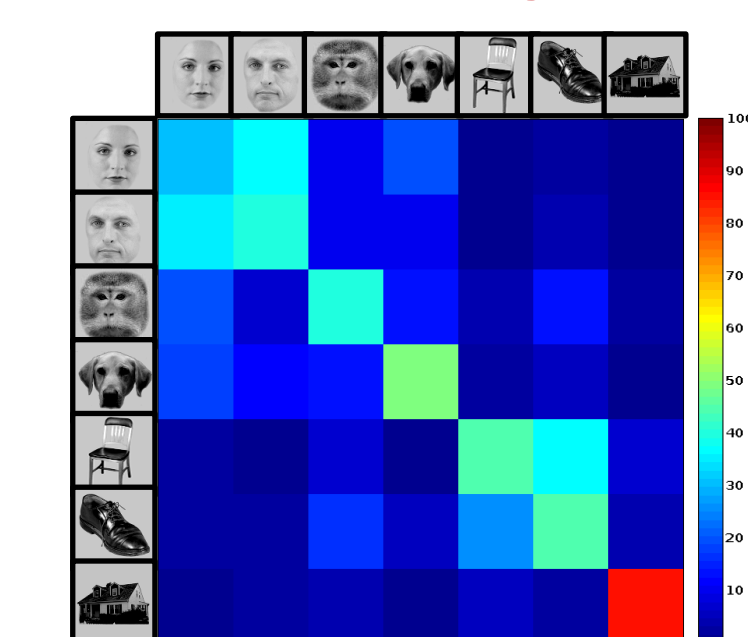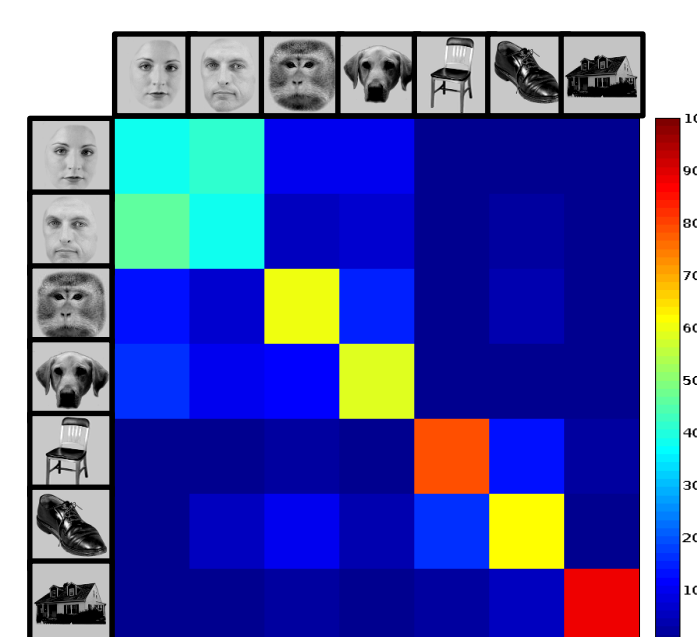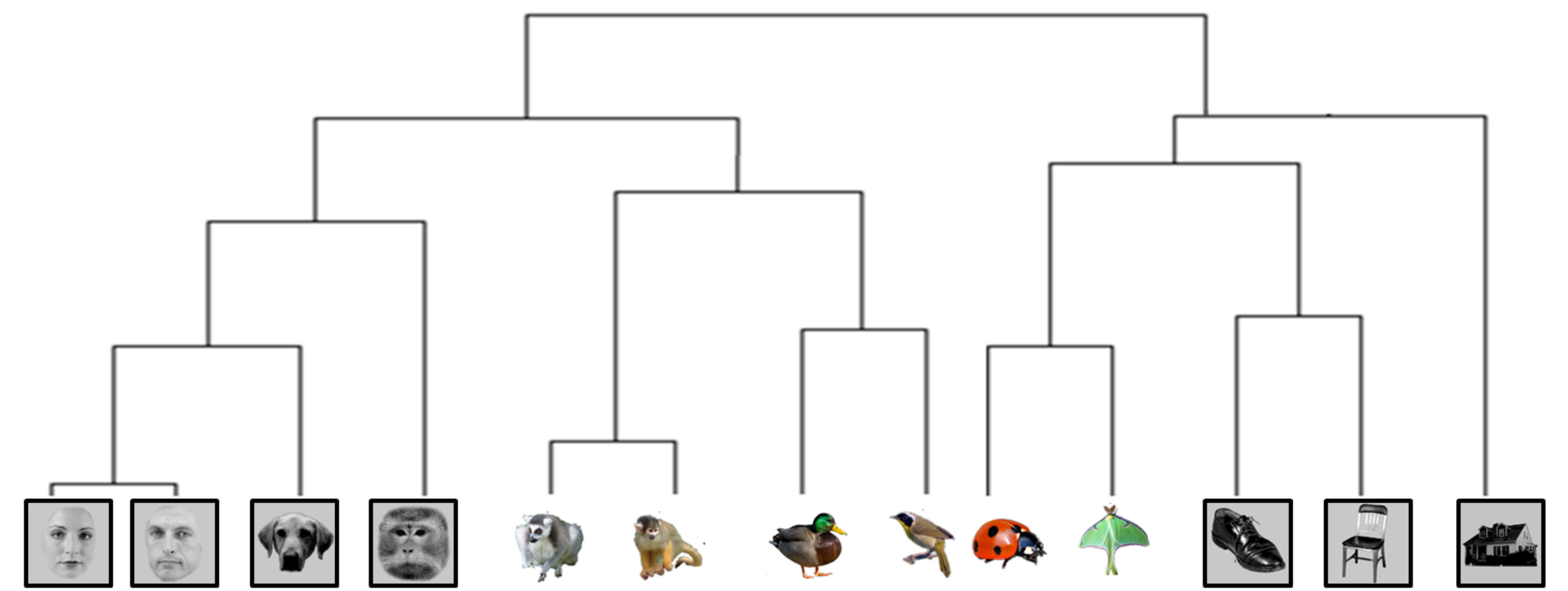
Within-subject Classification

