ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

How does learning to read shape the neural representation of spoken and written language?

Adam Jowett

Dr Joanne Taylor[1]
Dr Angelika Lingnau[2]
Professor Kathy Rastle[2]

[1]Aston University [2]Royal Holloway, University of London

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

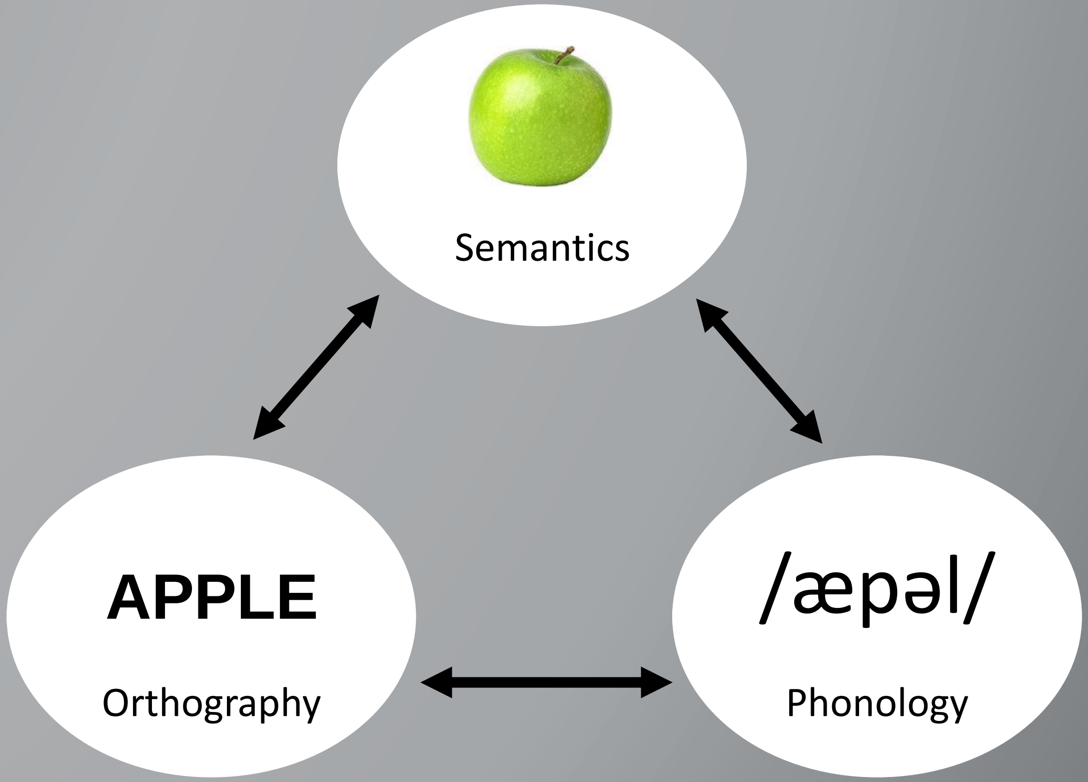
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Background



1. Harm & Seidenberg (2004)

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

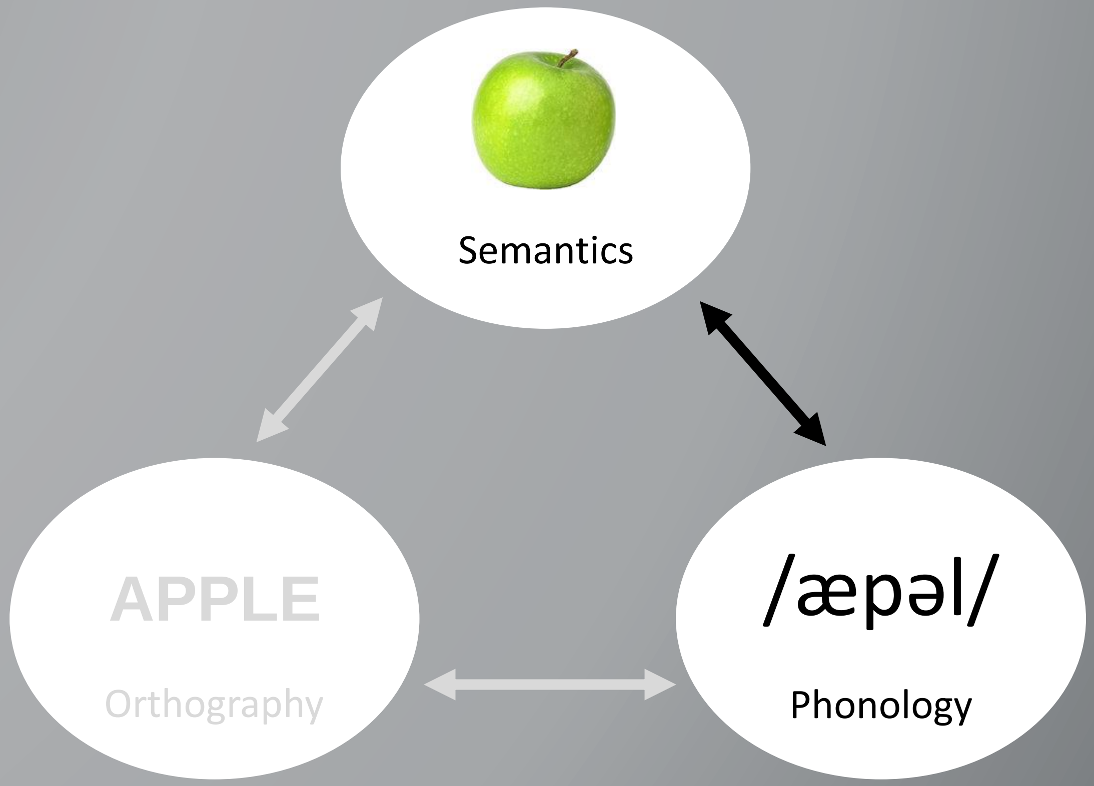
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Background



Before acquiring skills in reading and writing, most of us have developed relative competence in understanding spoken language

1. Harm & Seidenberg (2004)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Background

Contents

Background

Methods

Stimuli

Procedure

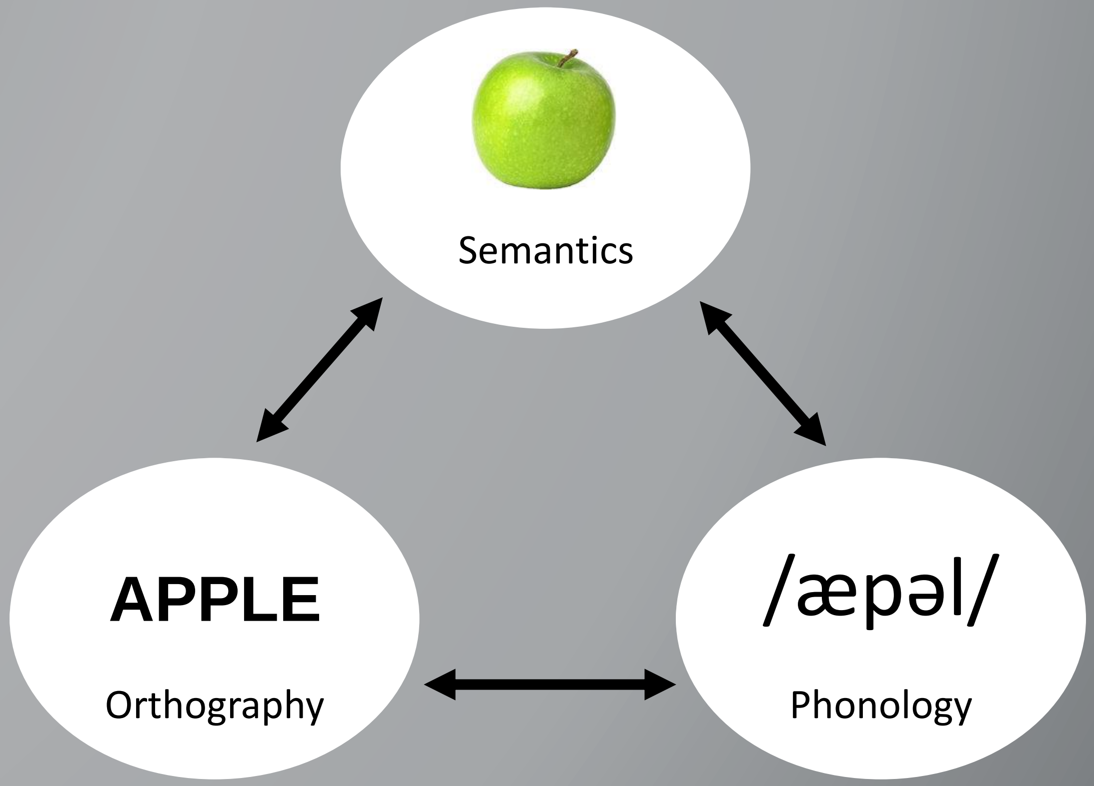
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Learning to read requires acquiring mappings from orthography onto existing phonological and semantic representations

1. Harm & Seidenberg (2004)

Background

Languages vary in the way that writing expresses the sounds and meanings of spoken language

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Background

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Languages vary in the way that writing expresses the sounds and meanings of spoken language

BEACH	PEACH
/biːʧ/	/piːʧ/

Alphabetic languages = High orthographic transparency

Information about phonological structure within orthography
Each sound usually mapped to one orthographic symbol

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Background

Languages vary in the way that writing expresses the sounds and meanings of spoken language

郑	张
/ˈtʂəŋ/	/ˈtʂɑːŋ/

Logographic languages = Low orthographic transparency

Less information about phonological structure within orthography
Each sound usually mapped to multiple orthographic symbols

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

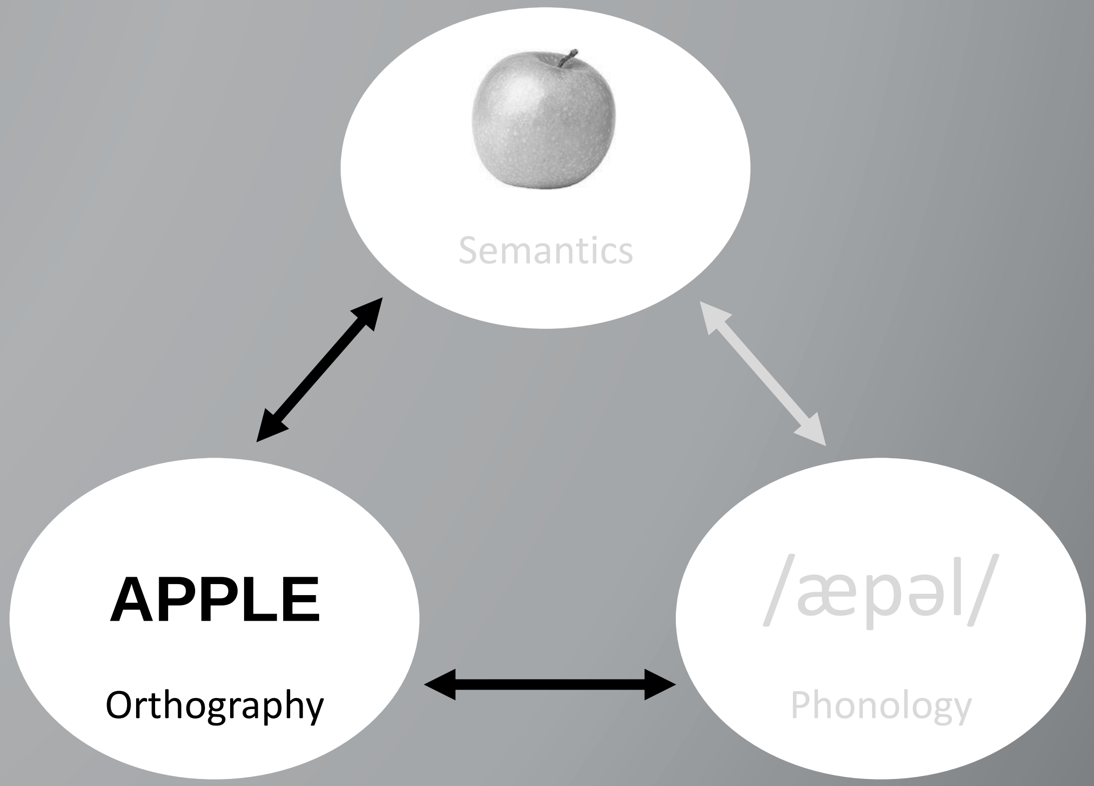
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

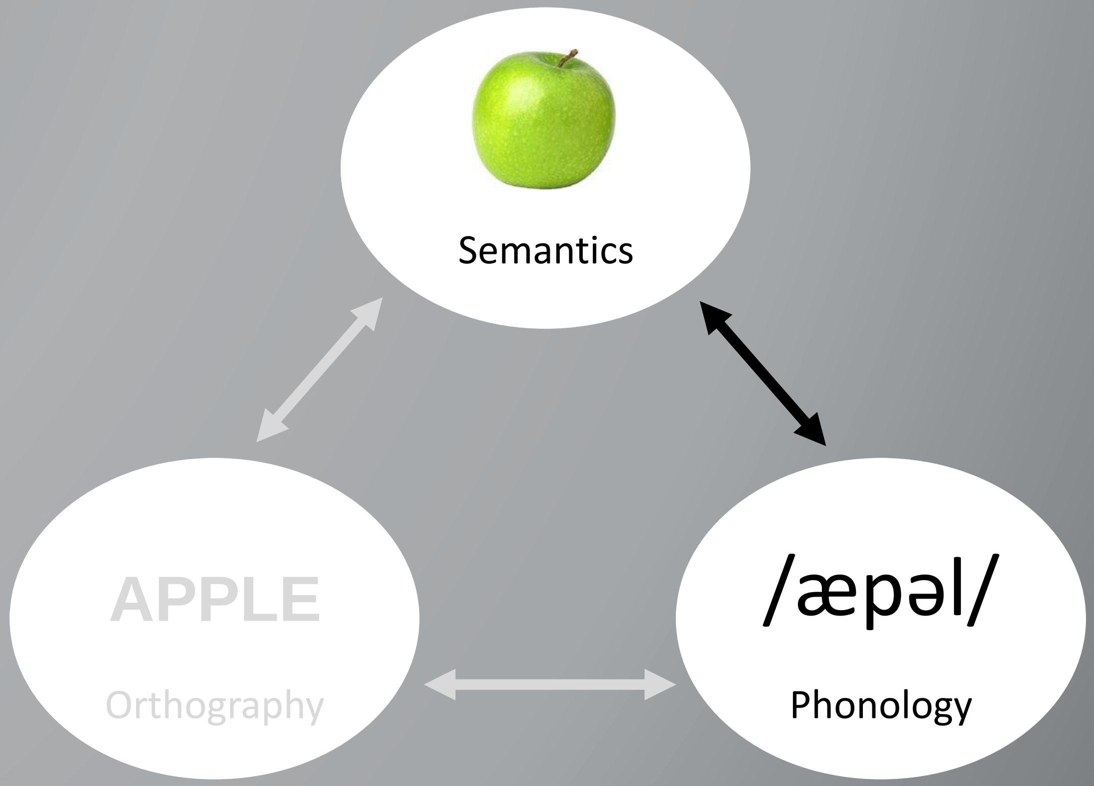
Summary

Background



Such differences in orthographic structure impacts on the nature of reading acquisition…

Background



…as well as wider impacts on existing spoken language systems [2]

2. Rastle et al. (2011)

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Methods

Language training study combining behavioural testing and fMRI analyses

Methods

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Language training study combining behavioural testing and fMRI analyses

Participants

24 monolingual native English speakers (16 females)

Aged between 19-34 (*M* = 22.16, *SD* = 3.97)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Methods

Language training study combining behavioural testing and fMRI analyses

Participants

24 monolingual native English speakers (16 females)
Aged between 19-34 (*M* = 22.16, *SD* = 3.97)

Within subjects design

All participants learned two artificial languages with alphabetic and logographic writing systems

Methods

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Language training study combining behavioural testing and fMRI analyses

Participants

24 monolingual native English speakers (16 females)
Aged between 19-34 (M = 22.16, SD = 3.97)

Within subjects design

All participants learned two artificial languages with alphabetic and logographic writing systems

Artificial orthographies

Each language contained 24 pseudowords, each denoted by visual, spoken, and semantic components

