

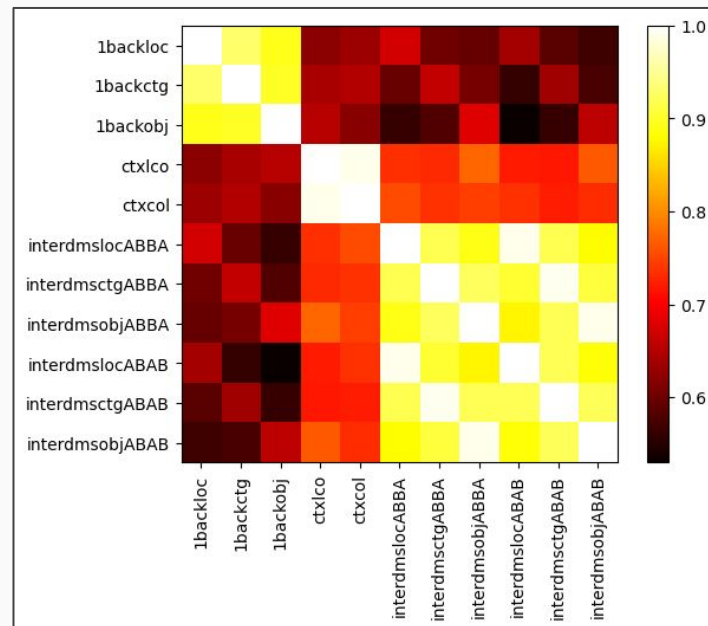
Compositional Tasks - FMRI Analysis

Bashivan Lab, April 24, 2024

Sentence Embeddings (original instructions)

Comparing tasks similarity by language....

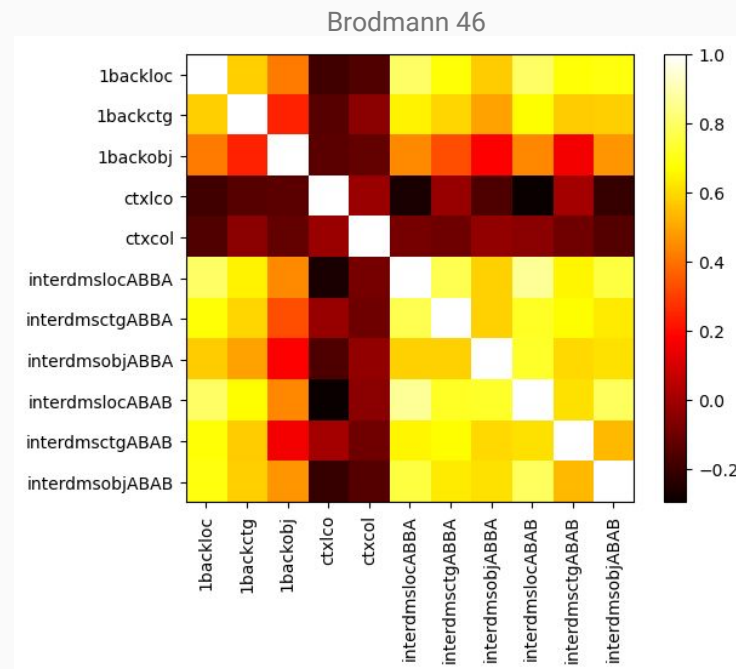
- Sentence embeddings
- Cosine similarity -> RSM

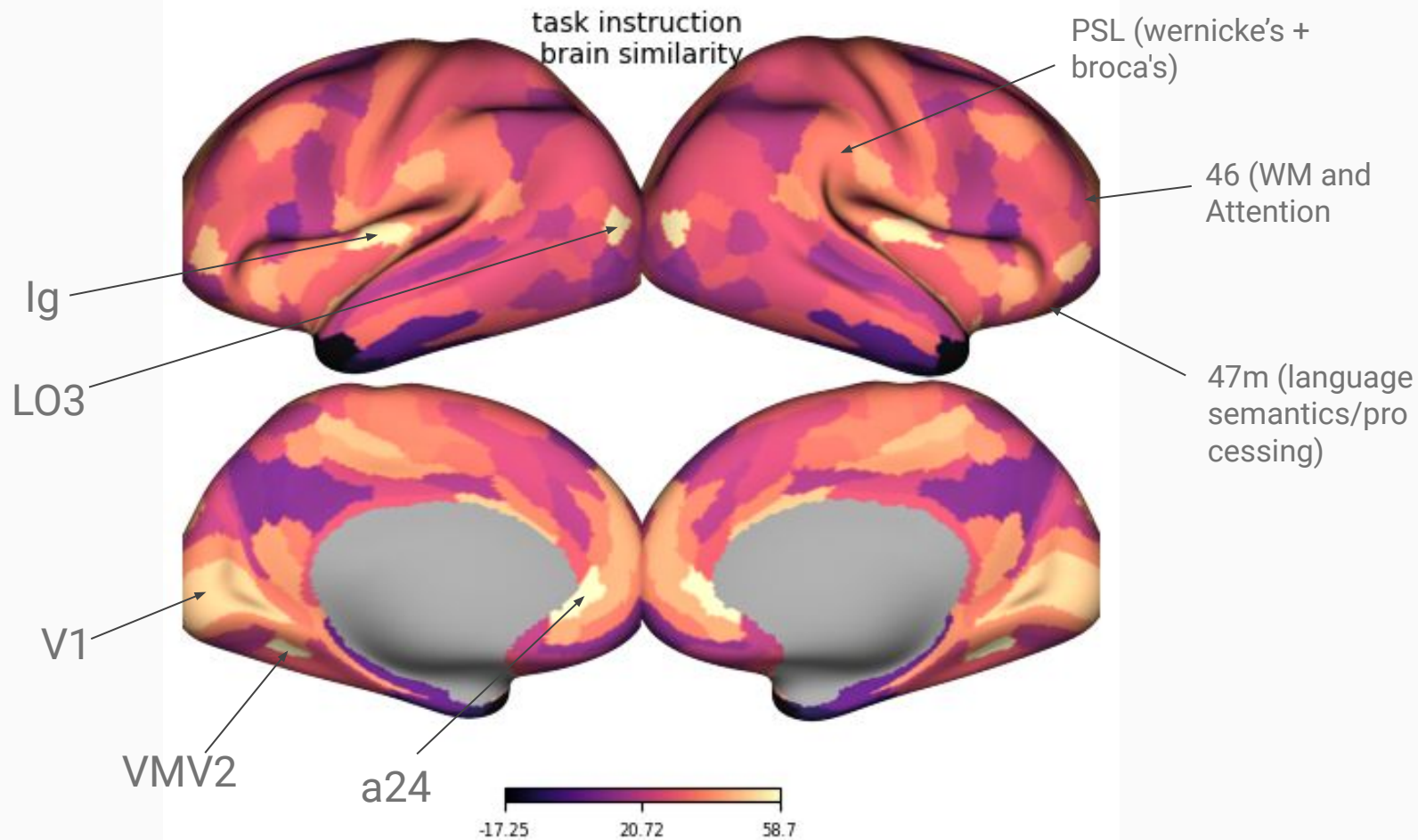


FMRI Data

Averaged GLM Betas across runs and trials...