Between-subject classification (Anatomical alignment)

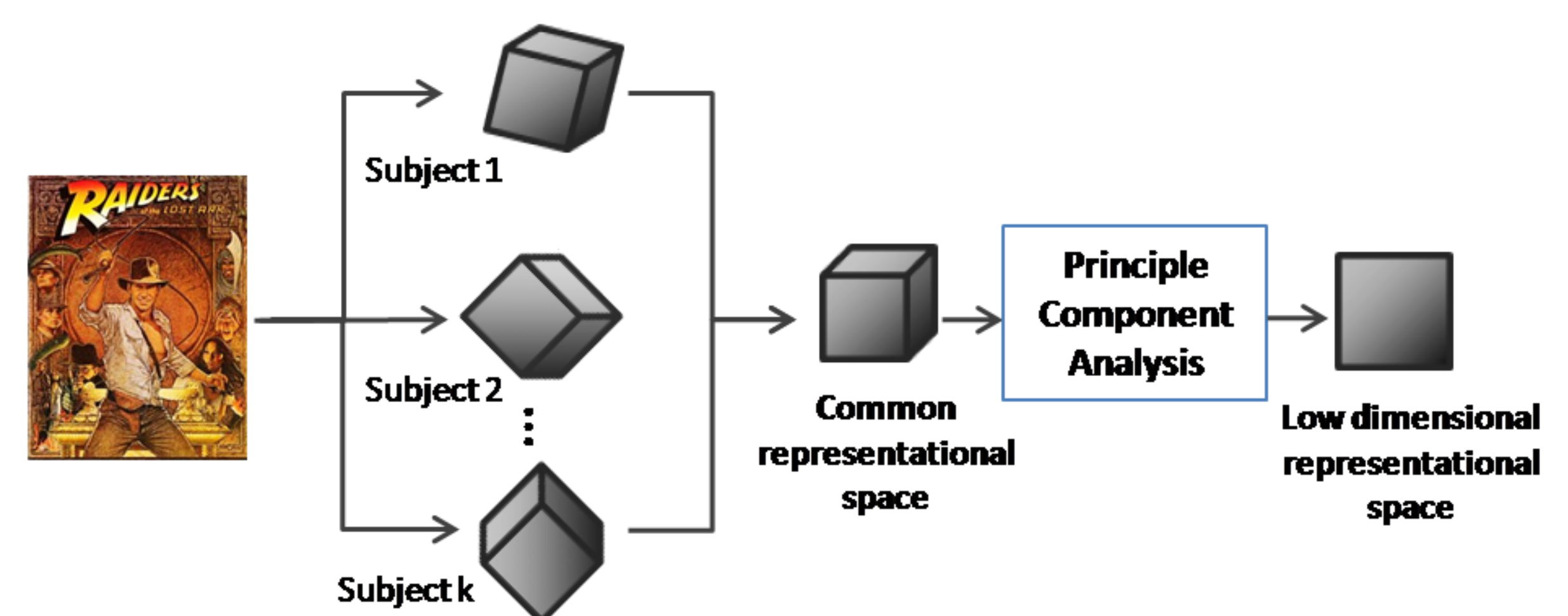Between-subject