Alphabetic

Contents

Background

Methods

Stimuli

Procedure

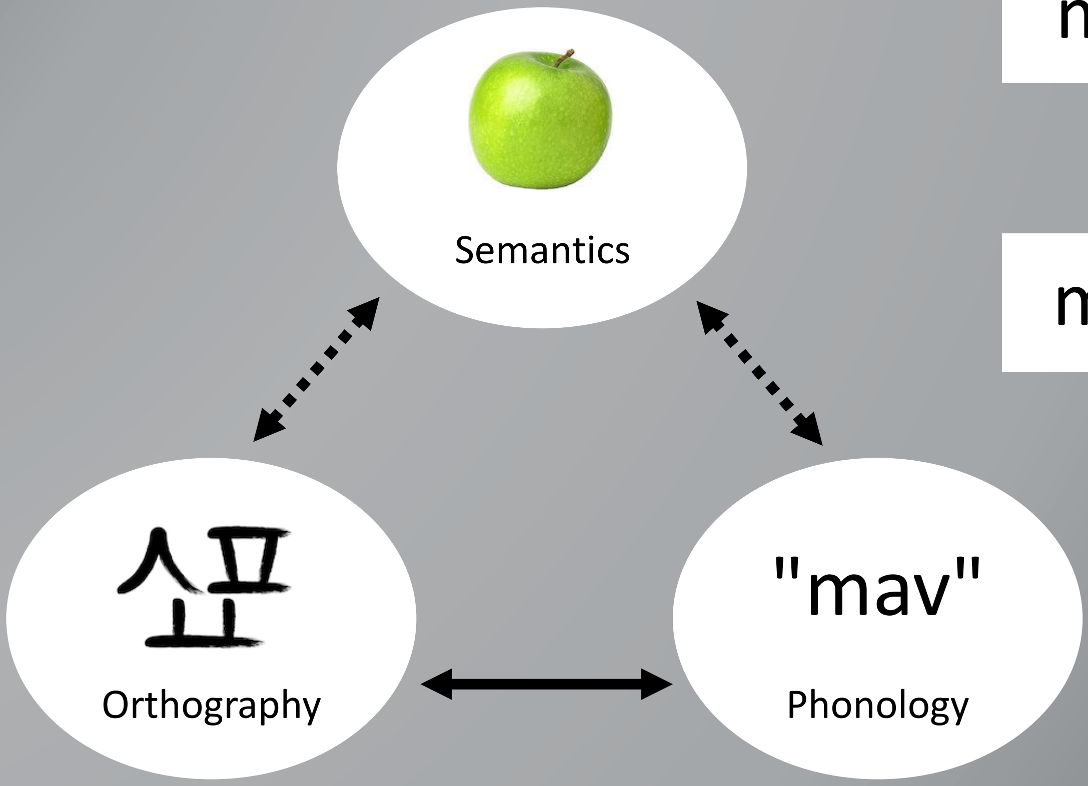
Behavioural data

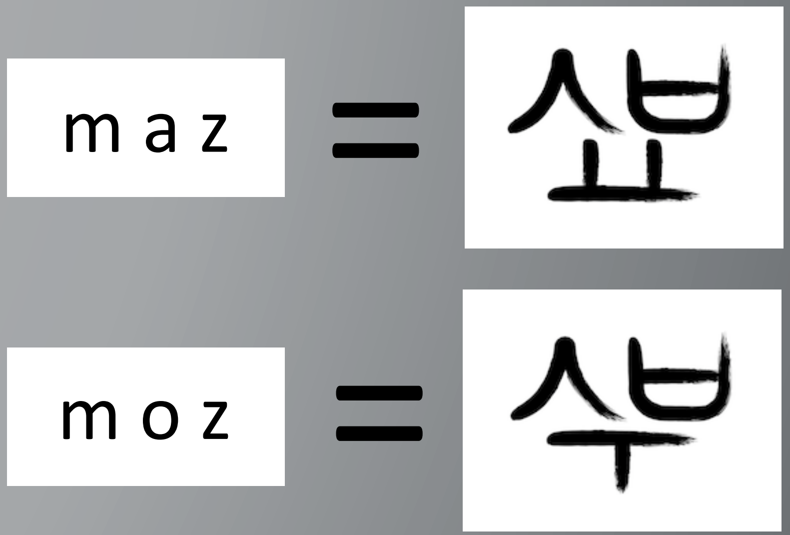
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary





Each word is three letters long. Each sound has a corresponding letter. A vowel is always underneath.

Stimuli inspired by – 3. Taylor et al. (2017); 4. Mei et al. (2014)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

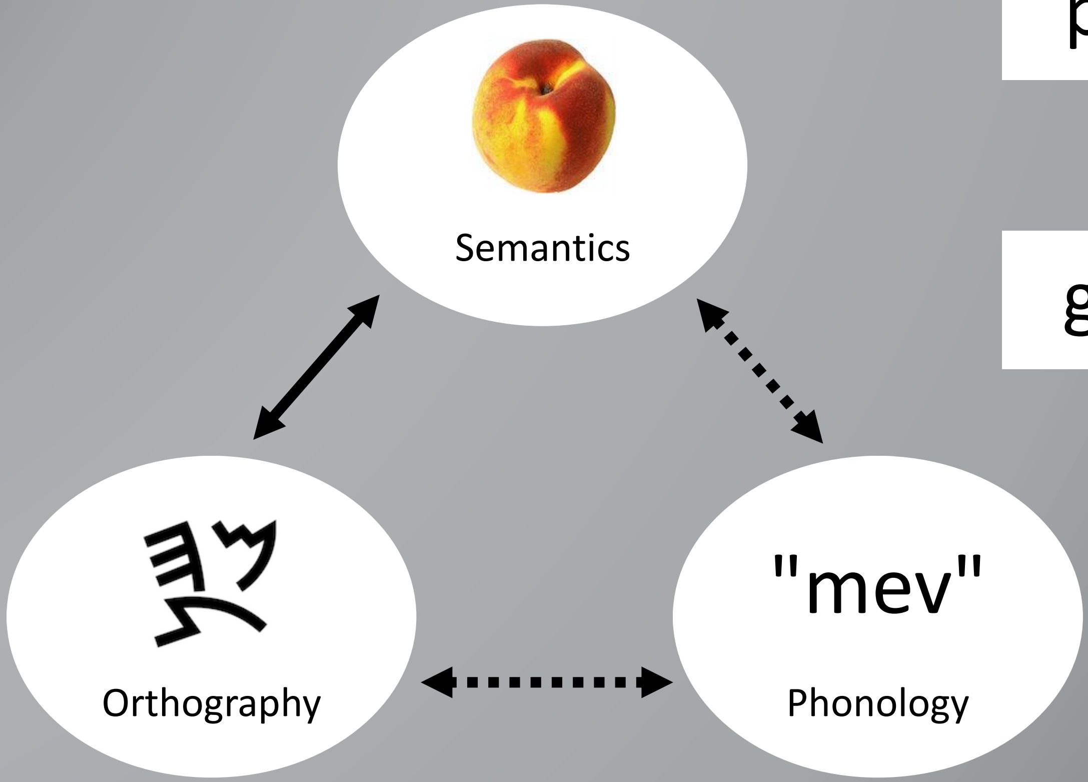
fMRI paradigm

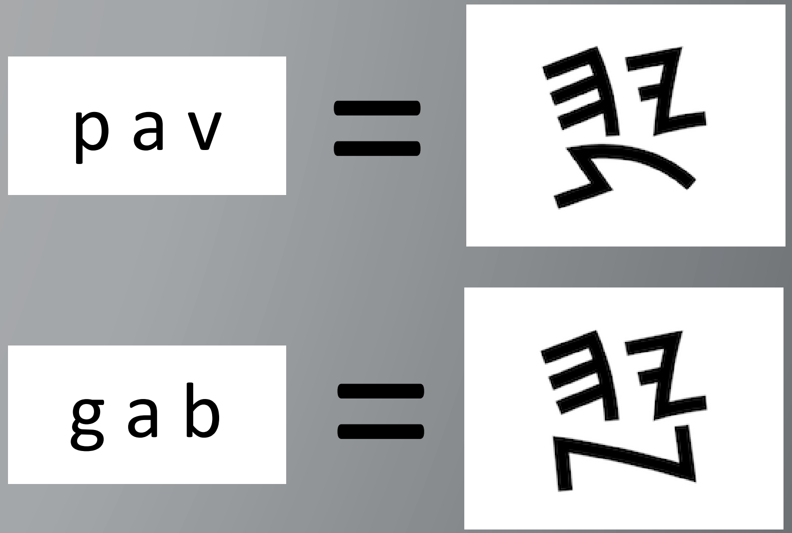
Univariate contrasts

Representational Similarity Analysis

Summary

Logographic





Each spoken word has three sounds, but there is no relationship between each sound and the written word

Stimuli inspired by – 3. Taylor et al. (2017); 4. Mei et al. (2014)

Procedure

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Individual differences
Spelling Spoonerisms VocabShipley Towre-2

Day 1	Day 2	D3	D4	D5	D6	D7	D8	D9	Day 10	Day 11	Day 12
Pre-exposure		Training							Testing	Scanning	
Repetition Picture Search Picture Naming	Repetition Reading Aloud Auditory Orthographic Search	Picture Naming Picture Search Reading Aloud Auditory Orthographic Search Saying Meaning Semantic Orthographic Search							Picture Naming Reading Aloud Saying Meaning Auditory Shadowing Phoneme Reversal Auditory Lexical Decision Visual Lexical Decision Auditory Semantic Monitoring (practice) Visual Semantic Monitoring (practice)	Auditory Semantic Monitoring Visual Semantic Monitoring	Auditory Semantic Monitoring Visual Semantic Monitoring

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Procedure

Individual differences
Spelling Spoonerisms VocabShipley Towre-2

Day 1	Day 2	D3	D4	D5	D6	D7	D8	D9	Day 10	Day 11	Day 12
Pre-exposure		Training							Testing	Scanning	
Repetition Picture Search Picture Naming	Repetition Reading Aloud Auditory Orthographic Search	Picture Naming Picture Search Reading Aloud Auditory Orthographic Search Saying Meaning Semantic Orthographic Search							Picture Naming Reading Aloud Saying Meaning Auditory Shadowing Phoneme Reversal Auditory Lexical Decision Visual Lexical Decision Auditory Semantic Monitoring (practice) Visual Semantic Monitoring (practice)	Auditory Semantic Monitoring Visual Semantic Monitoring	Auditory Semantic Monitoring Visual Semantic Monitoring

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

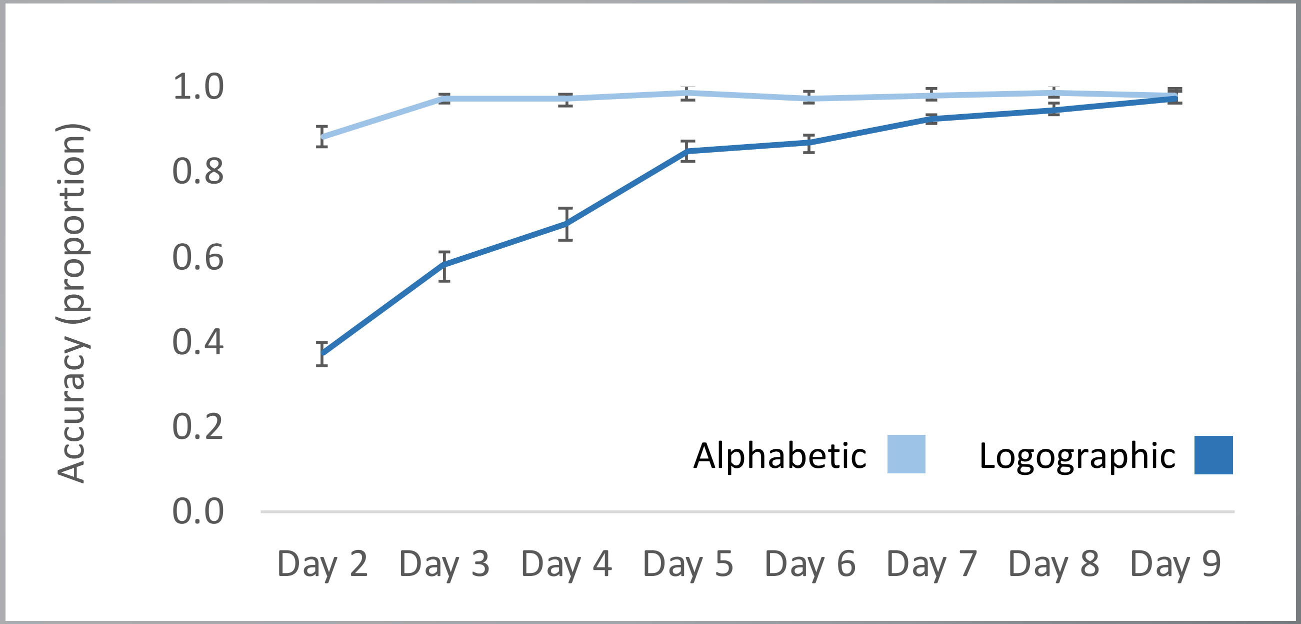
Univariate contrasts

Representational Similarity Analysis

Summary

Reading Aloud

See trained word  Say pronunciation *"bev"*



Alphabetic writing system benefits accuracy and speed of Reading Aloud during training and testing = alphabetic easier to learn and faster to retrieve

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Reading Aloud

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

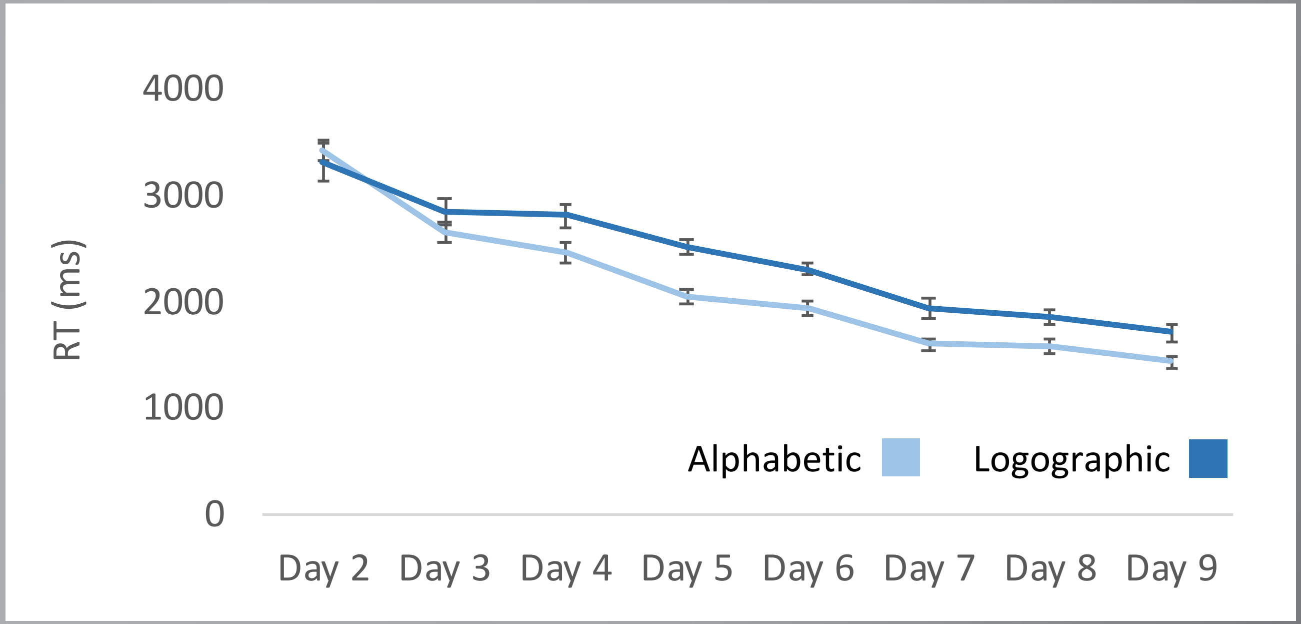
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

See trained word  Say pronunciation *"bev"*



Alphabetic writing system benefits accuracy and speed of Reading Aloud during training and testing = alphabetic easier to learn and faster to retrieve