- Per region and per task betas
- Cosine Similarity -> RSMs for all regions





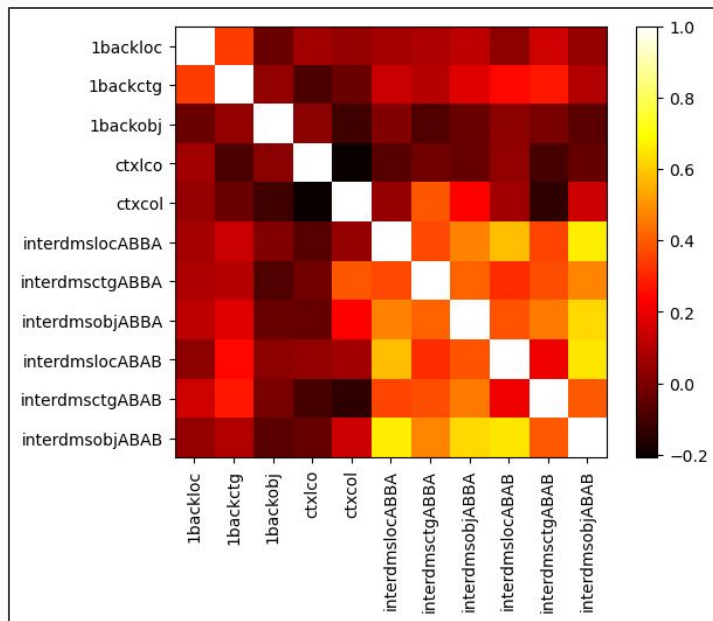
Brain & Language RSM Correlation Map (original instructions)

Top 5 Similar Regions (original instructions)

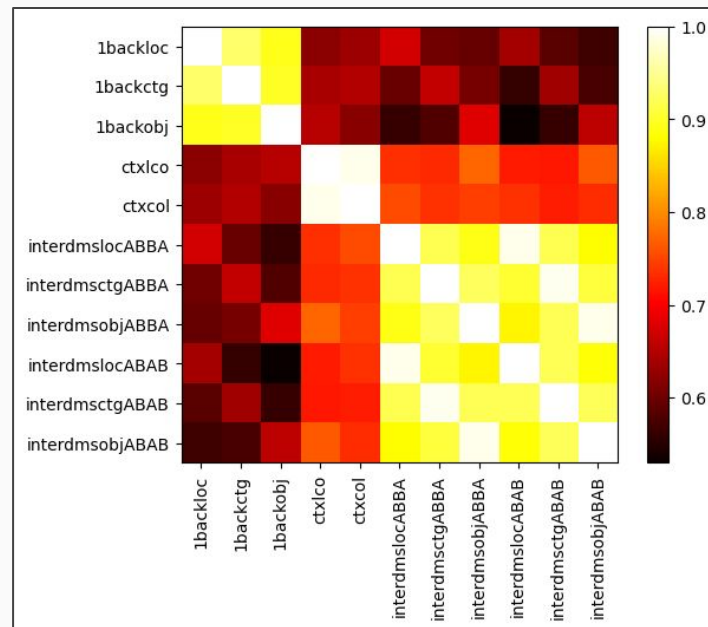
Region	Similarity	Function Info
VMV2 (PHC-1) - VentroMedial Visual Area 2	0.5870	Episodic memory, spatial processing, and the encoding of novel stimuli.
a24 - Narrow strip of anterior cingulate cortex	0.5810	Attention allocation, reward anticipation, decision-making, impulse control (e.g. performance monitoring and error detection), and emotion.
LO3 - Area Lateral Occipital 3	0.5505	Visuospatial processing, distance and depth perception, color determination, object and face recognition, and memory formation.
Ig - Insular Granular Complex	0.53790	Variety of functions ranging from sensory processing to representing feelings and emotions, autonomic and motor control, risk prediction and decision-making.
V1 - Primary visual cortex	0.4952	Receives, integrates, and processes visual information relayed from the retinas.

Comparing Top Region RSM

VMV2 (PHC-1)



Sentence Embeddings



Adjusting the 1-back instructions

1backloc:

- 'In this task, you will see sequences of six stimuli. From the second stimulus onwards, you must answer whether the current stimulus matches the previous one in LOCATION?'

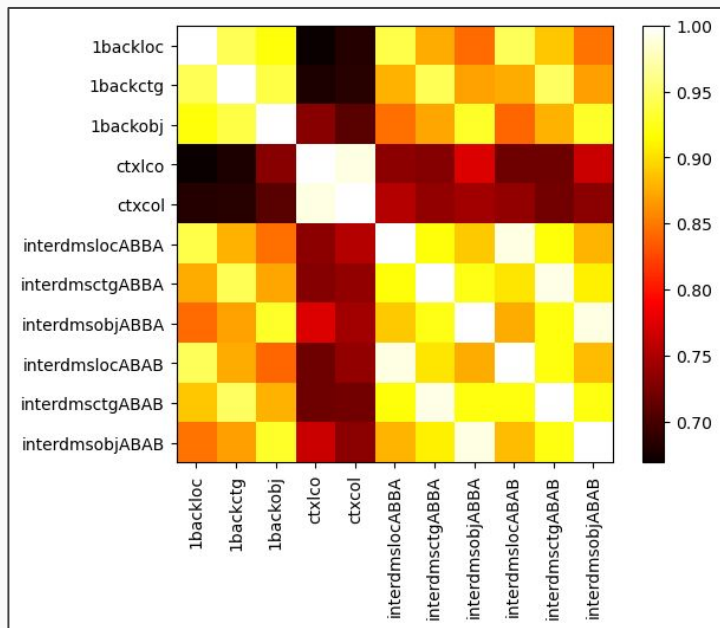
New 1backloc:

- '1backloc': 'Match stimuli 1 and 2, 2 and 3, 3 and 4, 4 and 5, 5 and 6 based on LOCATION. Respond as fast as you can'

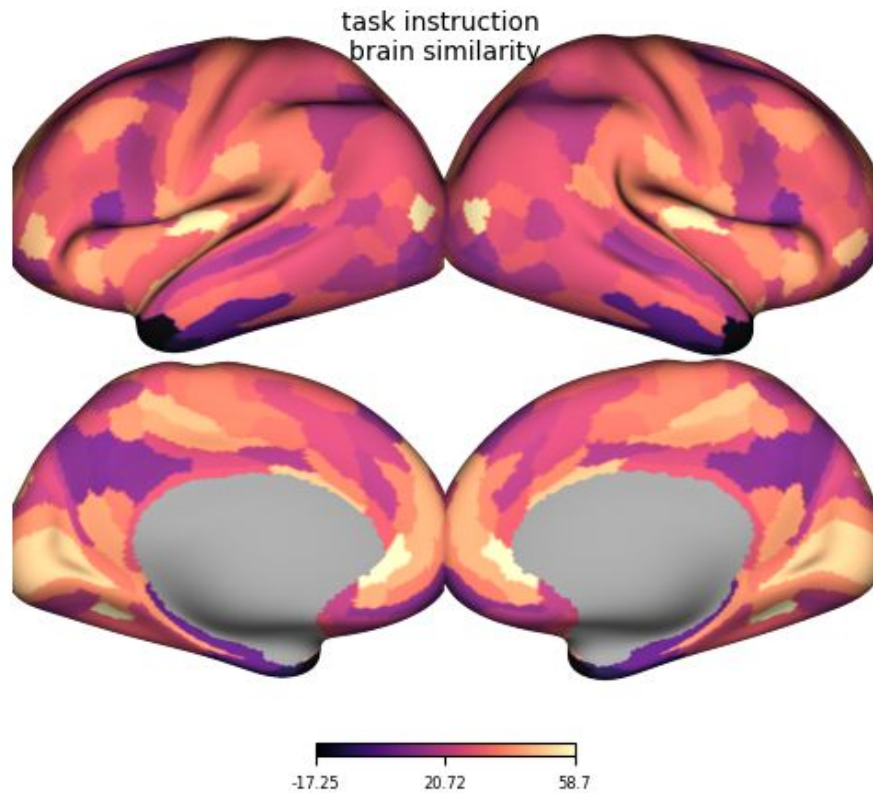
Sentence Embeddings (w/ 1back instructions adapted)

Comparing tasks similarity by language....