classification (Hyperalignment)
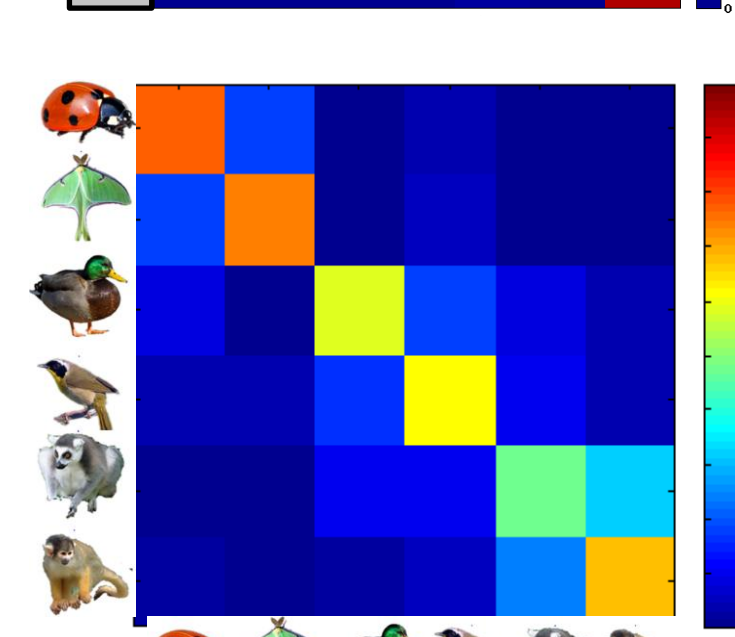