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

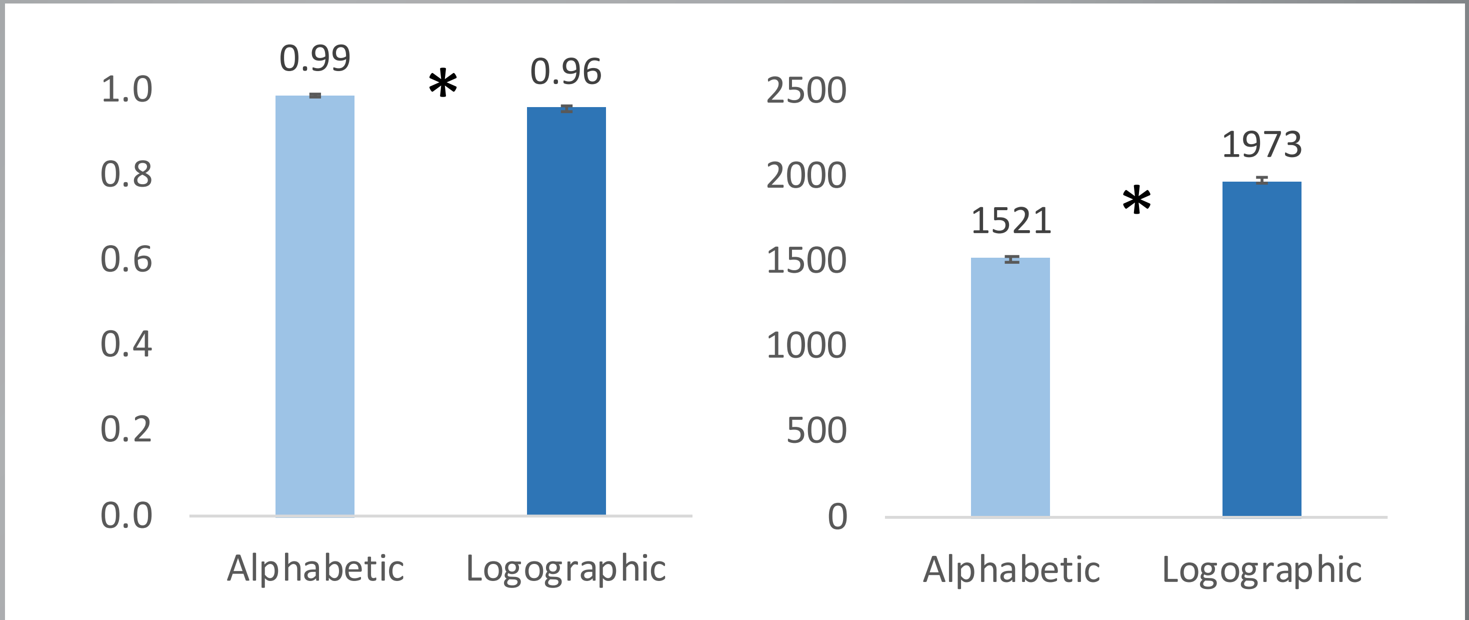
Univariate contrasts

Representational Similarity Analysis

Summary

Reading Aloud

See trained word  Say pronunciation *"bev"*



Alphabetic writing system benefits accuracy and speed of Reading Aloud during training and testing = alphabetic easier to learn and faster to retrieve

Saying the Meaning

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

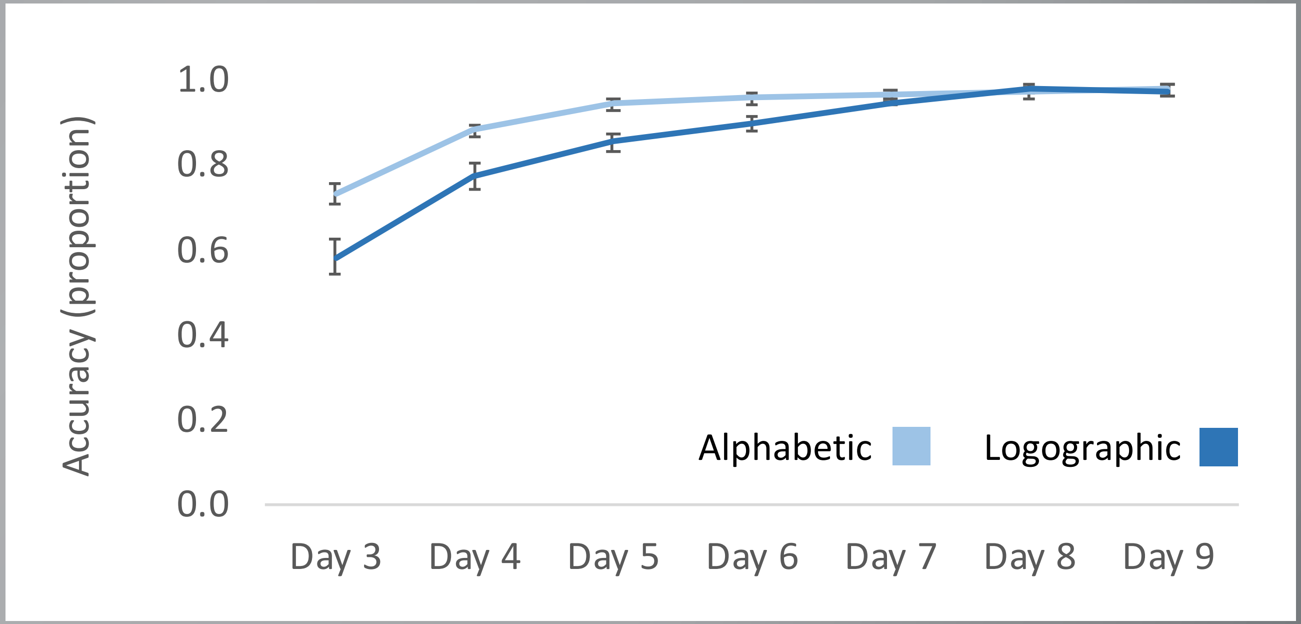
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

See trained word  Say meaning *"apple"*



Alphabetic benefits accuracy but logographic benefits speed during training.
Logographic was faster during testing with no differences in accuracy.

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

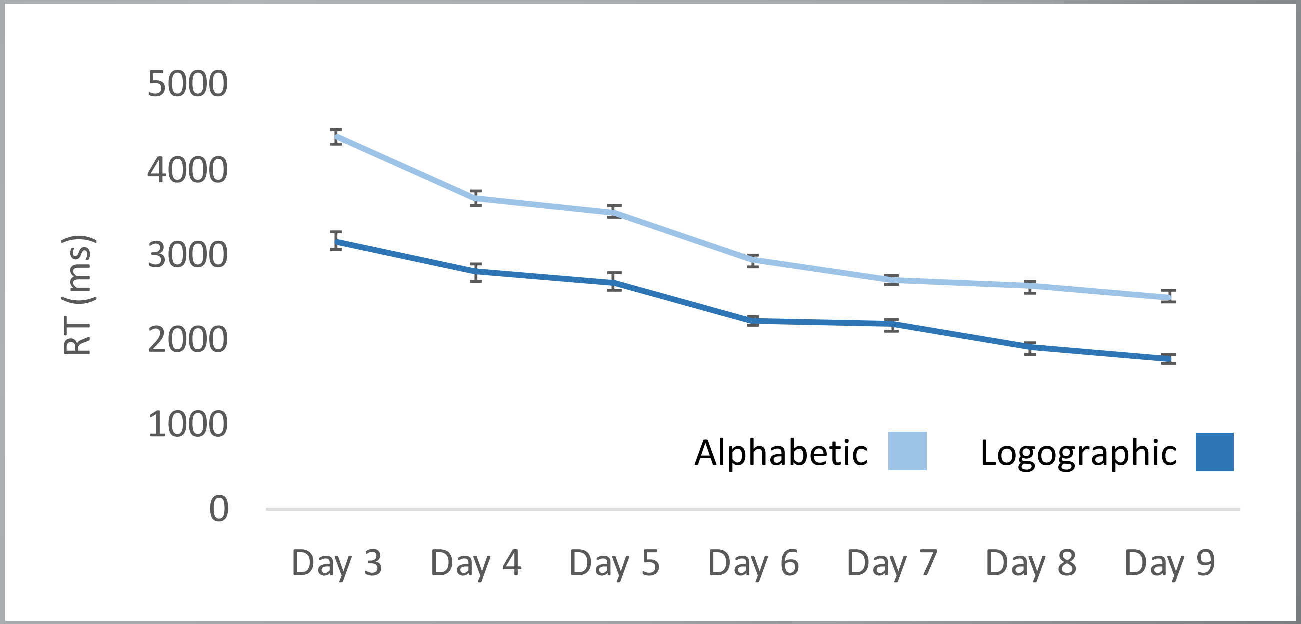
Univariate contrasts

Representational Similarity Analysis

Summary

Saying the Meaning

See trained word  Say meaning *"apple"*



Alphabetic benefits accuracy but logographic benefits speed during training.
Logographic was faster during testing with no differences in accuracy.

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

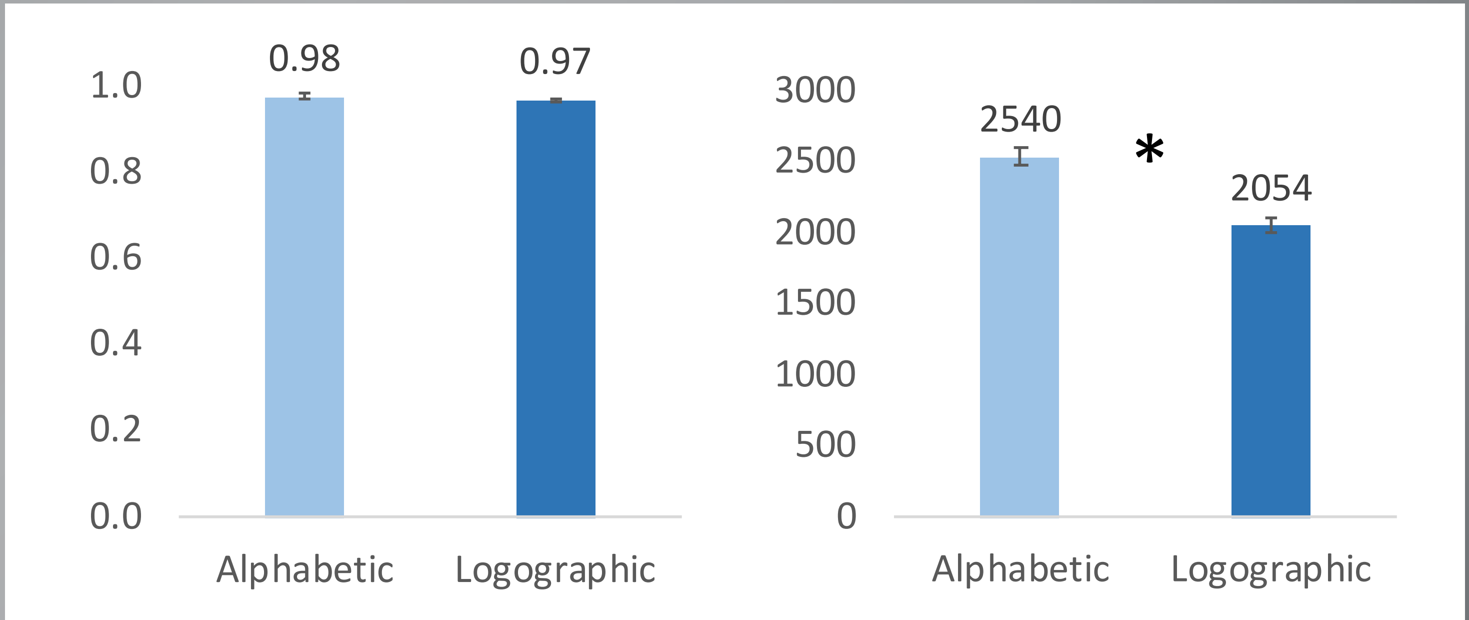
Univariate contrasts

Representational Similarity Analysis

Summary

Saying the Meaning

See trained word  Say meaning *"apple"*



Alphabetic benefits accuracy but logographic benefits speed during training.
Logographic was faster during testing with no differences in accuracy.

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

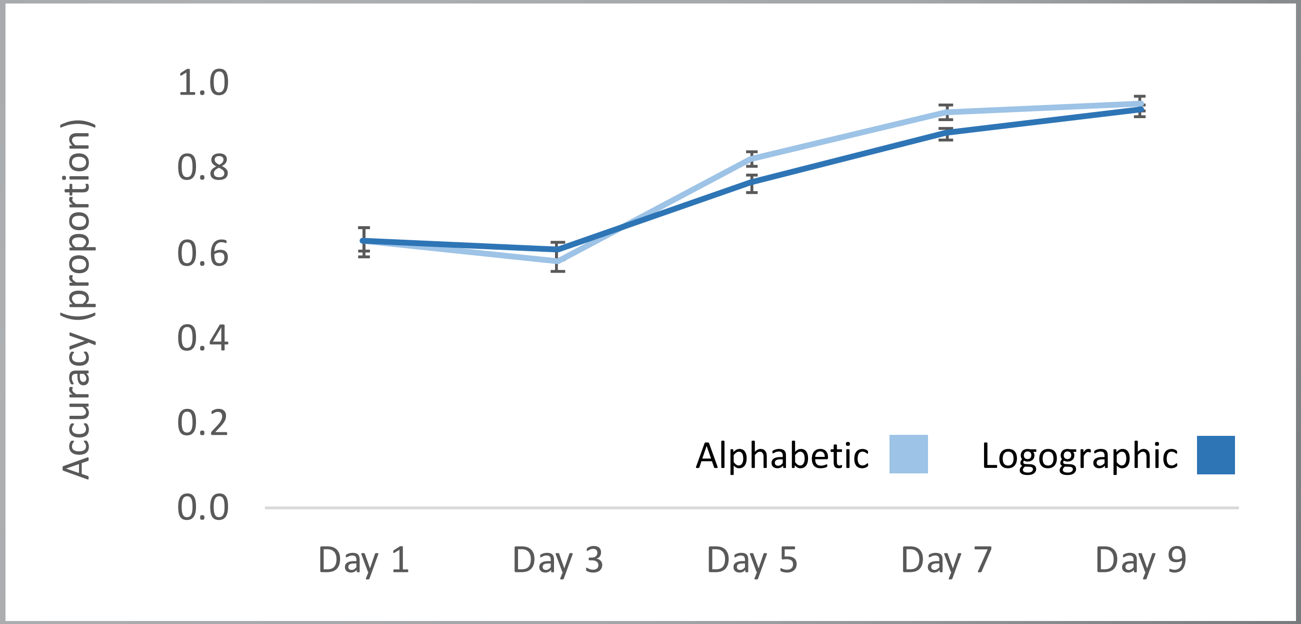
Univariate contrasts

Representational Similarity Analysis

Summary

Picture Naming

See meaning "apple"   Say pronunciation "bev"



No differences in accuracy or speed for Picture Naming during training and testing

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

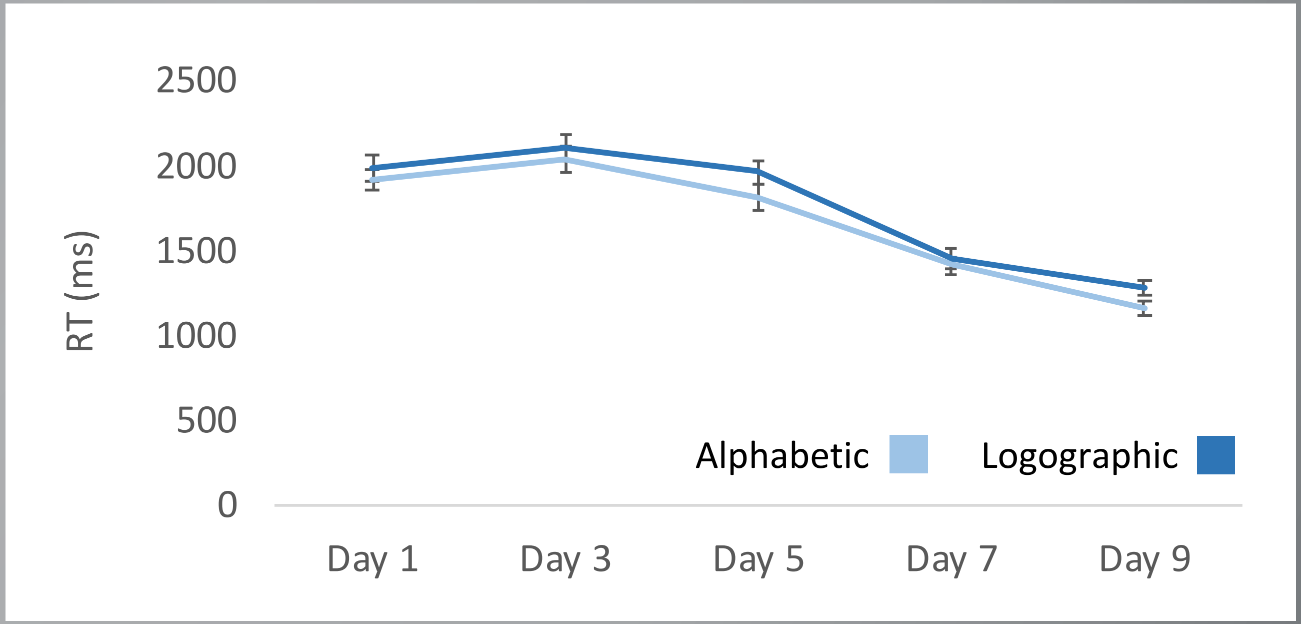
Univariate contrasts

Representational Similarity Analysis

Summary

Picture Naming

See meaning "apple”   Say pronunciation "bev"