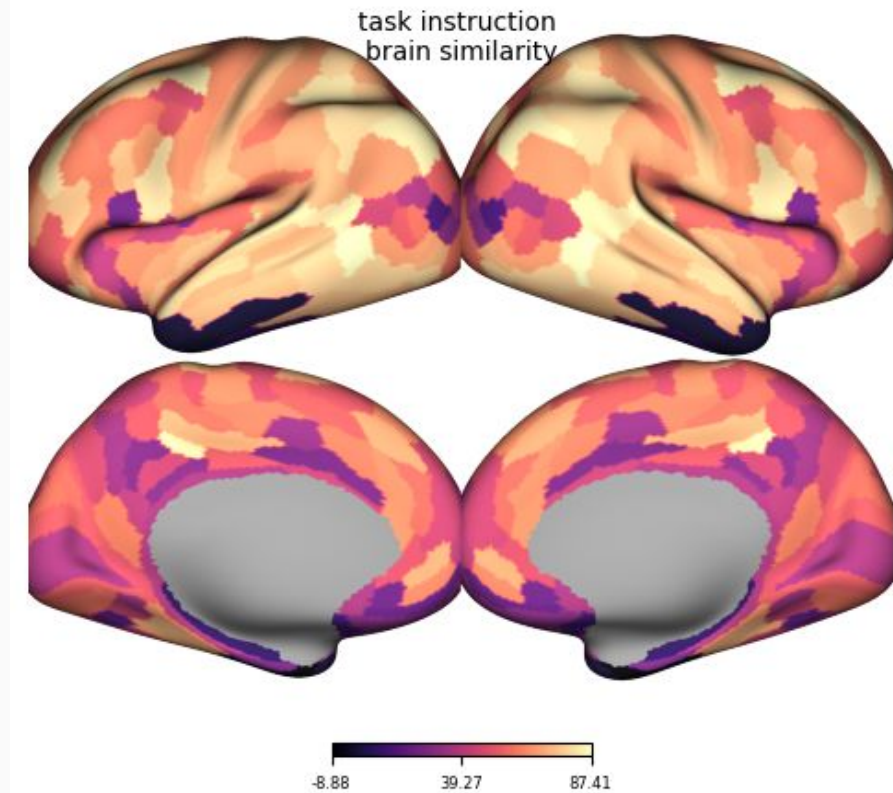
- Sentence embeddings
- Cosine similarity -> RSM

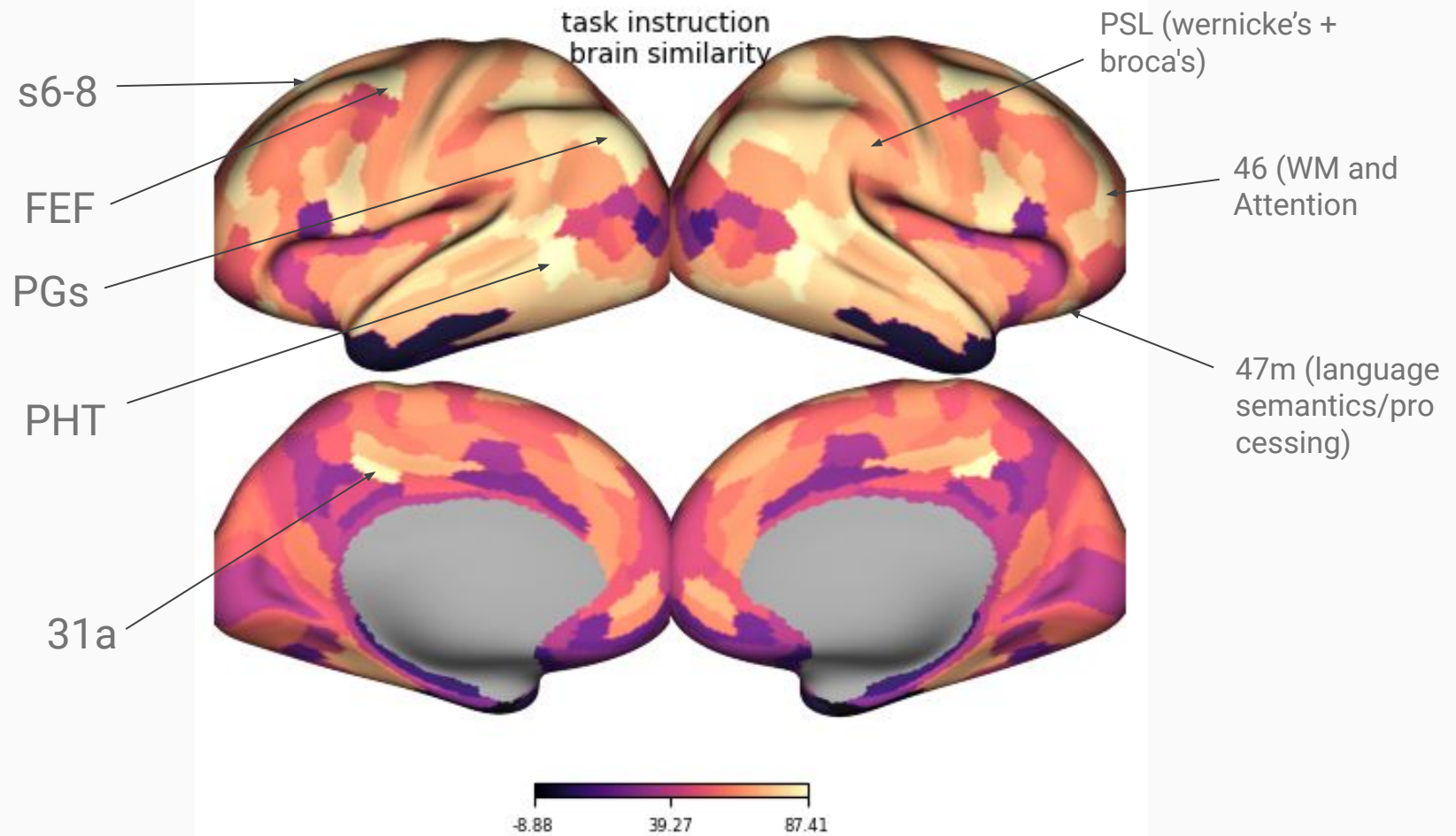


Before Instruction Change



After Instruction Change





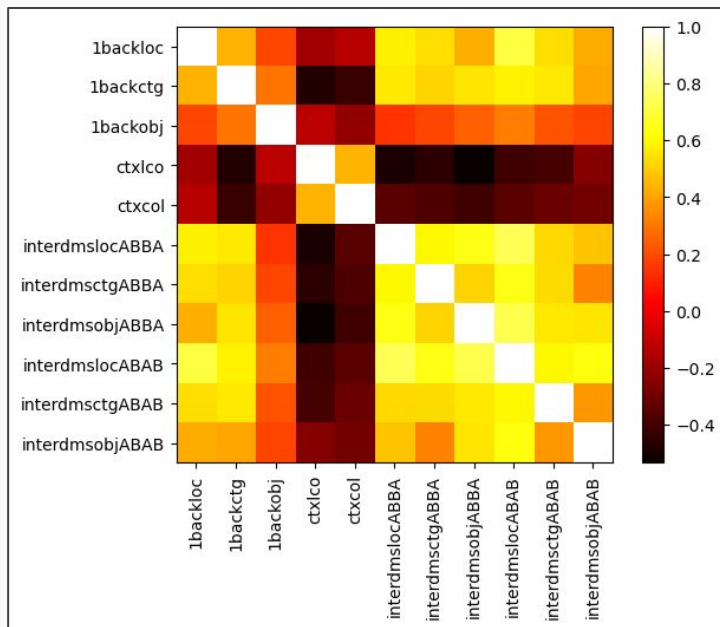
Brain & Language RSM Correlation Map (w/ 1back instructions adapted)