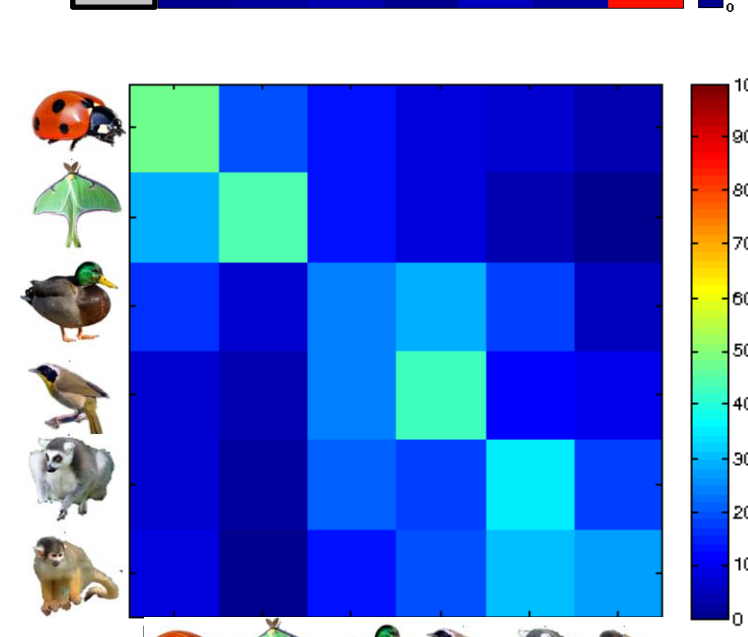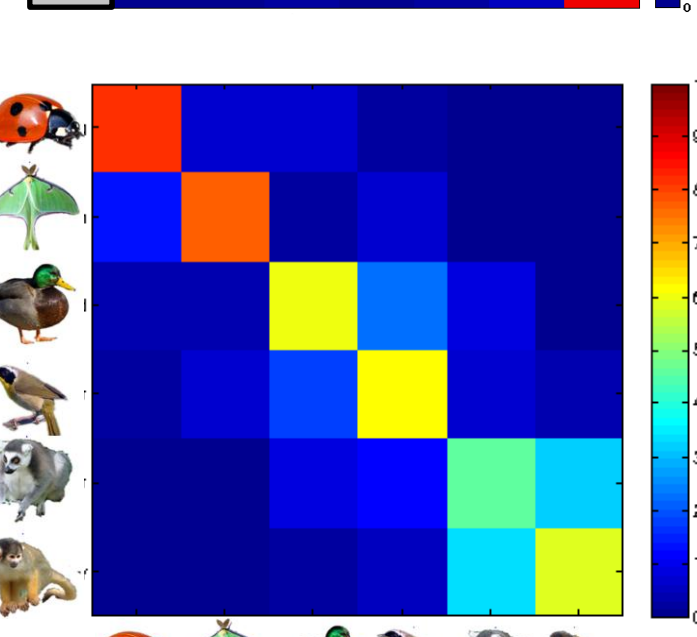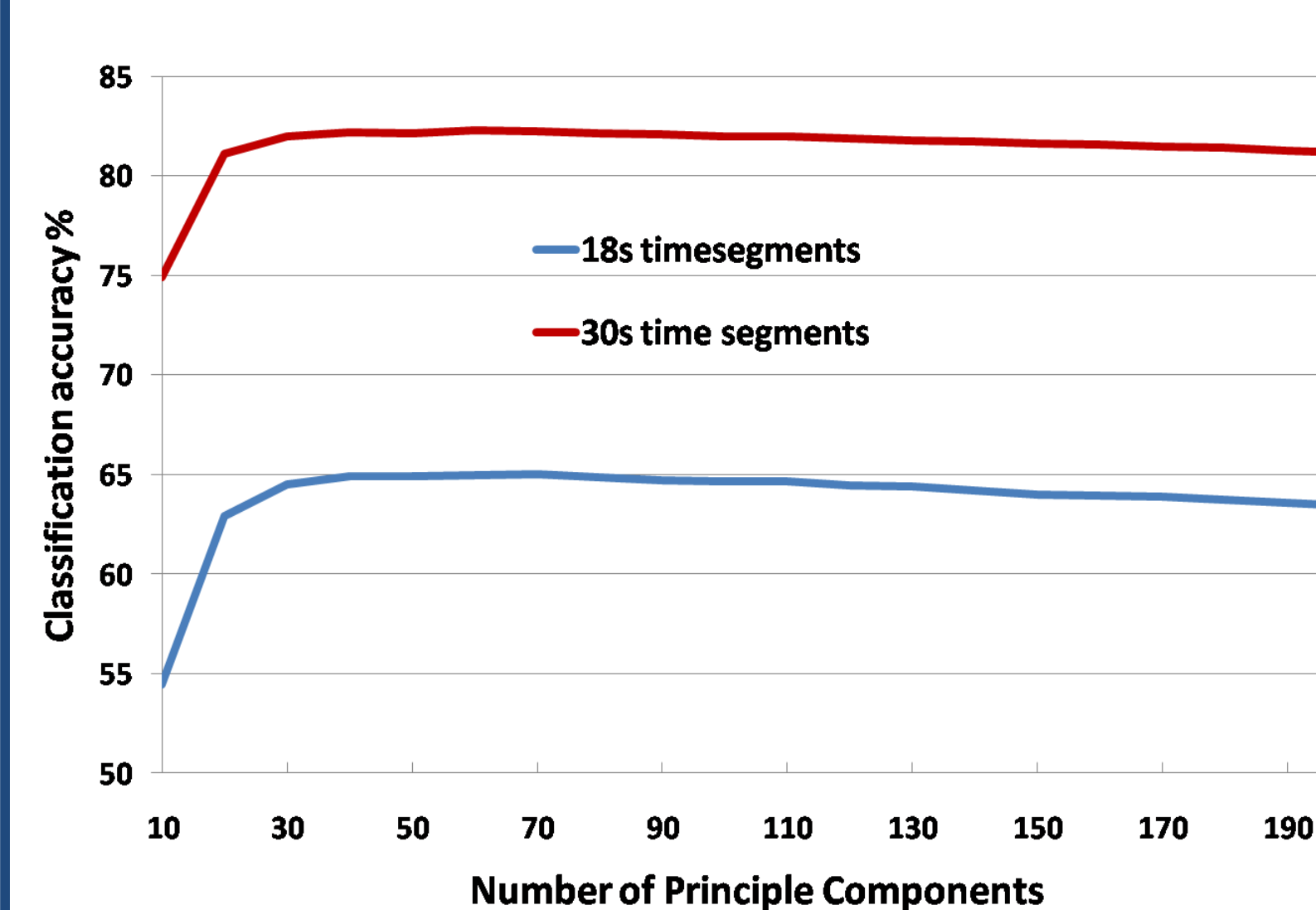