No differences in accuracy or speed for Picture Naming during training and testing

Picture Naming

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

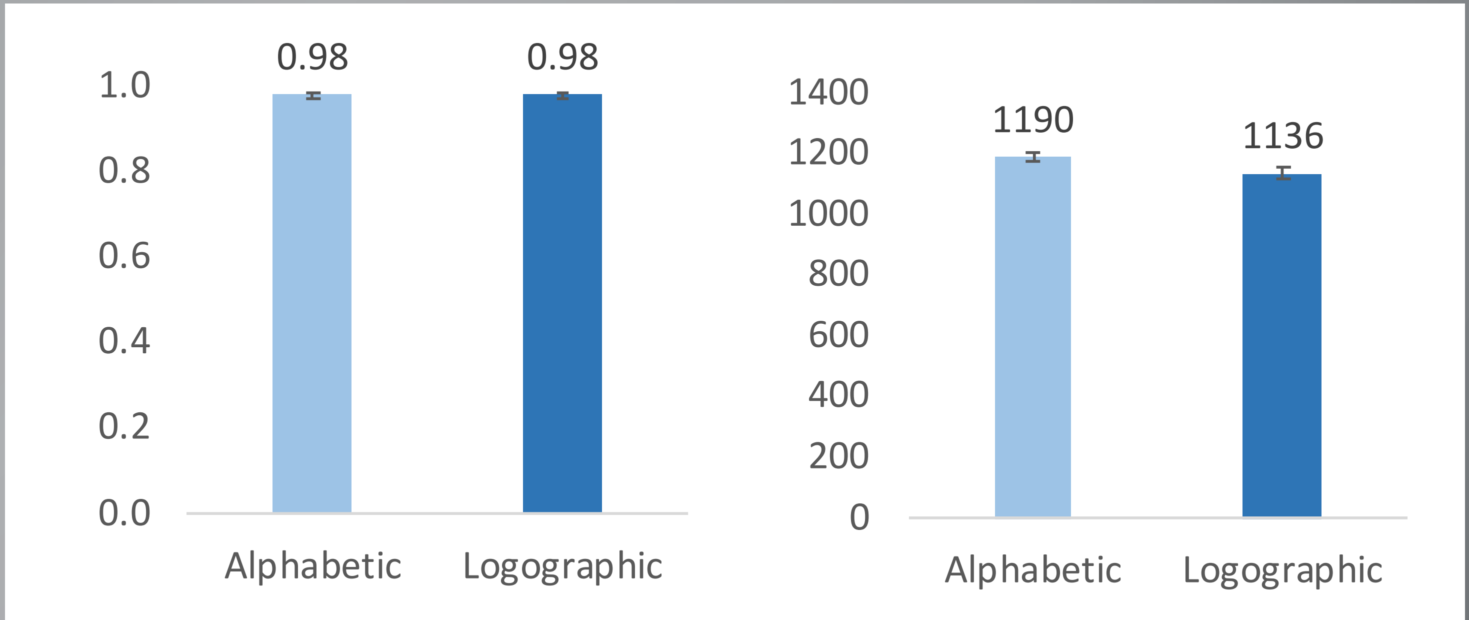
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

See meaning "apple”   Say pronunciation "bev"



No differences in accuracy or speed for Picture Naming during training and testing

Procedure

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Individual differences
Spelling
Spoonerisms
VocabShipley
Towre-2

Day 1	Day 2	D3 D4 D5 D6 D7 D8 D9	Day 10	Day 11	Day 12
Pre-exposure		**Training**	**Testing**	**Scanning**	
Repetition Picture Search Picture Naming	Repetition Reading Aloud Auditory Orthographic Search	Picture Naming Picture Search Reading Aloud Auditory Orthographic Search Saying Meaning Semantic Orthographic Search	Picture Naming Reading Aloud Saying Meaning Auditory Shadowing Phoneme Reversal Auditory Lexical Decision Visual Lexical Decision Auditory Semantic Monitoring (practice) Visual Semantic Monitoring (practice)	Auditory Semantic Monitoring Visual Semantic Monitoring	Auditory Semantic Monitoring Visual Semantic Monitoring

fMRI paradigm

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

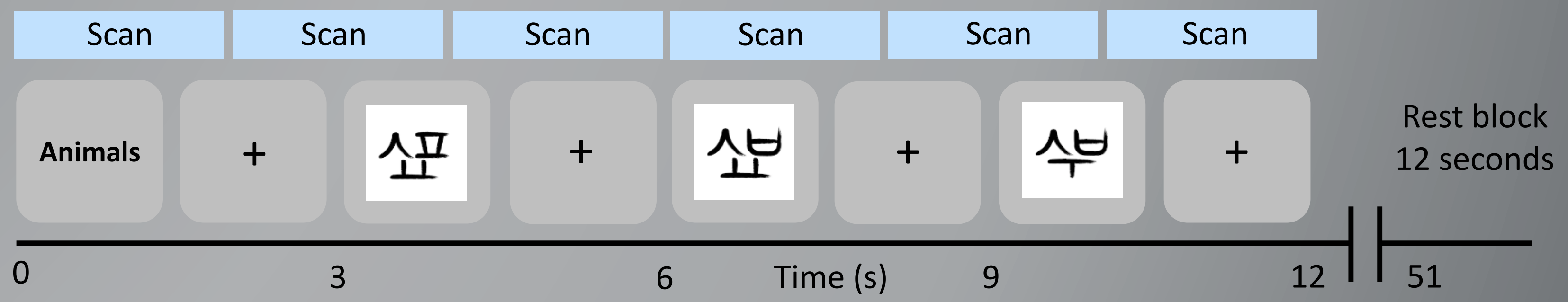
fMRI paradigm

Univariate contrasts

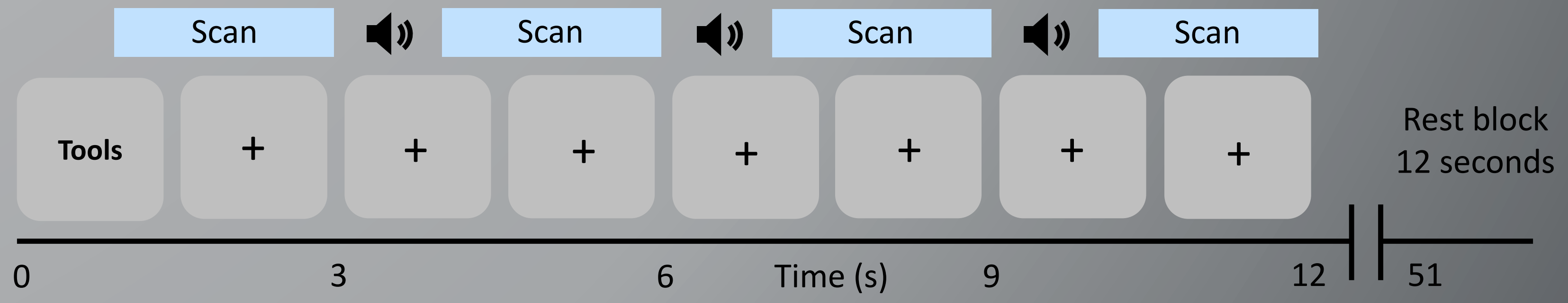
Representational Similarity Analysis

Summary

Visual Semantic Monitoring (TR=2s, TA=2s)



Auditory Semantic Monitoring (TR=3s, TA=2s)



ROYAL HOLLOWAY UNIVERSITY OF LONDON

Visual Semantic Monitoring

Contents

Background

Methods

Stimuli

Procedure

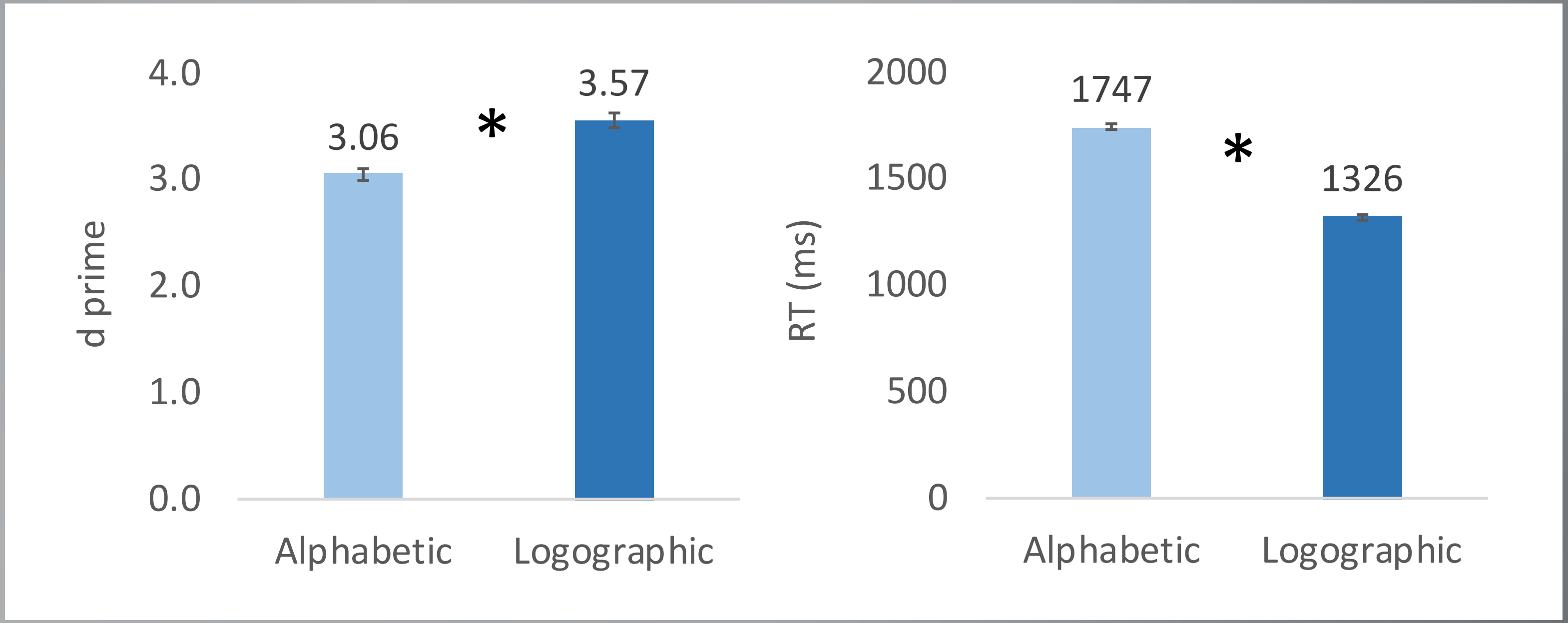
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Logographic benefits accuracy and speed of visual modality.
Accuracy data possibly due to length of trial; 3s compared to 9s

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

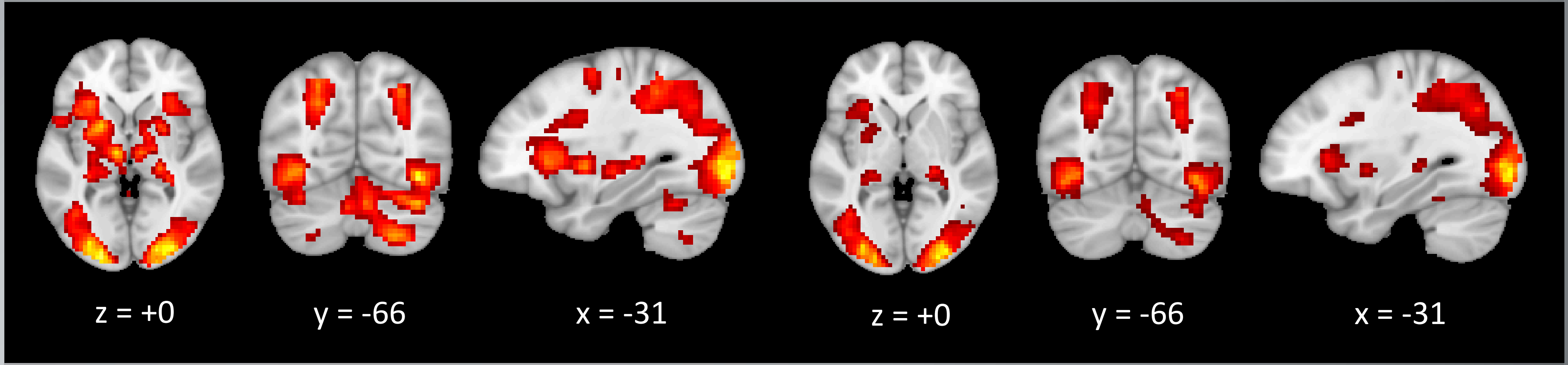
Representational Similarity Analysis

Summary

Univariate contrasts - Visual

Alphabetic > Baseline

Logographic > Baseline



Shared activity in bilateral occipitotemporal and parietal cortices. Left precentral gyrus (PrG) and superior parietal lobule (SPL) more active for alphabetic. Left superior frontal gyrus and bilateral angular gyrus (AnG) and middle occipital gyrus (MOG) more active for logographic.

p < .001 uncorrected, *p* < .05 cluster-level corrected

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

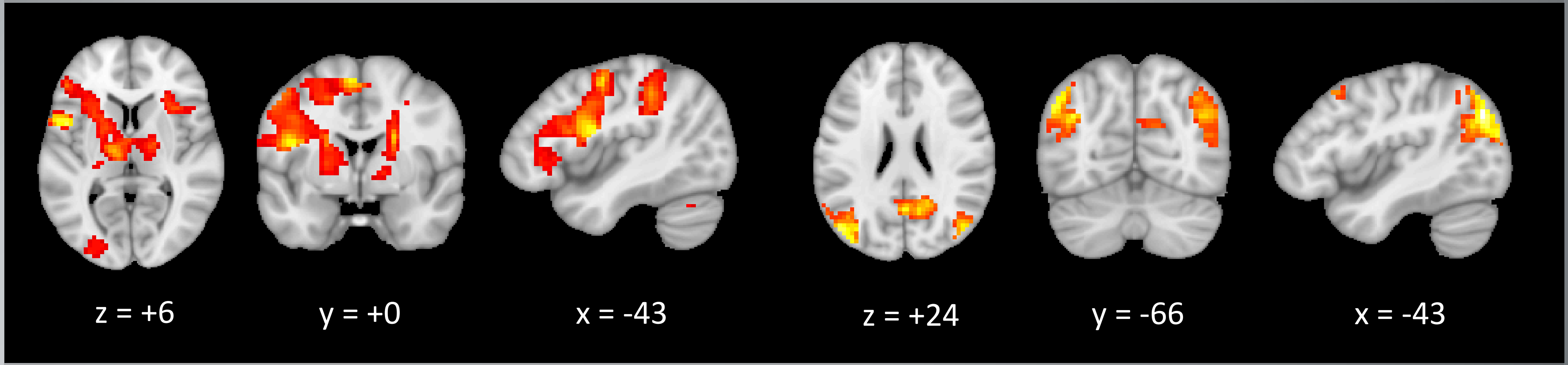
Representational Similarity Analysis

Summary

Univariate contrasts - Visual

Alphabetic > Logographic

Logographic > Alphabetic



Shared activity in bilateral occipitotemporal and parietal cortices. Left precentral gyrus (PrG) and superior parietal lobule (SPL) more active for alphabetic. Left superior frontal gyrus and bilateral angular gyrus (AnG) and middle occipital gyrus (MOG) more active for logographic.