Top 5 Similar Regions (w/ 1back instructions adapted)

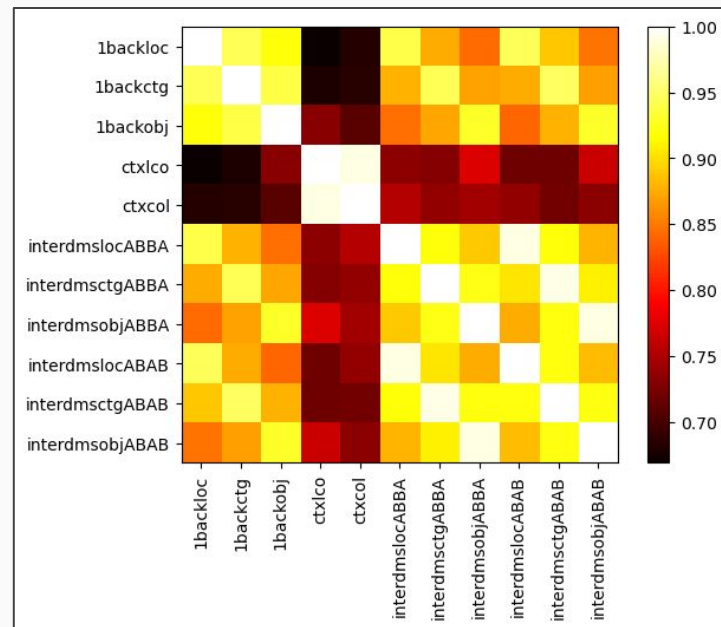
Region	Similarity	Function Info
PHT - anterior portions of the subcentral gyrus	0.8741	Involved in the automatic retrieval of specific semantic information
S6-8 - located at the posterior most superior frontal gyrus	0.8594	involved in the maintenance of spatial information
FEF - frontal eye field	0.8502	it is involved in voluntary eye movements
31a - part of posterior cingulate cortex	0.8456	strong associations for activity during many cognitive tasks.
PGs - Posterior half of inferior parietal cortex	0.8424	Spatial attention, multimodal sensory integration, and oculomotor control