Combined similarity structure

Combined data from different imaging studies conducted at different imaging centers on different subjects.
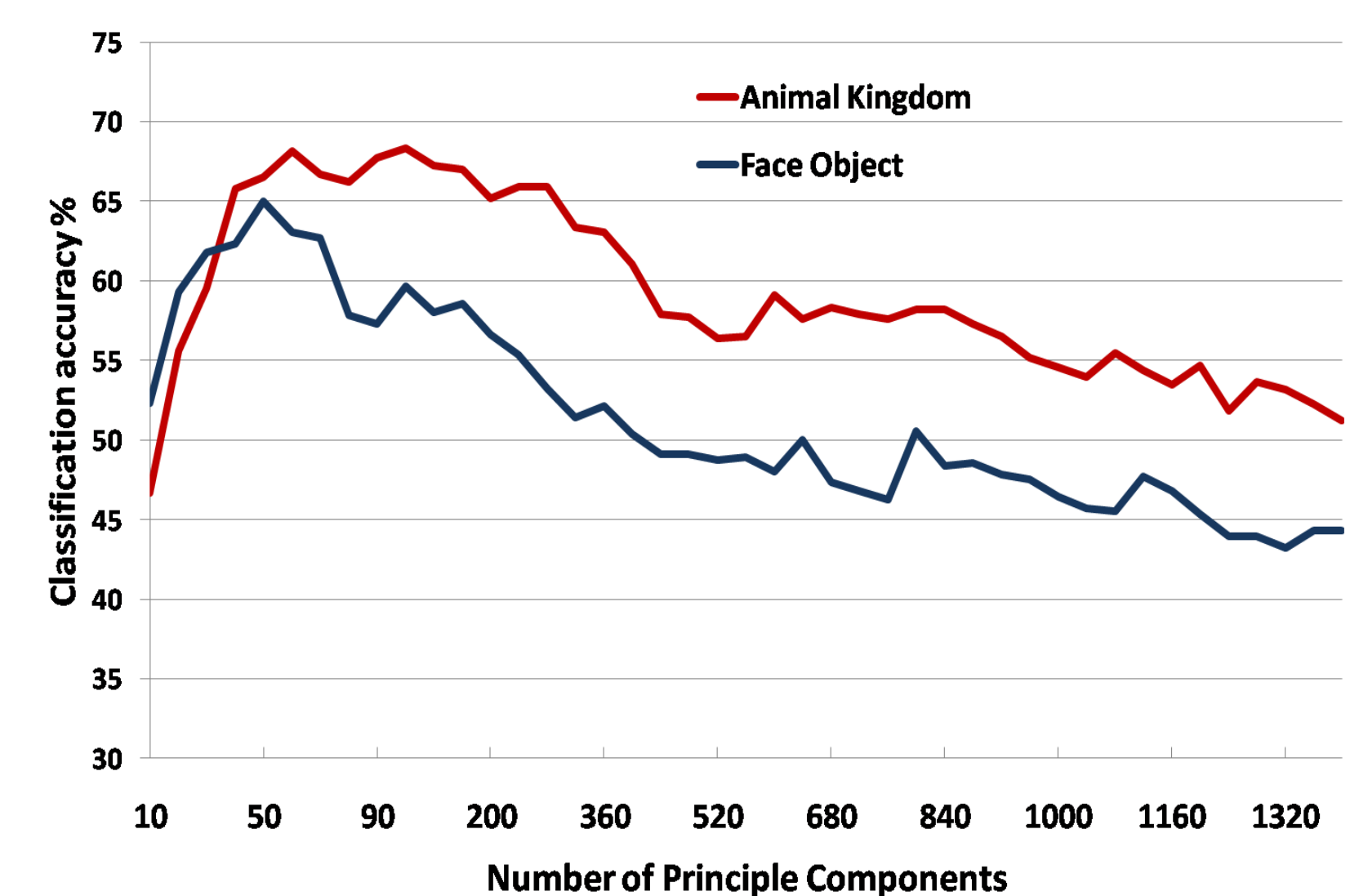
Representational space
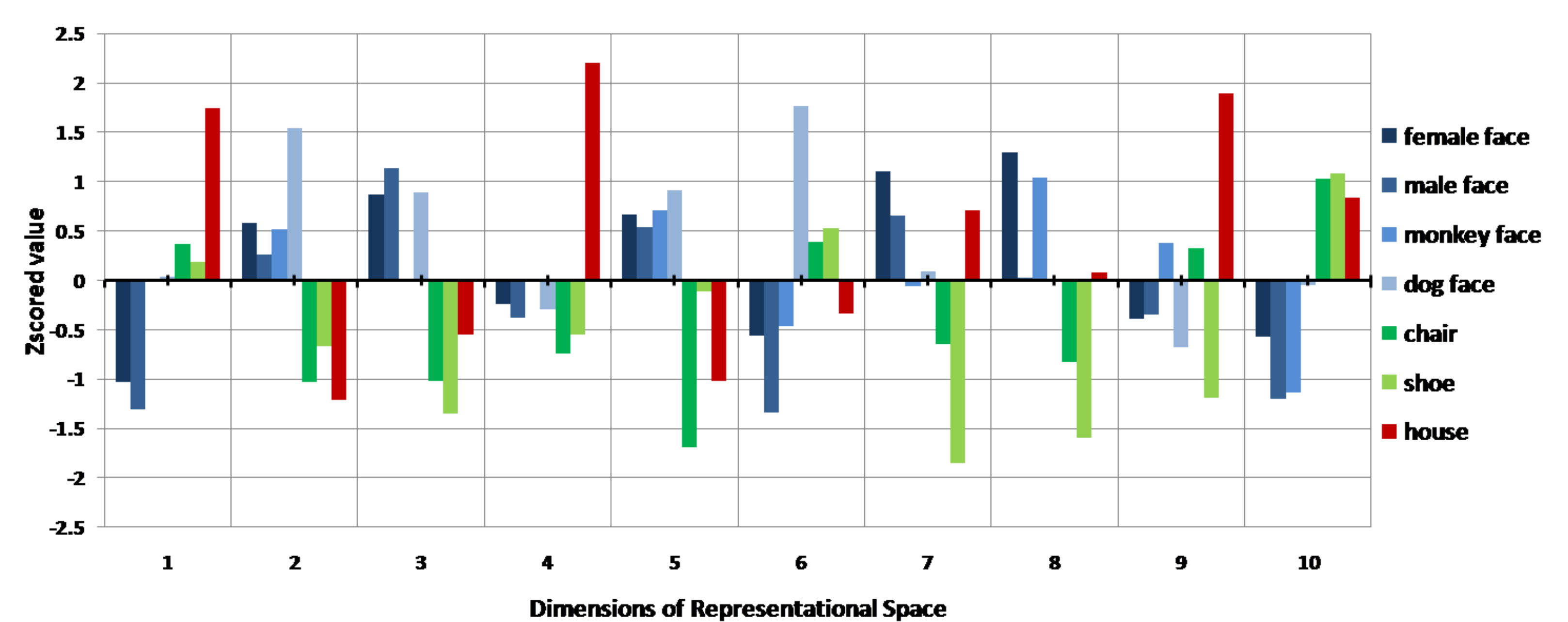
Deriving low dimensional representational space

Subject 1
Subject 2
Subject k
Common representational space → Principle Component Analysis → Low dimensional representational space

Movie time segment classification

18s timesegments
30s time segments

Number of Principle Components

Category classification

Animal Kingdom
Face Object

Number of Principle Components

Components of representational space

female face
male face
monkey face
dog face
chair
shoe
house

Dimensions of Representational Space

CONCLUSIONS

- **Hyperalignment** aligns the underlying neural representational spaces and **reveals** a higher level of **commonality in the** underlying **neural codes** across subjects**.**

- A low-dimensional representational space seems to capture the information represented in VT cortex.

References
1. Haxby, J.V., Gobbini, M.I., Furey, M.L., Ishai, A., Schouten, J.L., Pietrini, P. Distributed and overlapping representations of faces and objects in ventral temporal cortex. *Science* **293**, 2425-2430 (2001).