$p < .001$ uncorrected, $p < .05$ cluster-level corrected

Auditory Semantic Monitoring

Contents

Background

Methods

Stimuli

Procedure

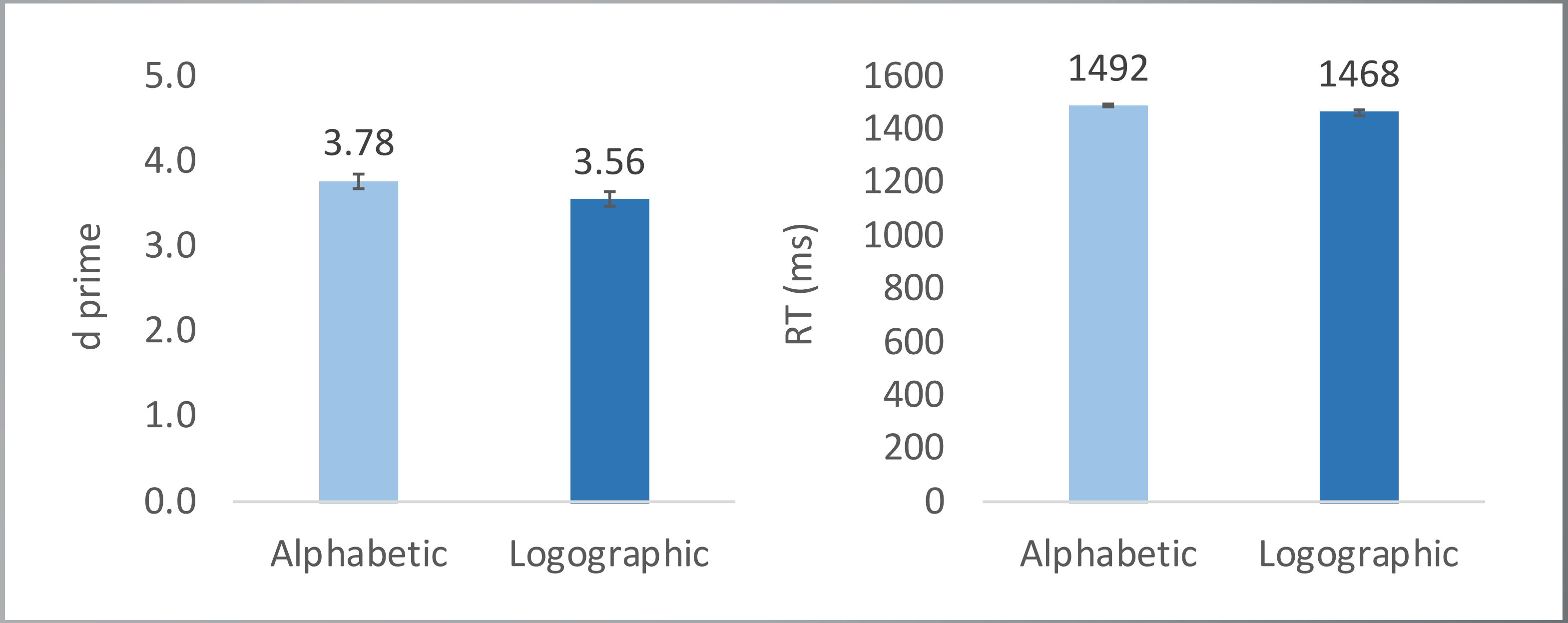
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



No differences in accuracy or speed for auditory modality

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

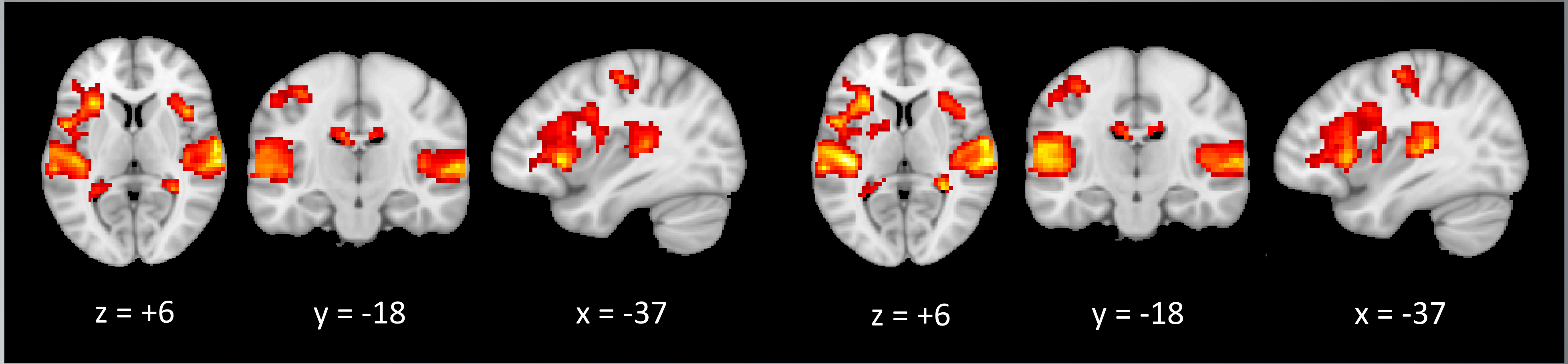
Representational Similarity Analysis

Summary

Univariate contrasts - Auditory

Alphabetic > Baseline

Logographic > Baseline



Shared activity in left frontal and bilateral temporal cortices, including left precentral and postcentral gyrus, bilateral anterior insula, frontal operculum, superior temporal gyrus, and transverse temporal gyrus. No brain areas more active for alphabetic/logographic system.

p < .001 uncorrected, p < .05 cluster-level corrected

Representational Similarity Analysis

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

6. Kriegeskorte & Kievit (2013)

Representational Similarity Analysis

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Investigate whether neural patterns differ between trained writing systems

When participants read written/hear spoken trained words, are the evoked neural representations more sensitive to phonemic structure (phoneme identity and position) and/or orthographic structure for the alphabetic compared to the logographic script?

6. Kriegeskorte & Kievit (2013)

Representational Similarity Analysis

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Investigate whether neural patterns differ between trained writing systems

When participants read written/hear spoken trained words, are the evoked neural representations more sensitive to phonemic structure (phoneme identity and position) and/or orthographic structure for the alphabetic compared to the logographic script?

Semantic monitoring

6. Kriegeskorte & Kievit (2013)

Representational Similarity Analysis

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Investigate whether neural patterns differ between trained writing systems

When participants read written/hear spoken trained words, are the evoked neural representations more sensitive to phonemic structure (phoneme identity and position) and/or orthographic structure for the alphabetic compared to the logographic script?

Visual | Auditory

Semantic monitoring

Visual | Auditory

6. Kriegeskorte & Kievit (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Representational Similarity Analysis

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Investigate whether neural patterns differ between trained writing systems

When participants read written/hear spoken trained words, are the evoked neural representations more sensitive to phonemic structure (phoneme identity and position) and/or orthographic structure for the alphabetic compared to the logographic script?

Visual | Auditory

Alphabetic | Logographic

Semantic monitoring

Visual | Auditory

Alphabetic | Logographic

6. Kriegeskorte & Kievit (2013)

Representational Similarity Analysis

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

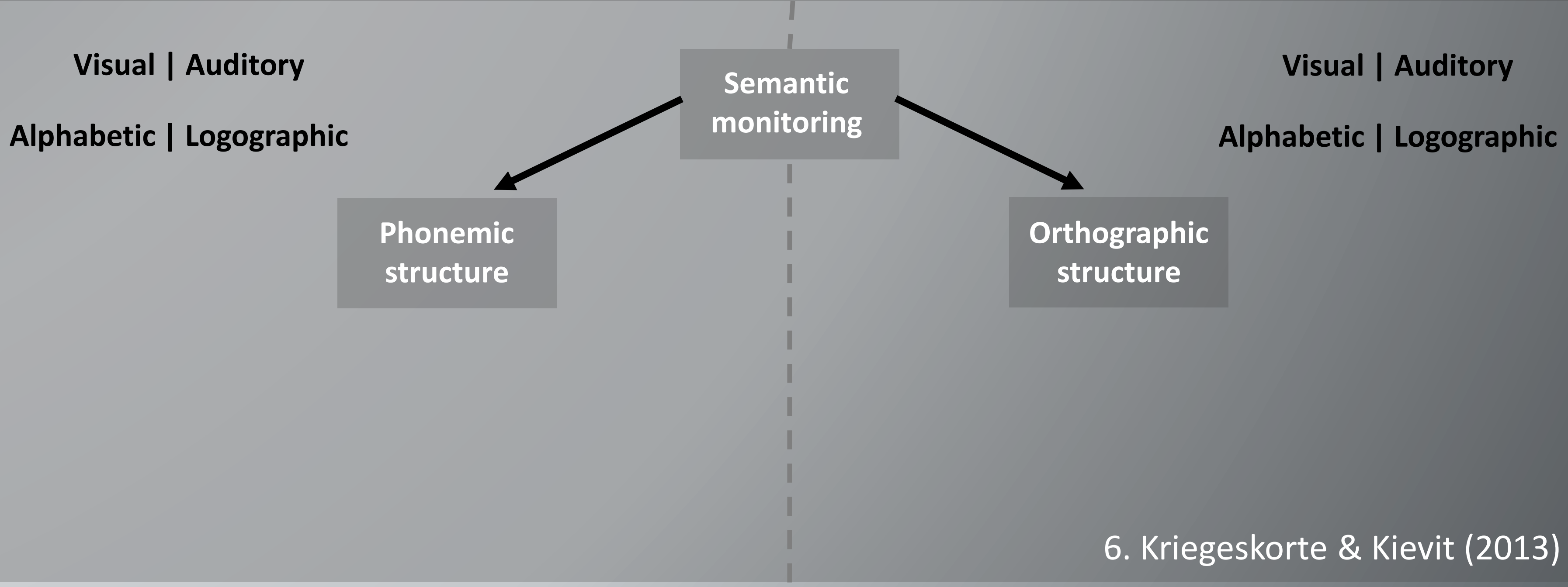
Univariate contrasts

Representational Similarity Analysis

Summary

Investigate whether neural patterns differ between trained writing systems

When participants read written/hear spoken trained words, are the evoked neural representations more sensitive to phonemic structure (phoneme identity and position) and/or orthographic structure for the alphabetic compared to the logographic script?



6. Kriegeskorte & Kievit (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Representational Similarity Analysis

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

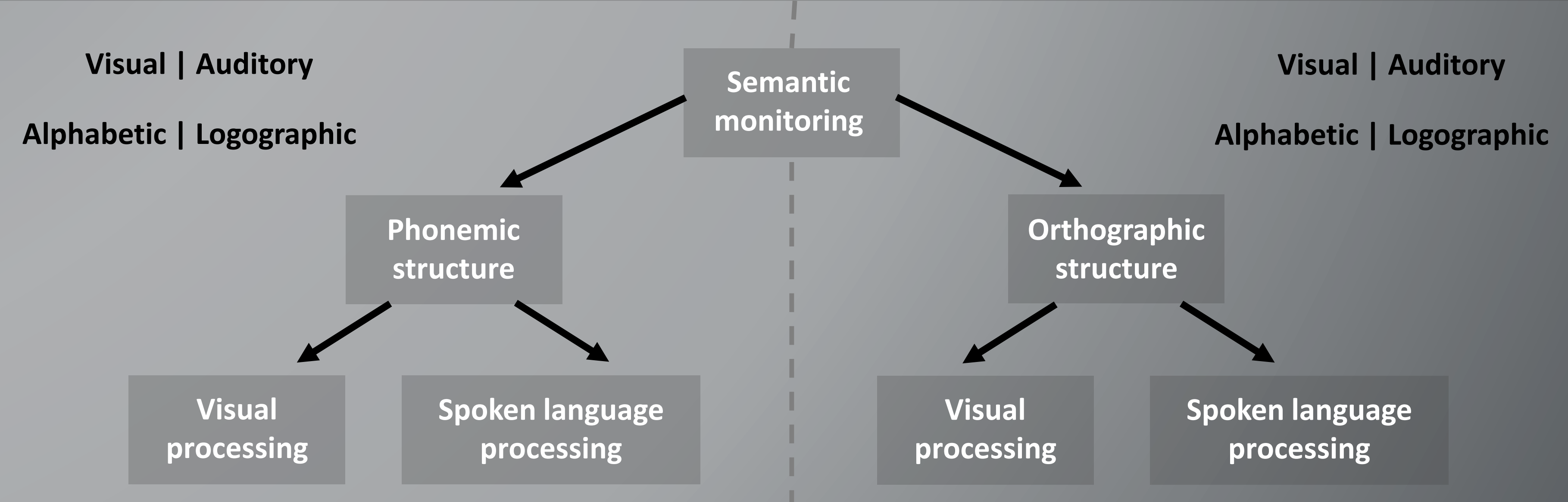
Univariate contrasts

Representational Similarity Analysis

Summary

Investigate whether neural patterns differ between trained writing systems

When participants read written/hear spoken trained words, are the evoked neural representations more sensitive to phonemic structure (phoneme identity and position) and/or orthographic structure for the alphabetic compared to the logographic script?



6. Kriegeskorte & Kievit (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Construct prediction matrices

Contents

Background

Methods

Stimuli

Procedure

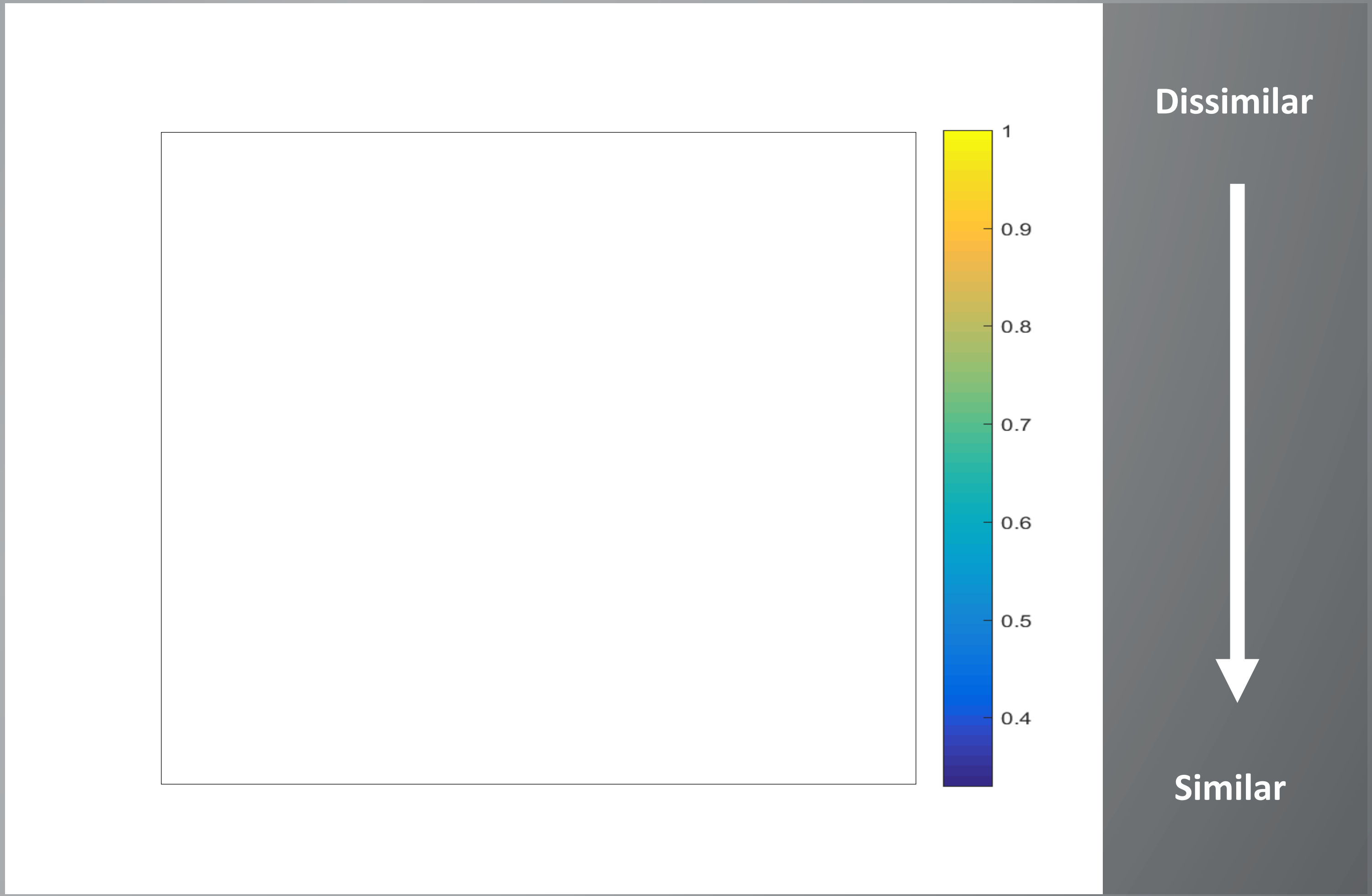
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