Comparing Top Region RSM

PHT

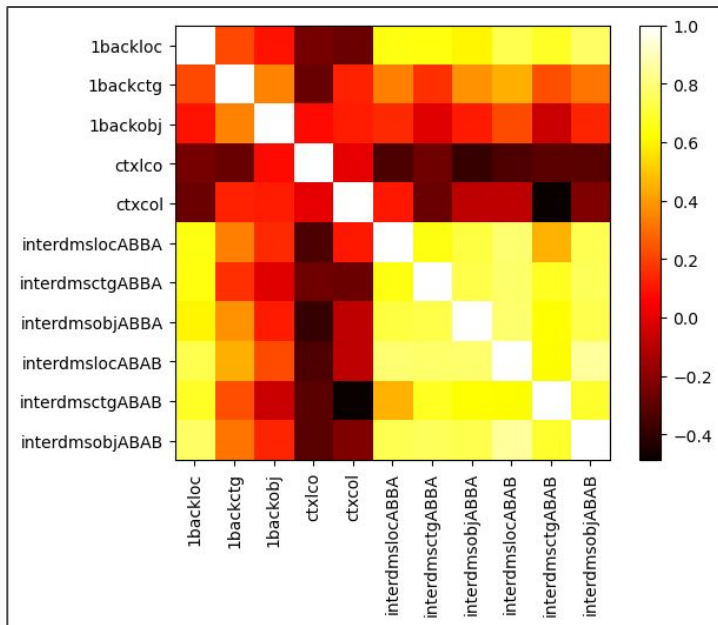


Sentence Embeddings

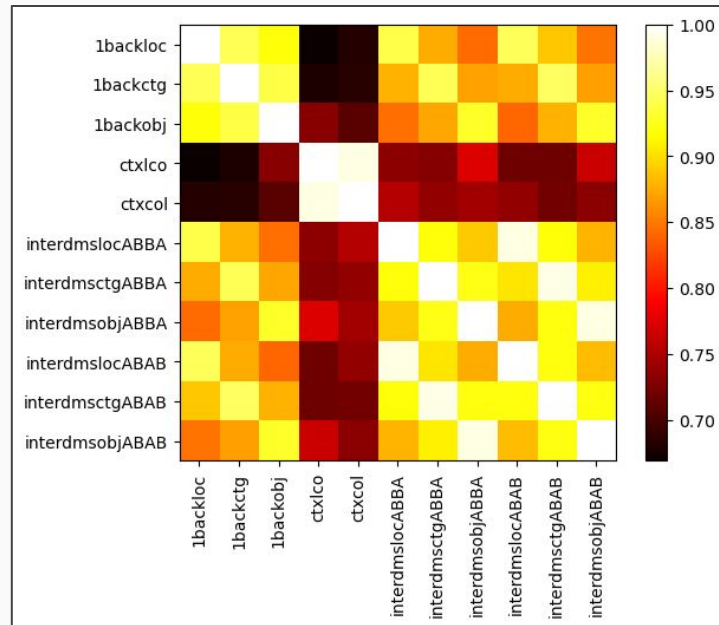


Comparing Broca/Wernicke RSM

PSL

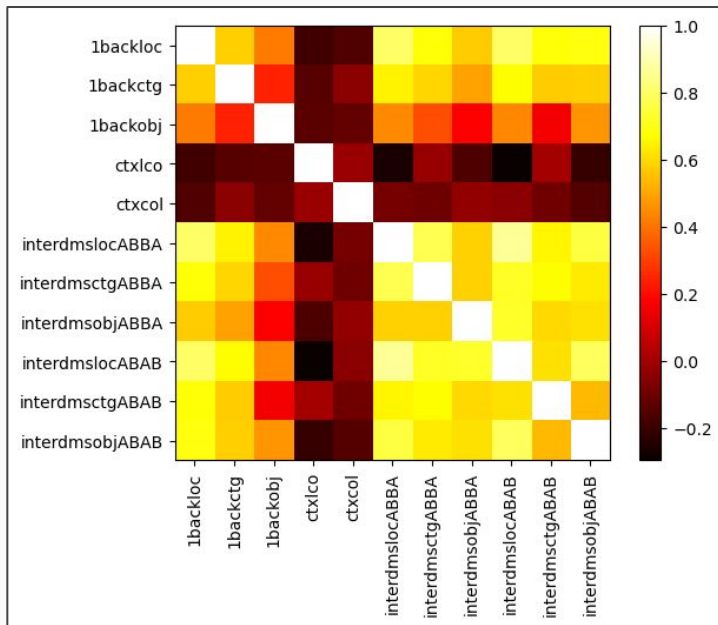


Sentence Embeddings

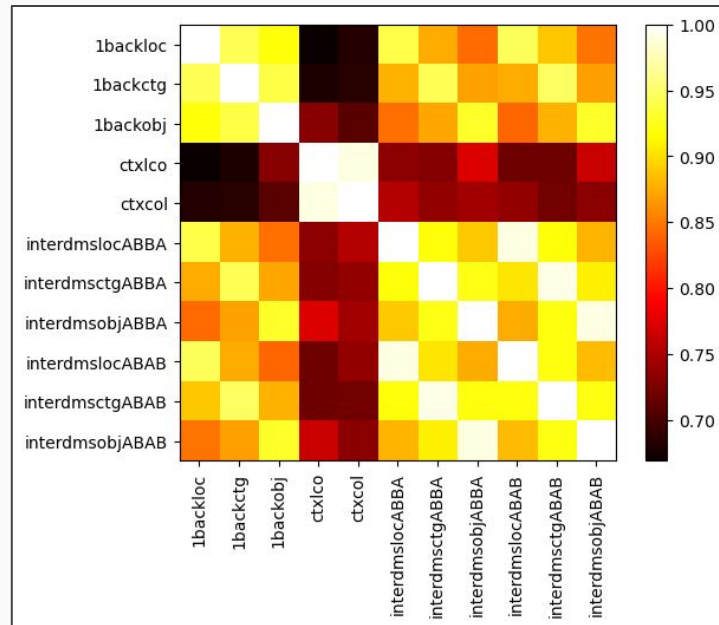


Comparing BA46 RSM

46



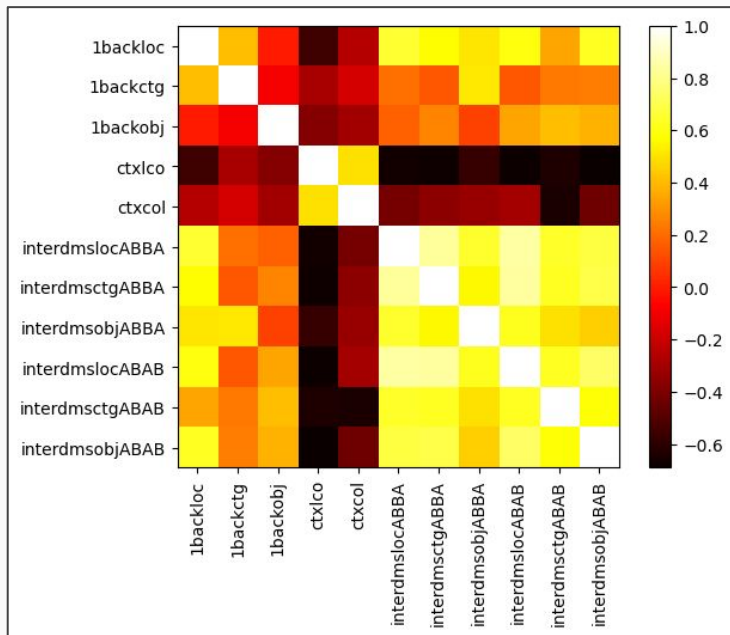
Sentence Embeddings



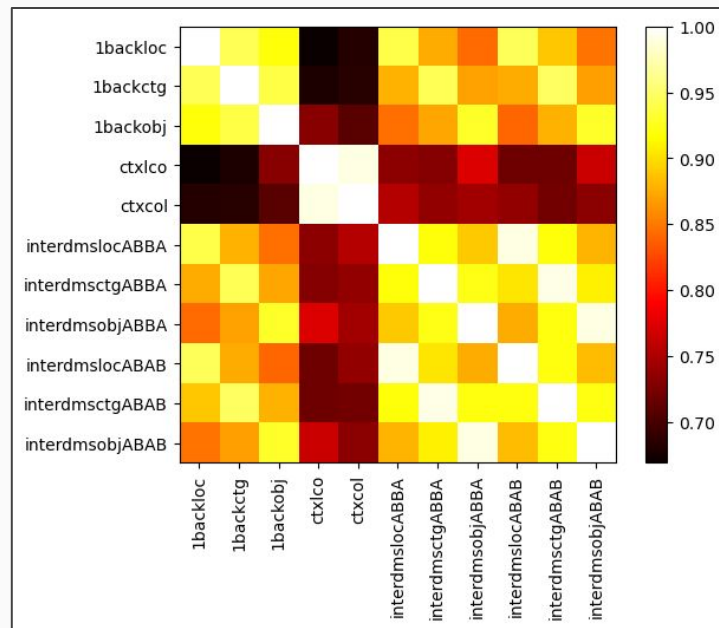
Comparing BA47m RSM

Analyze tasks based
on shared features. Zero out everything
but a single feature and mask the brain
data with and then compare the resulting RSMS