6. Kriegeskorte & Kievit (2013)

Construct prediction matrices

Contents

Background

Methods

Stimuli

Procedure

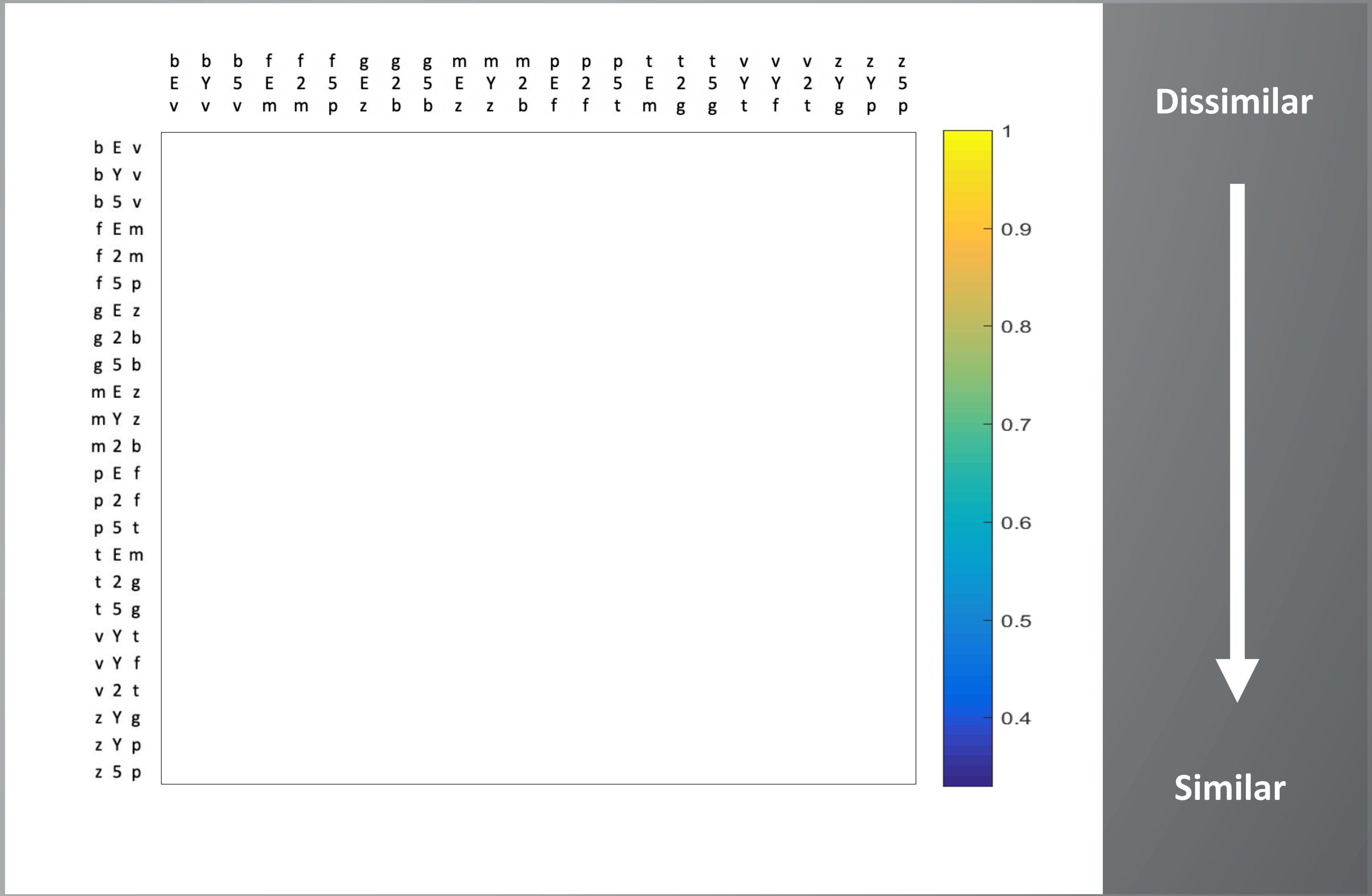
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



6. Kriegeskorte & Kievit (2013)

Construct prediction matrices

Contents

Background

Methods

Stimuli

Procedure

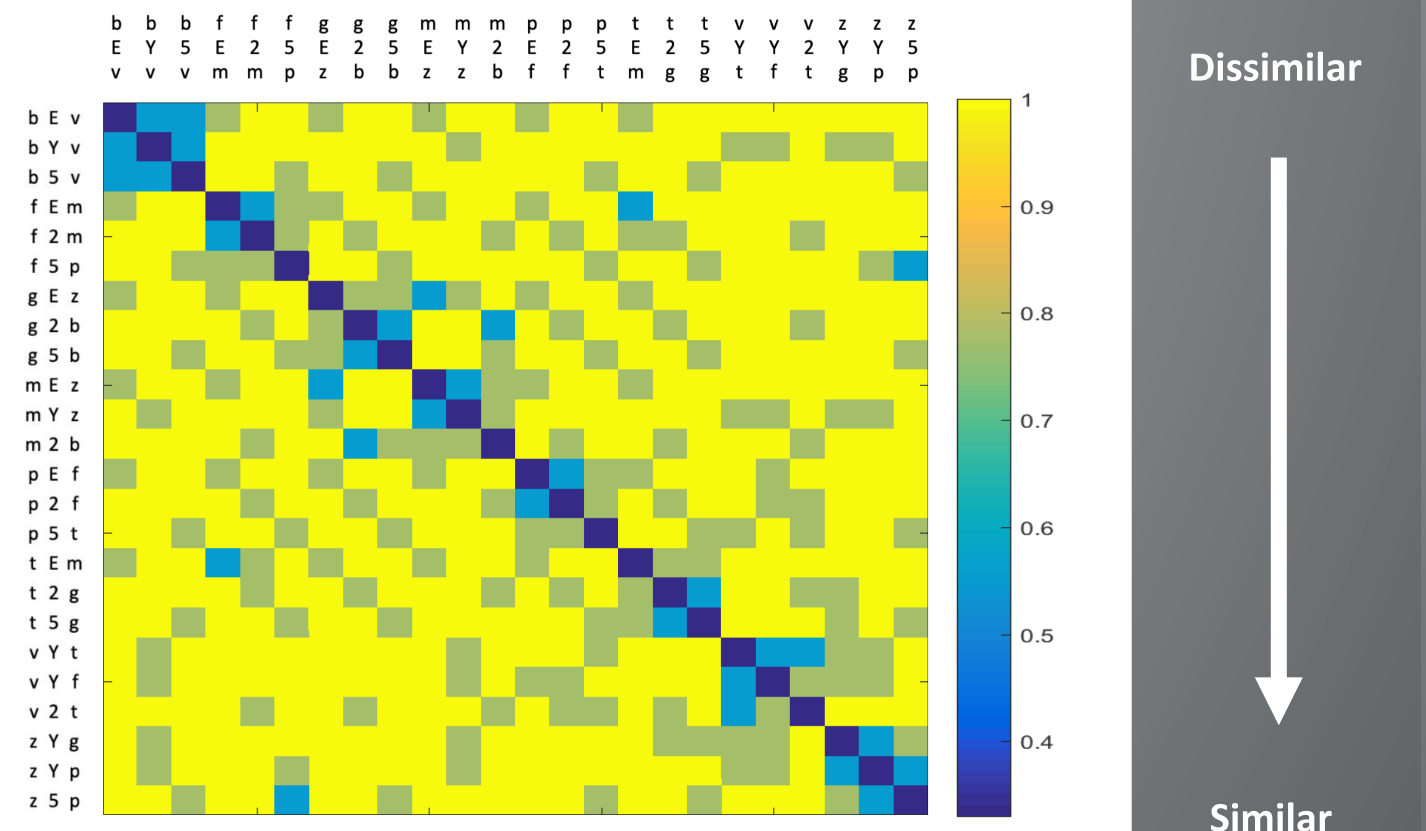
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Number of shared phonemes (position specific)

6. Kriegeskorte & Kievit (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

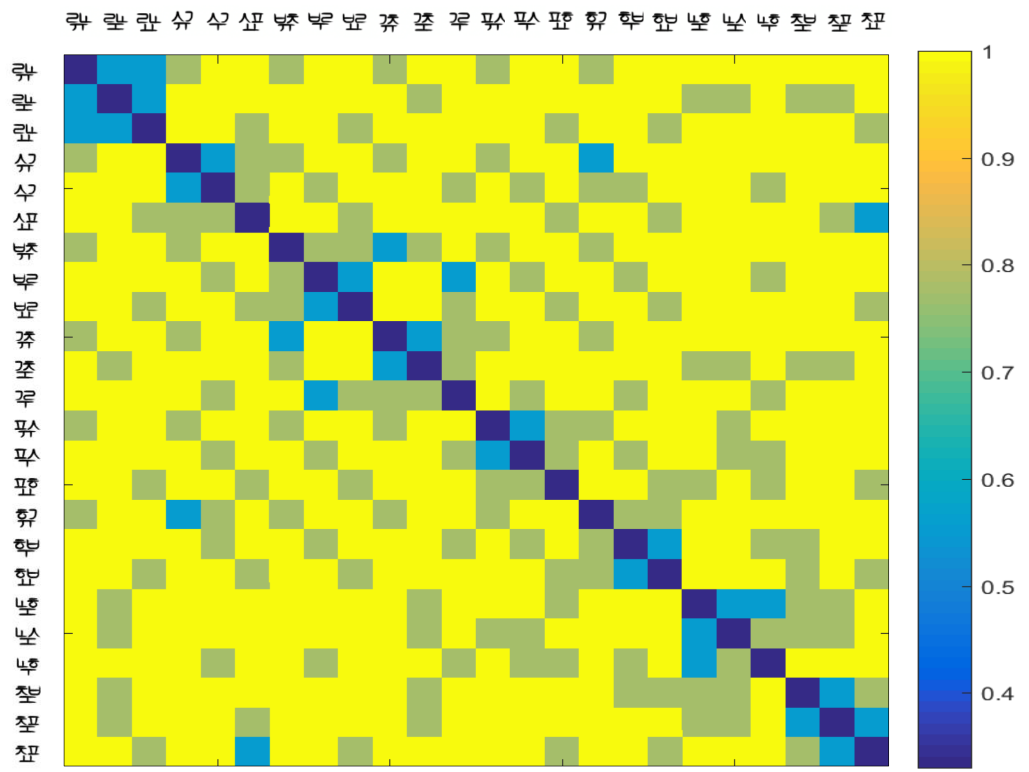
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Construct prediction matrices



Number of shared graphemes (position specific)

Dissimilar

Similar

6. Kriegeskorte & Kievit (2013)

Collect some data

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

6. Kriegeskorte & Kievit (2013)

Searchlight analysis

Contents

Background

Methods

Stimuli

Procedure

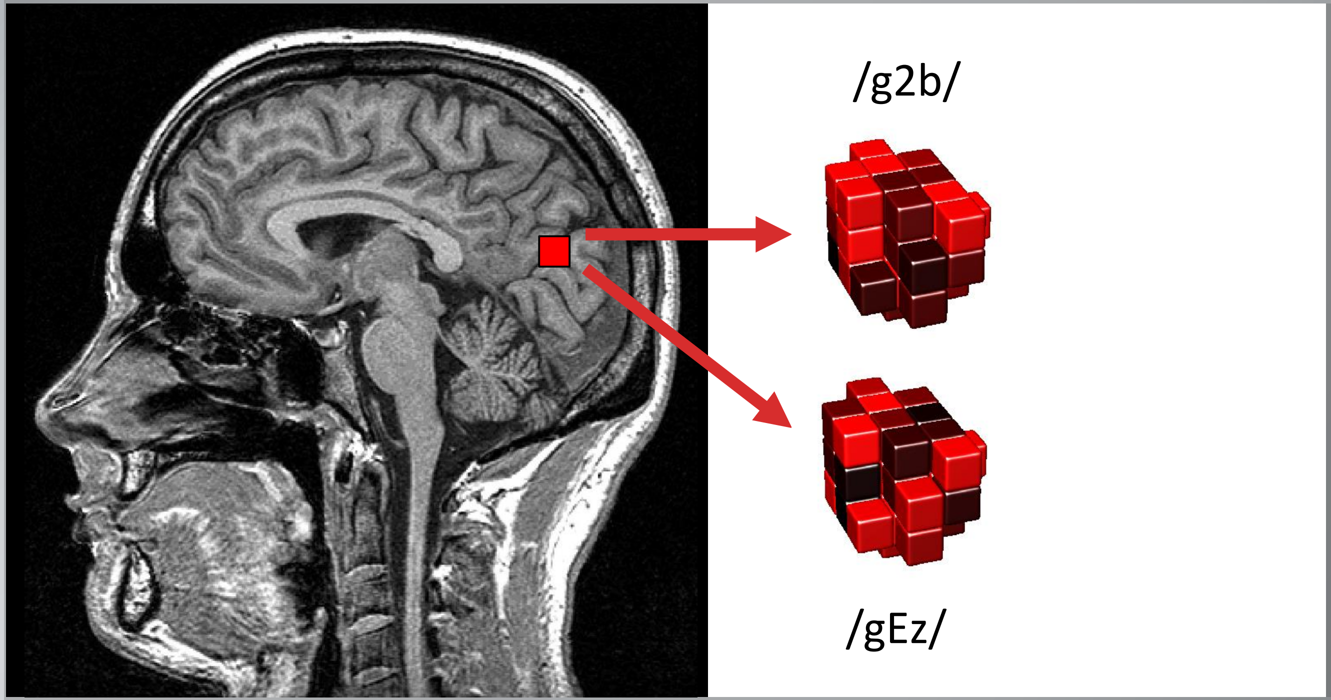
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate observed activation patterns

Contents

Background

Methods

Stimuli

Procedure

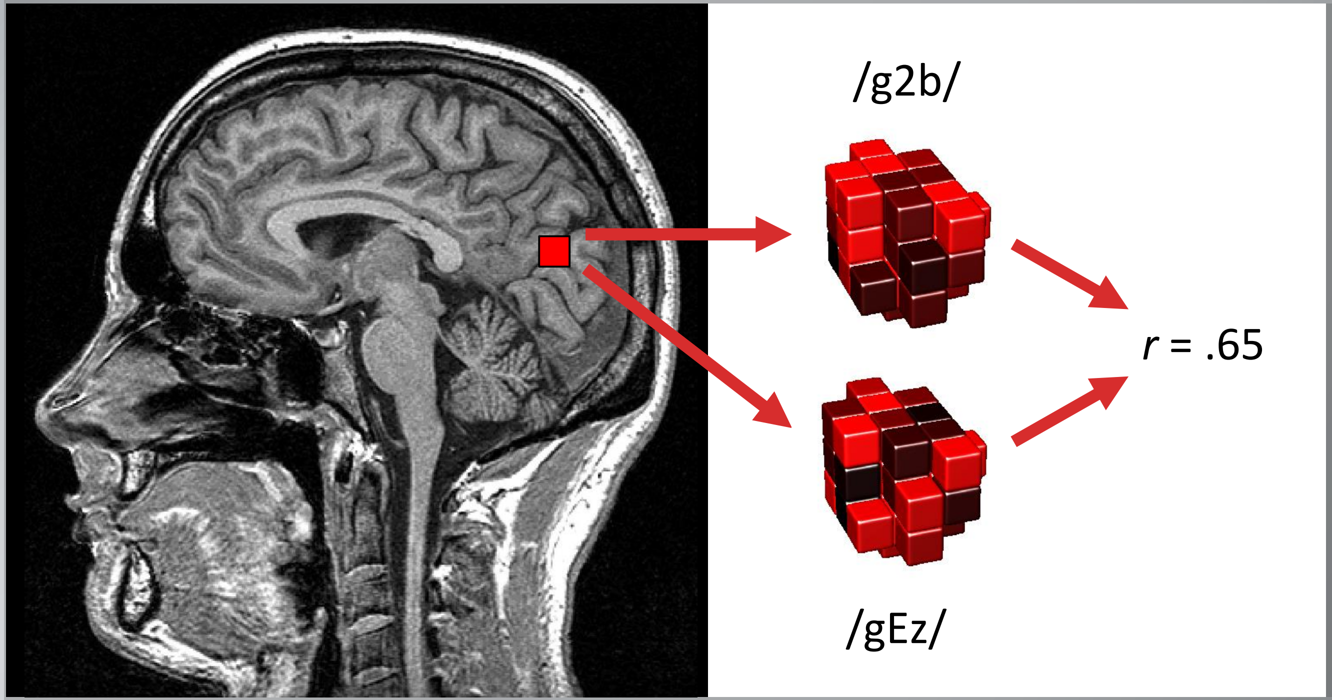
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate observed activation patterns

Contents

Background

Methods

Stimuli

Procedure

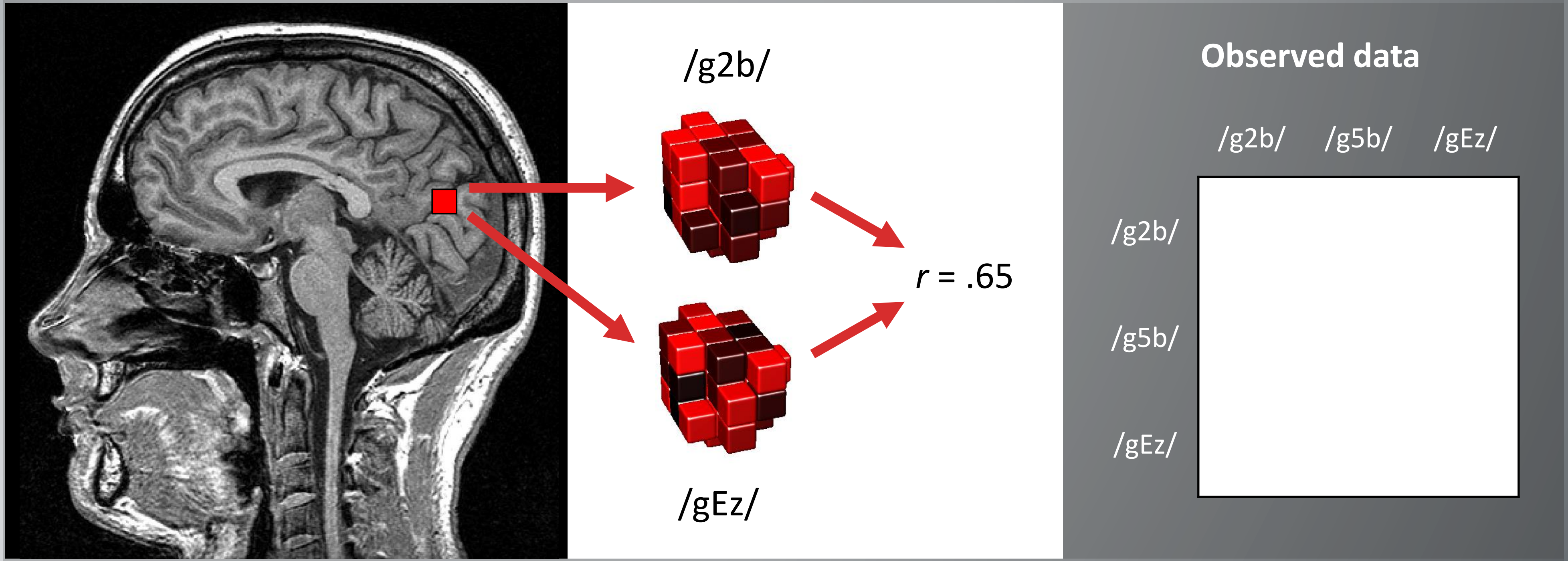
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Correlate observed activation patterns

Contents

Background

Methods

Stimuli

Procedure

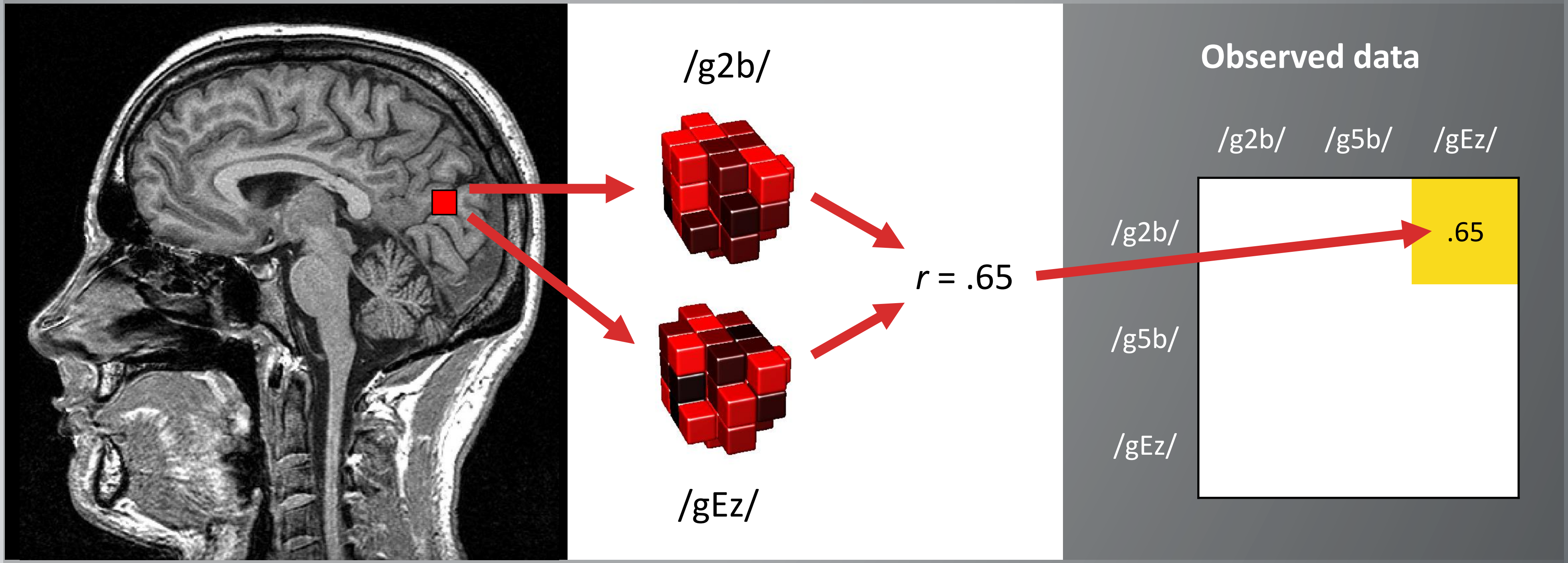
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate observed activation patterns

Contents

Background

Methods

Stimuli

Procedure

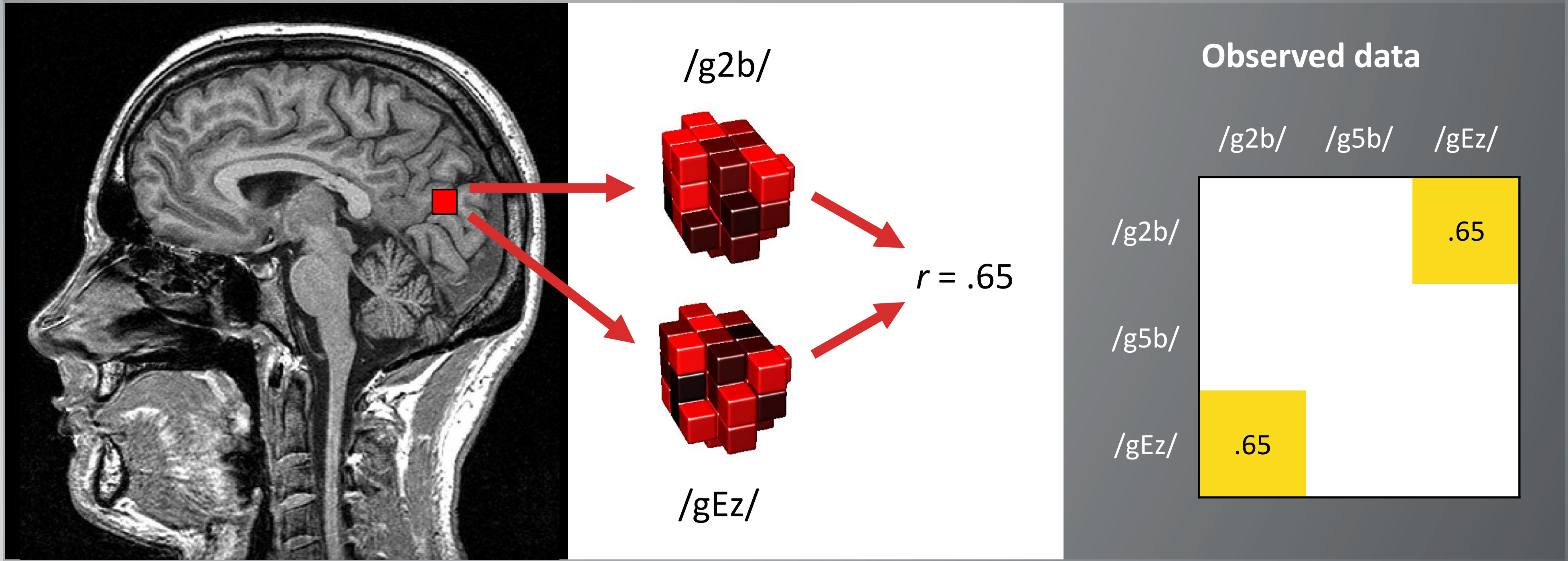
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate observed activation patterns

Contents

Background

Methods

Stimuli

Procedure

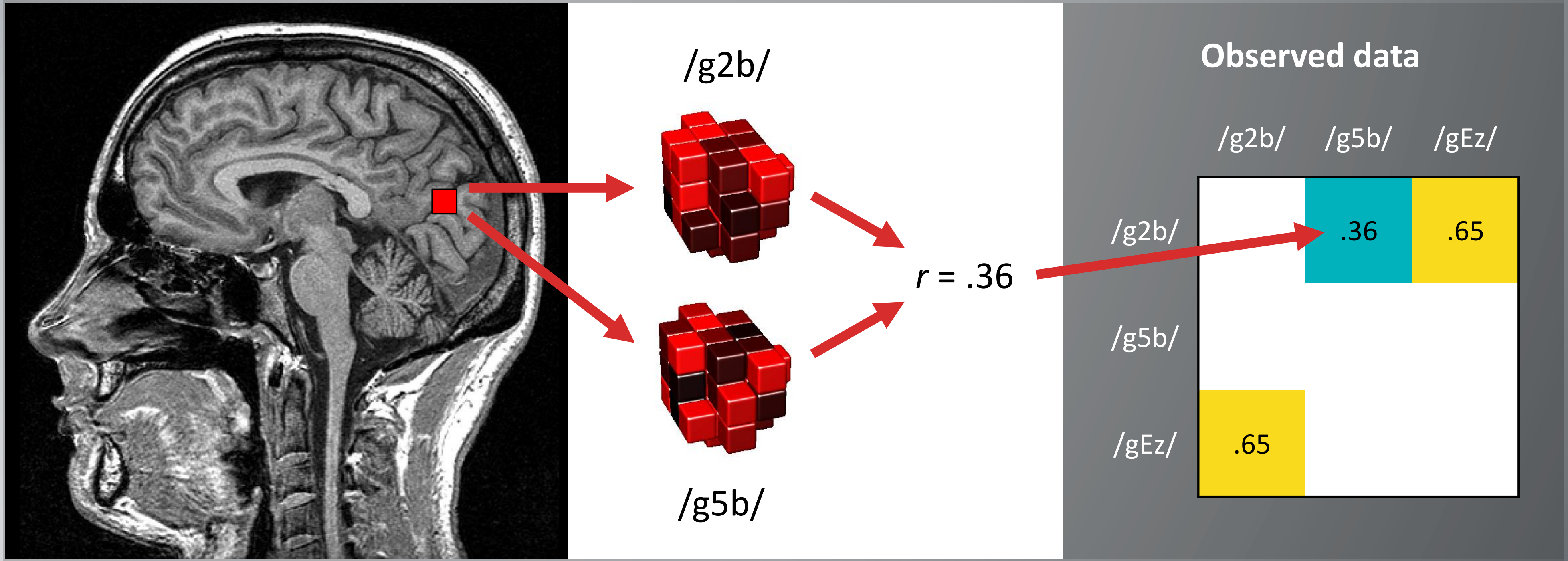
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Correlate observed activation patterns

Contents

Background

Methods

Stimuli

Procedure

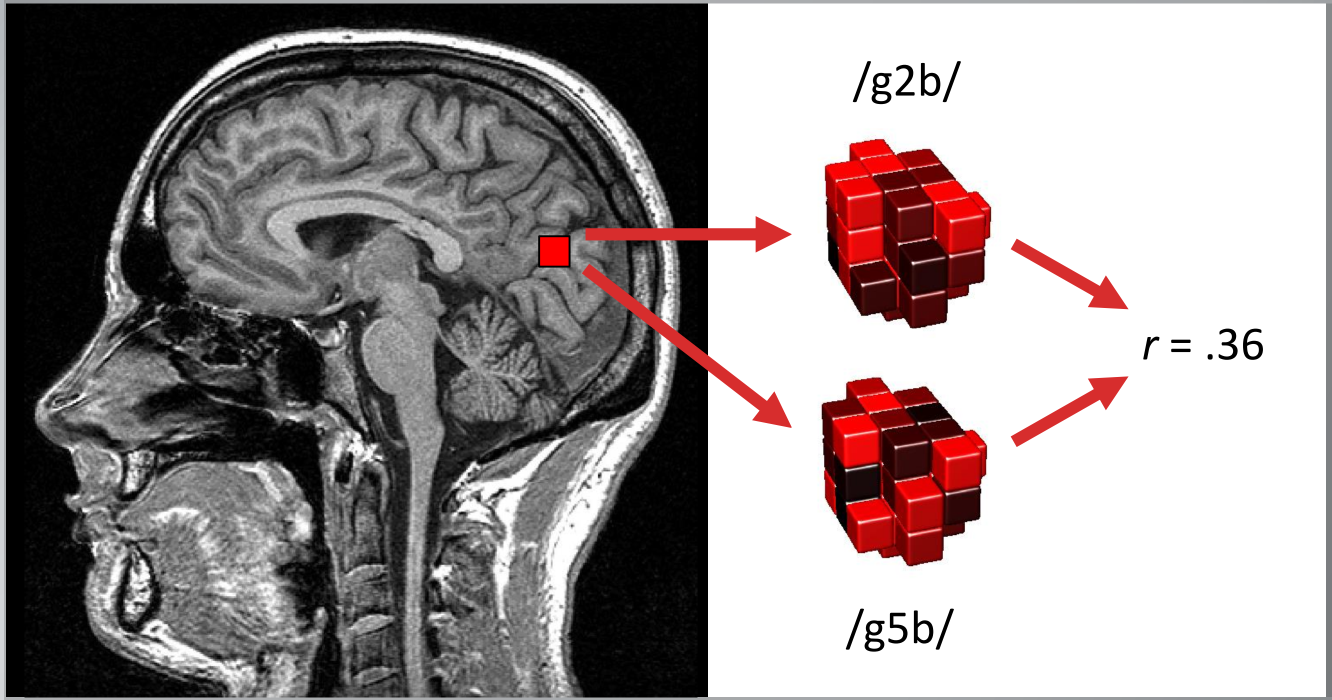
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Observed data

	/g2b/	/g5b/	/gEz/
/g2b/		.36	.65
/g5b/	.36		
/gEz/	.65		

Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate observed activation patterns

Contents

Background

Methods

Stimuli

Procedure

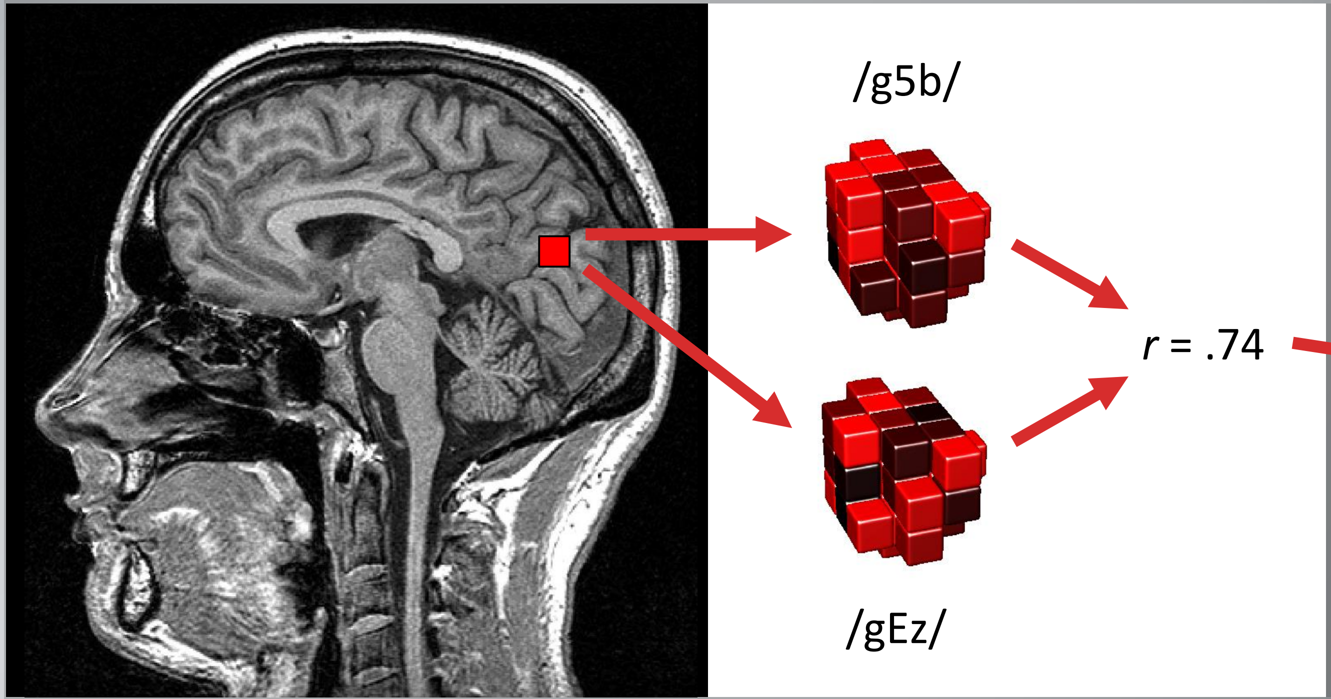
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Observed data