47m

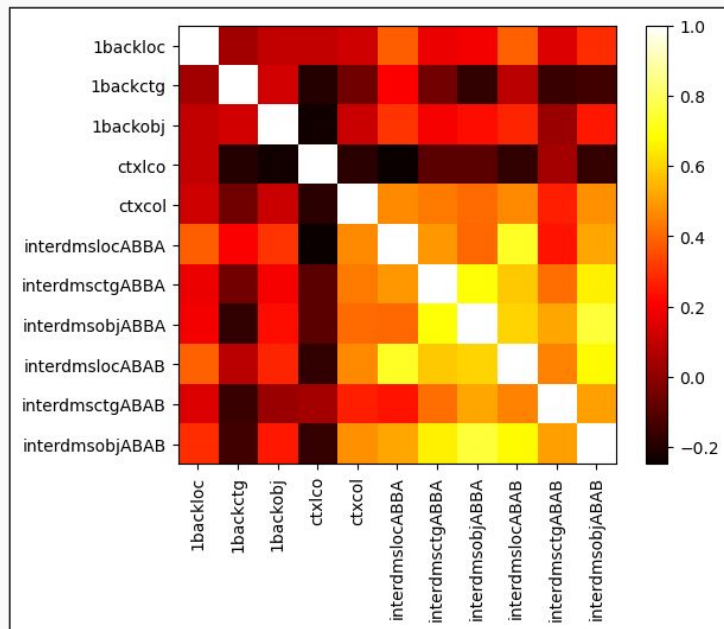


Sentence Embeddings

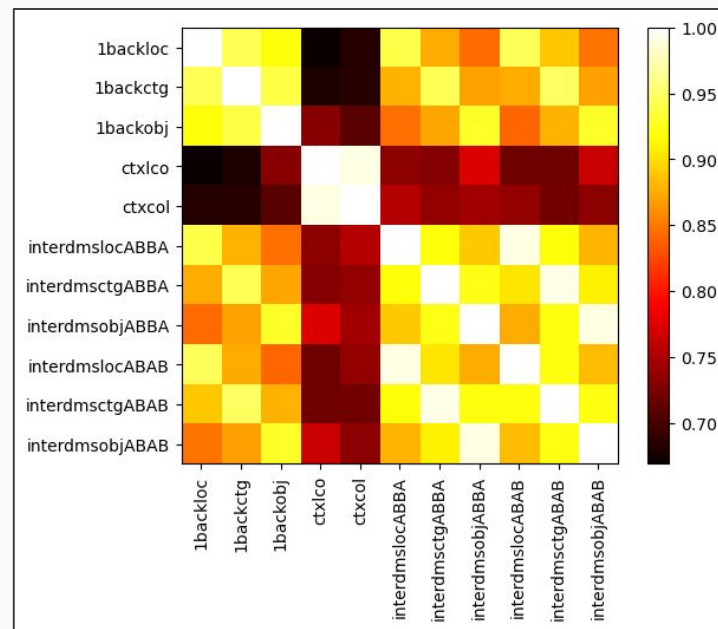


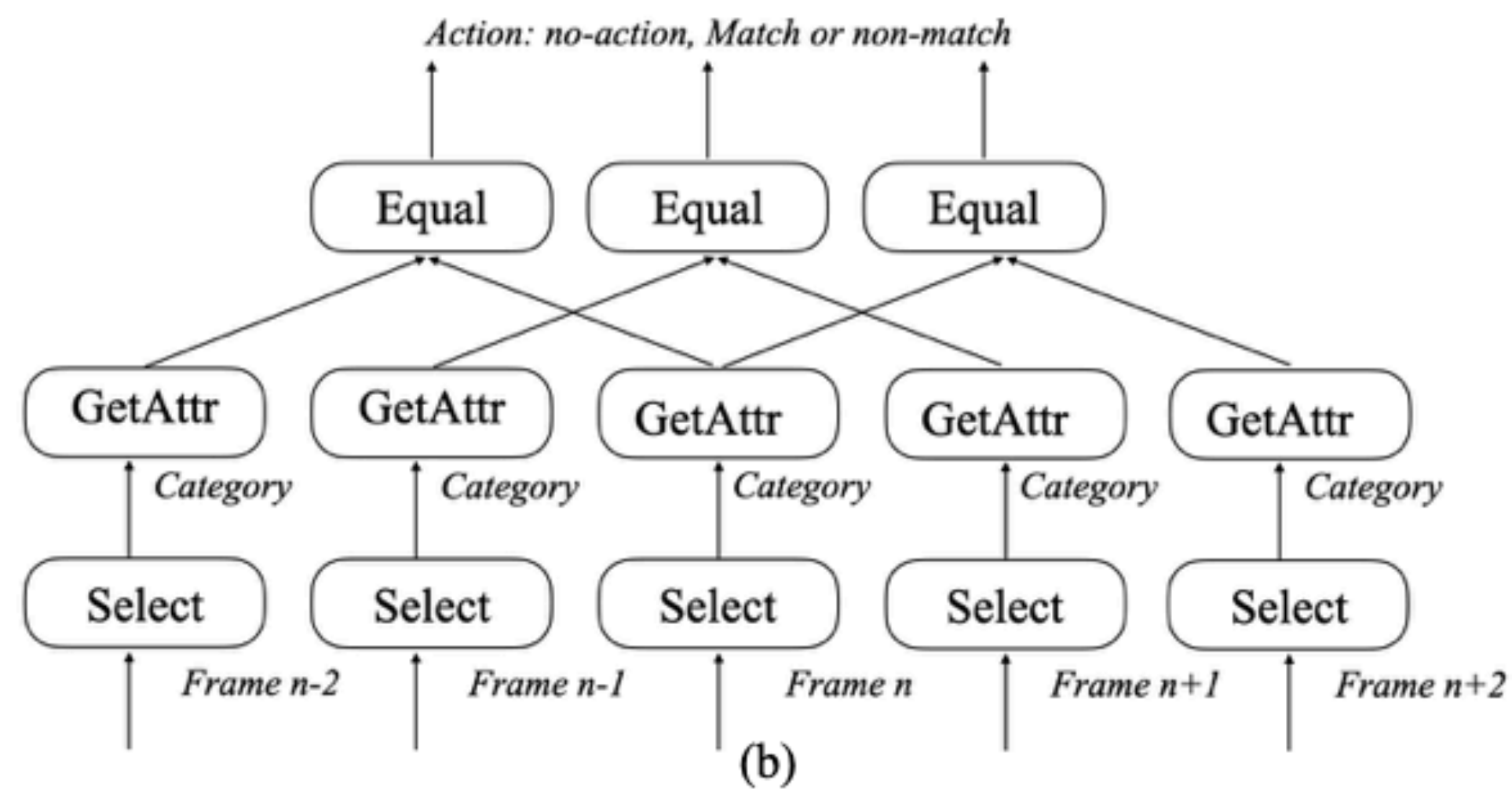
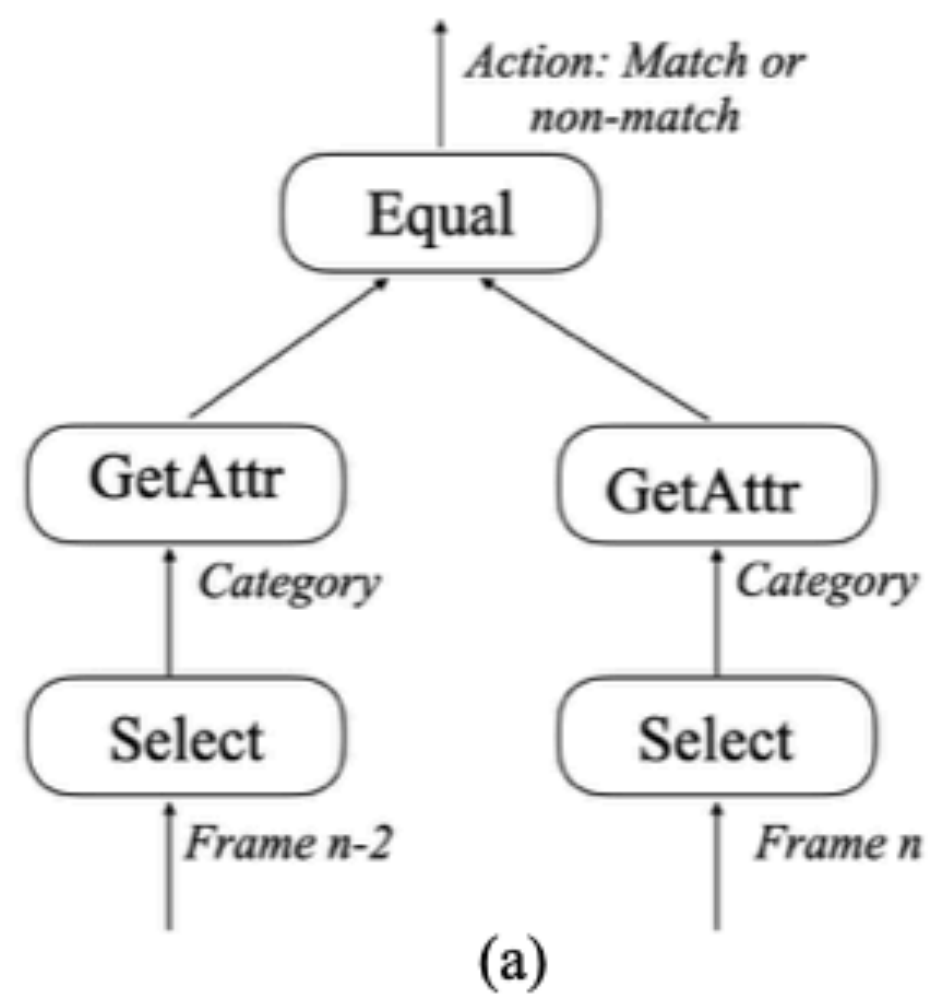
Comparing V1 RSM

V1



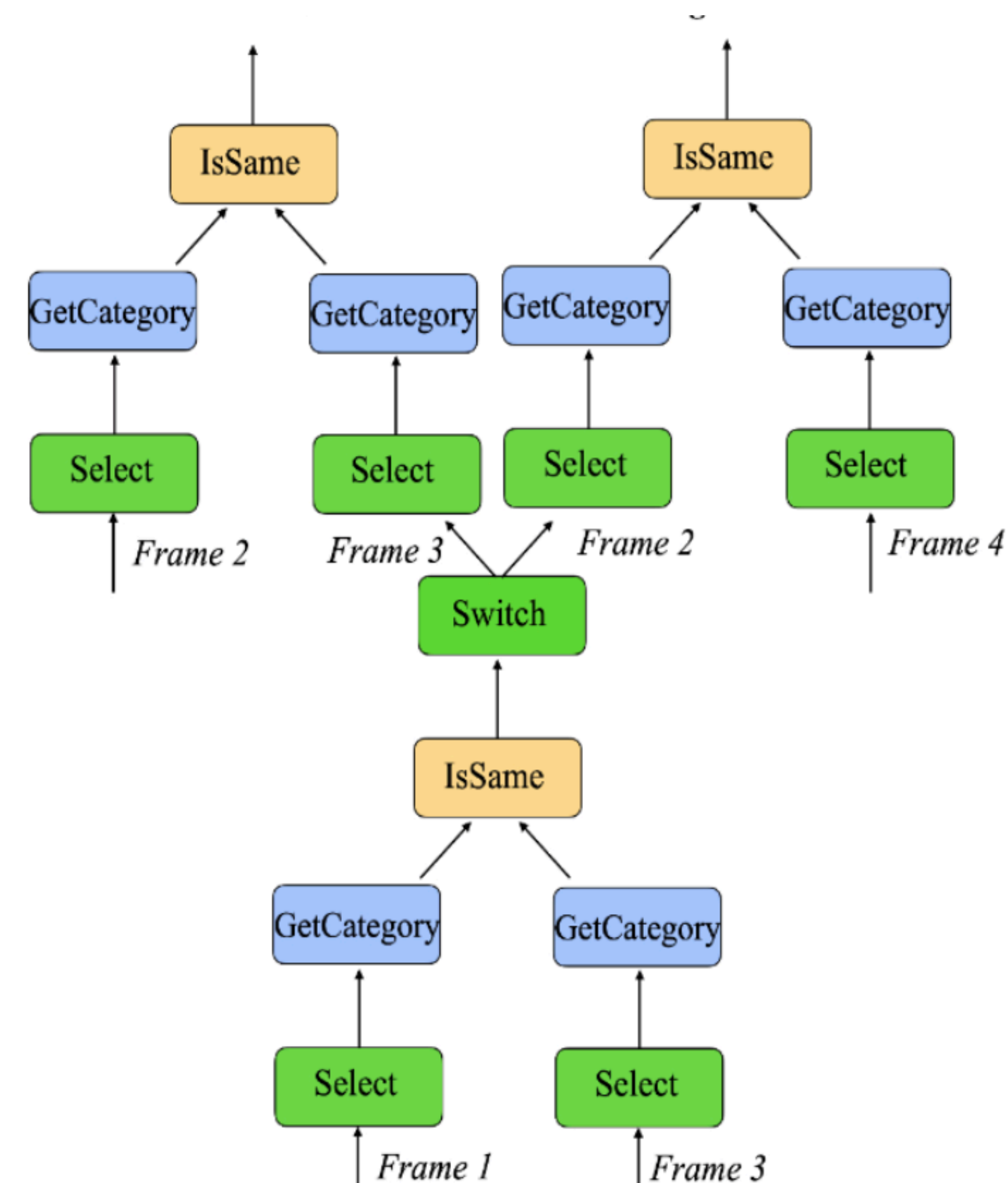
Sentence Embeddings





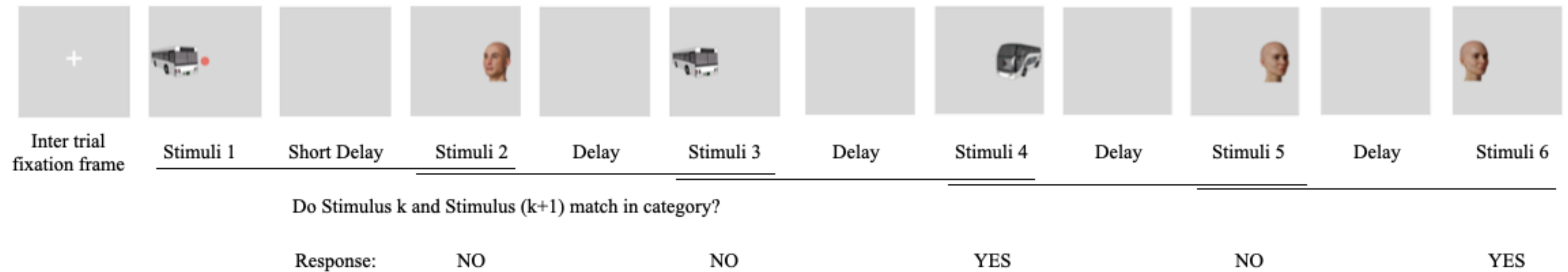
Delay Match To Sample

2-back: temporal composition of DMS

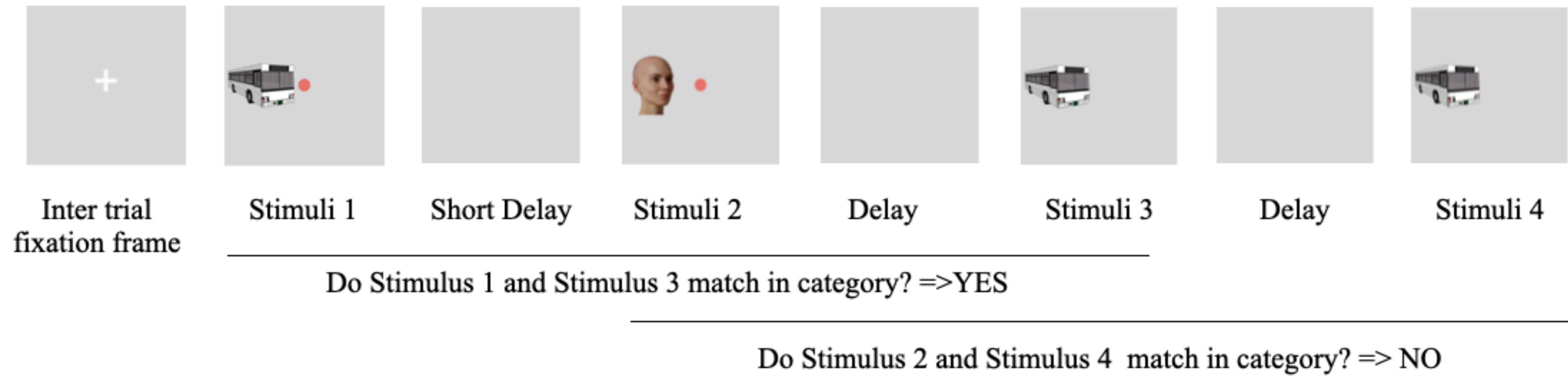


ctxDM: logical composition of DMS

Task Set: N-back: 3 task variations (n = 1, * 3 features of interest: category, identity and location)



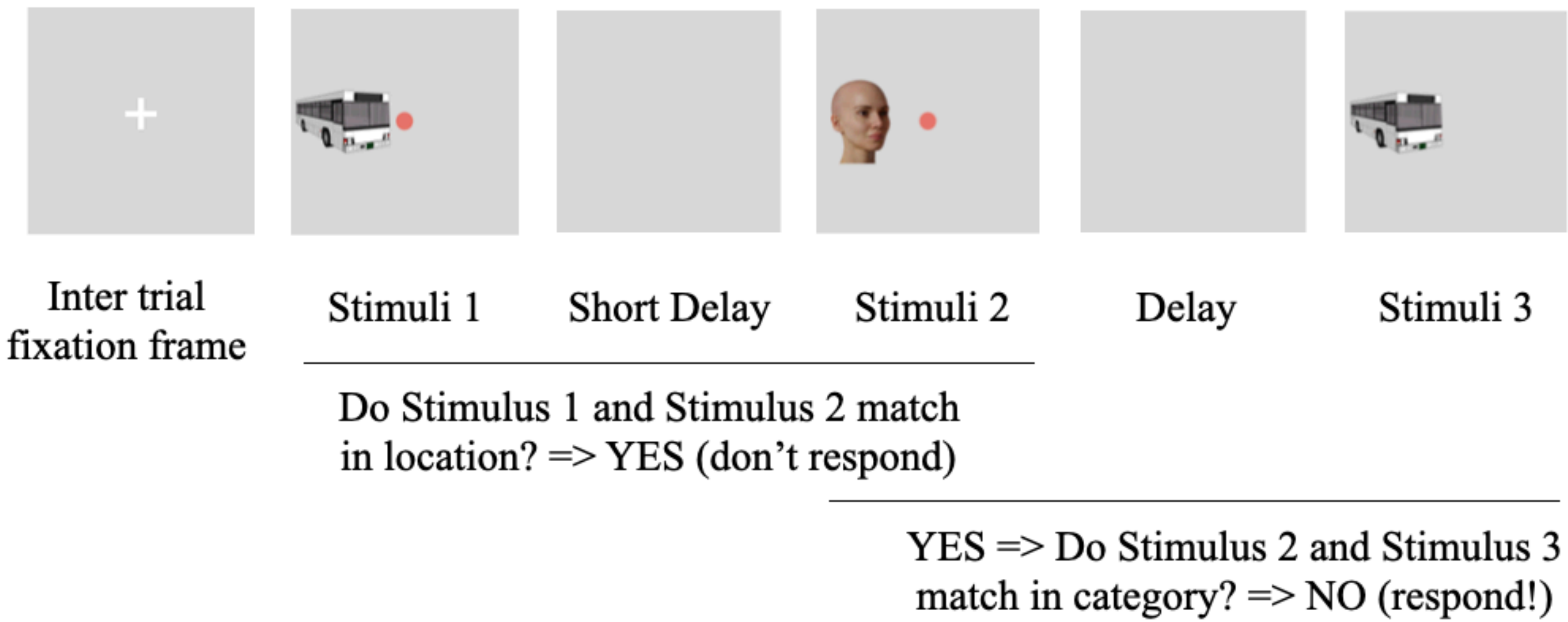
Task Set: Interleaved Delay Match to Sample (2 patterns * 3 features = 6 variations)



An example of interDMS ABAB category task

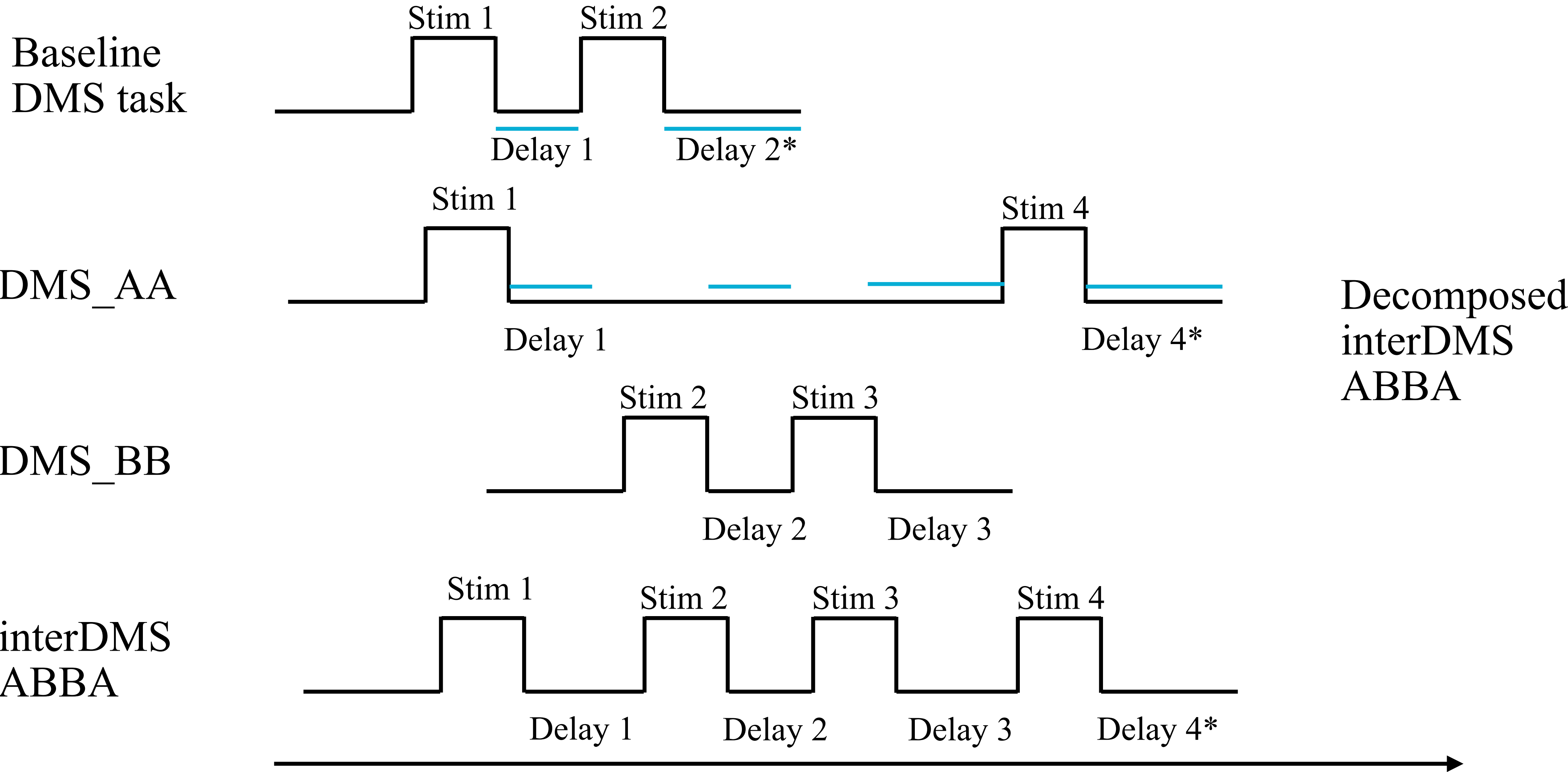
Example of ctxDM-LOCATION-CATEGORY-IDENTITY:

If stimuli 1 and 2 match in LOCATION, match stimuli 2 and 3 based on CATEGORY, otherwise on IDENTITY.



Approach 1: timeseries based decomposition

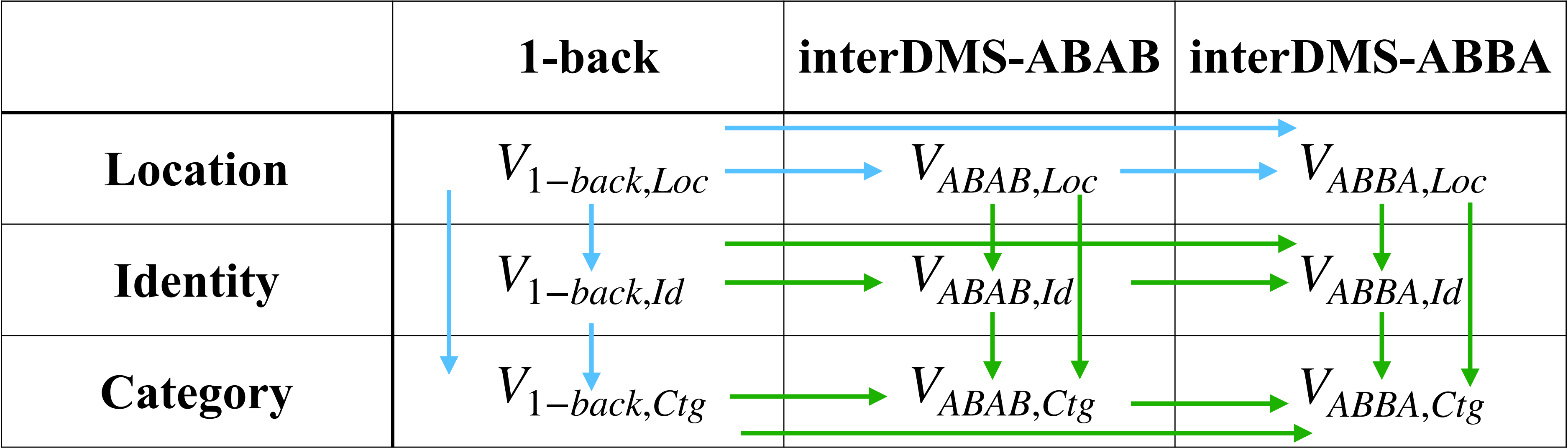
$$X_{interDMS_ABBA}(t) = \alpha X_{DMS_AA}(t) + \beta X_{DMS_BB}(t)$$



*: when subjects make

Approach 2: generalizable transformation across tasks

$V_{1-back,Loc}$: Vector representation for 1-back, Location task



→ : identified transformation
→ : generalization testing