	/g2b/	/g5b/	/gEz/
/g2b/		.36	.65
/g5b/	.36		.74
/gEz/	.65		

Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate observed activation patterns

Contents

Background

Methods

Stimuli

Procedure

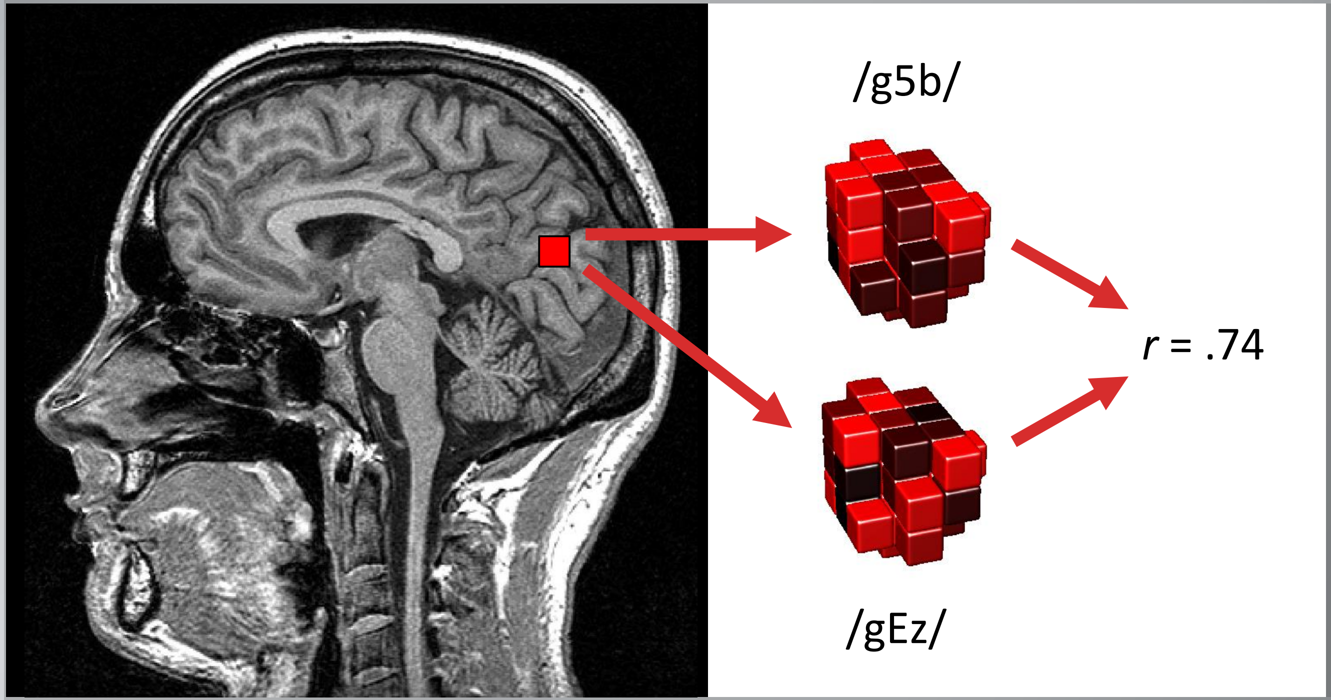
Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary



Observed data

	/g2b/	/g5b/	/gEz/
/g2b/		.36	.65
/g5b/	.36		.74
/gEz/	.65	.74	

Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

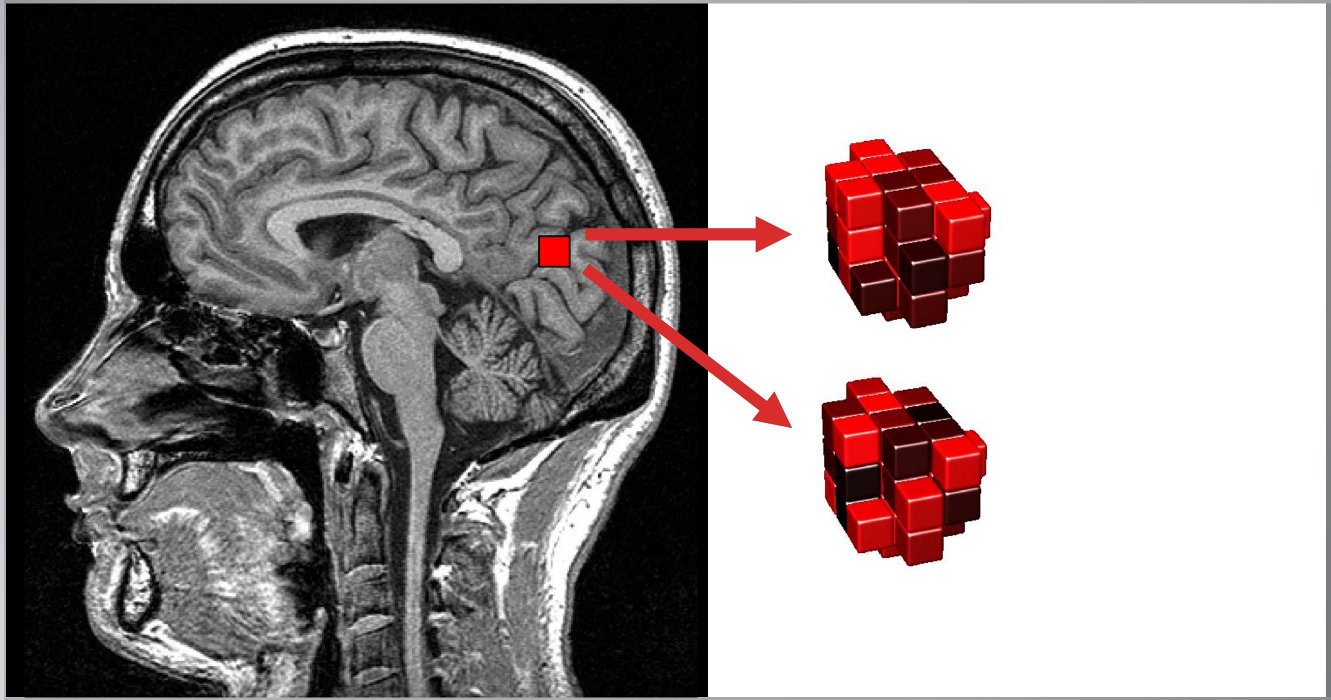
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Correlate observed activation patterns



Observed data

	/g2b/	/g5b/	/gEz/
/g2b/	NaN	.36	.65
/g5b/	.36	NaN	.74
/gEz/	.65	.74	NaN

Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate fit of prediction matrices

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

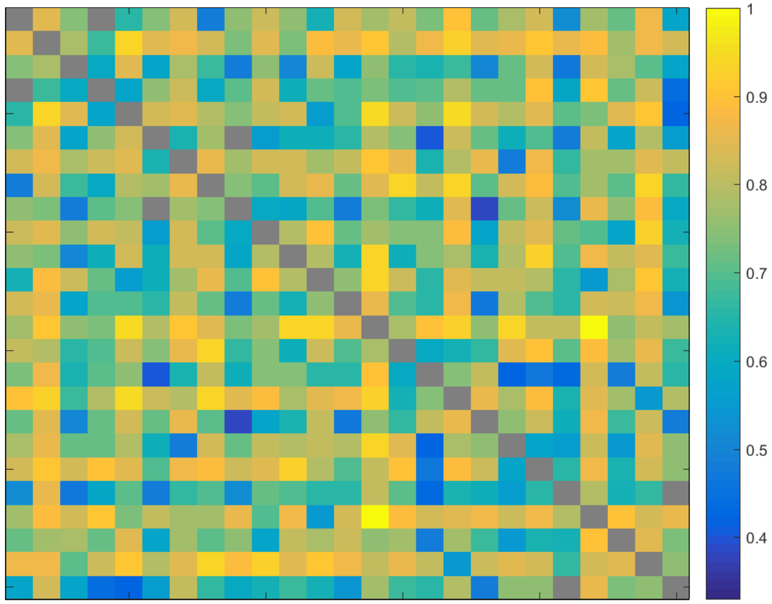
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Observed data



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate fit of prediction matrices

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

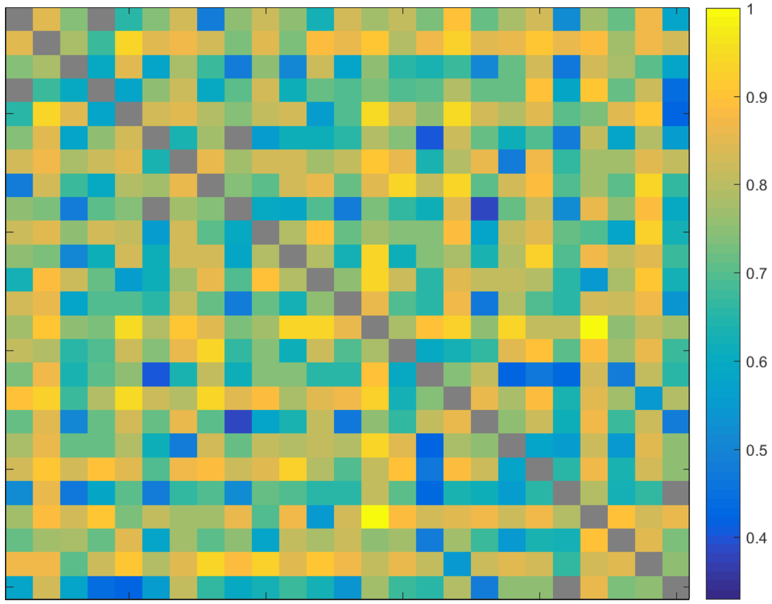
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

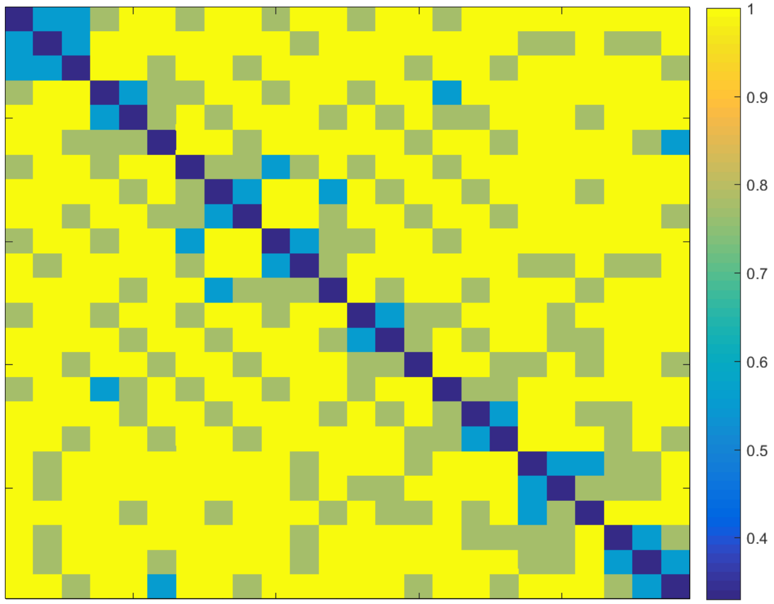
Summary

Observed data



r = 0.23

Prediction matrix (phonological)



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

Correlate fit of prediction matrices

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

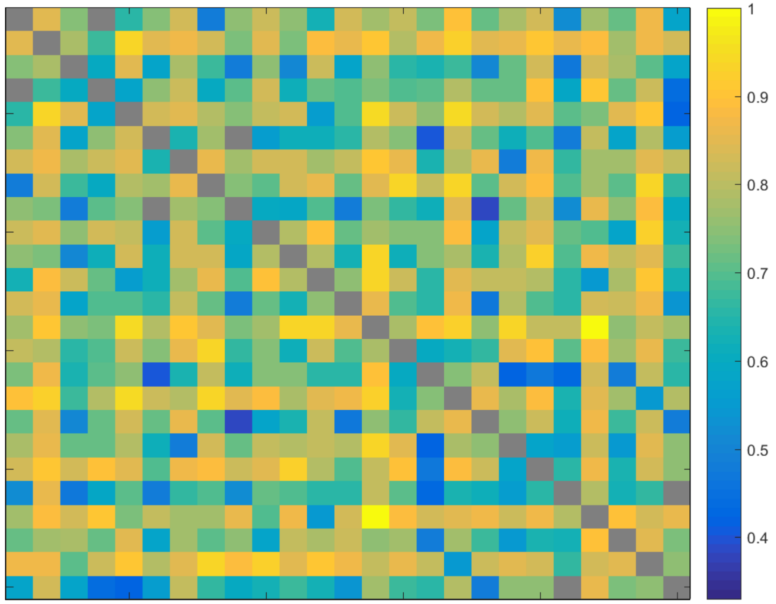
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

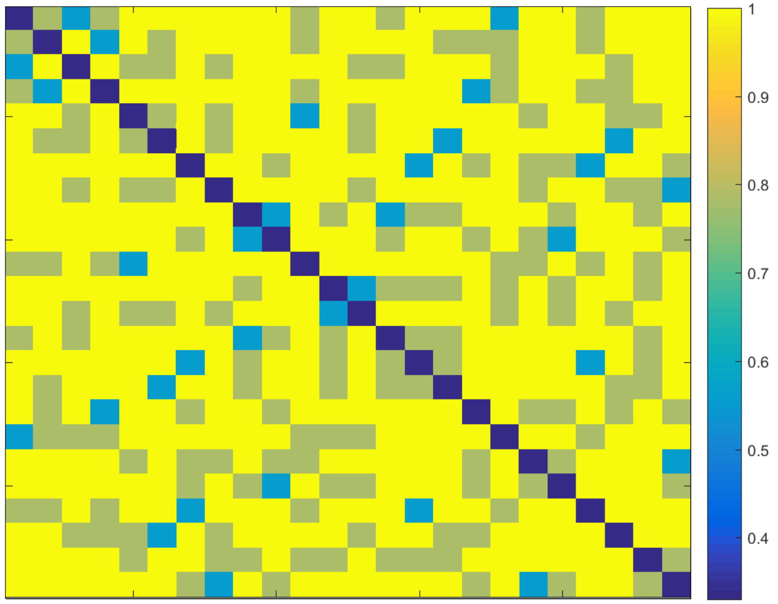
Summary

Observed data



r = 0.12

Prediction matrix (orthographic)



Slide content from Clare Lally

6. Kriegeskorte & Kievit (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Visual modality – Orthographic similarity

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

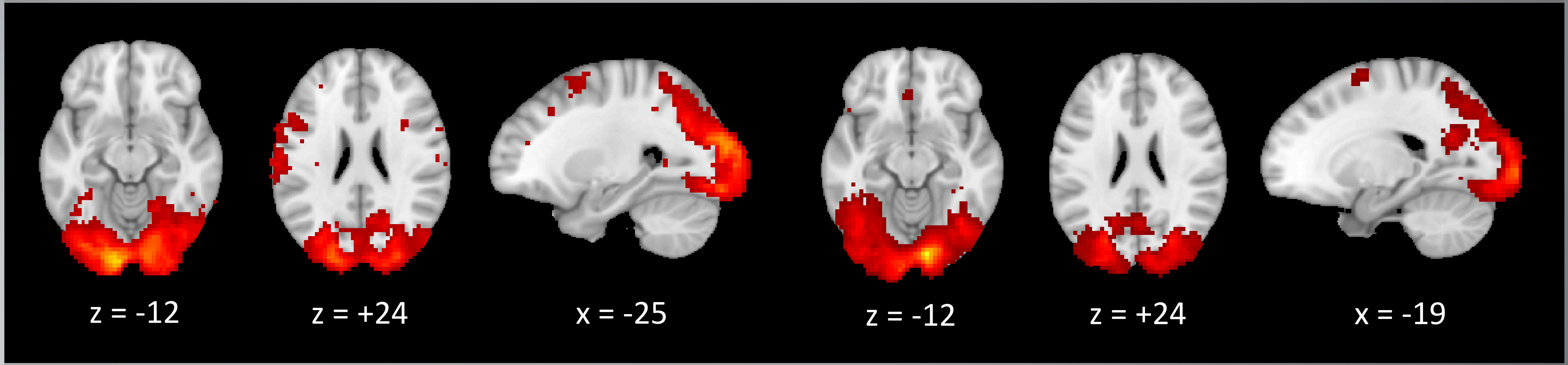
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Alphabetic > 0 | Logographic > 0



Orthographically structured representations found in regions that have been associated with written language processing and spoken language processing for alphabetic and logographic languages (very little in regions associated with spoken language processing for logographic)

p < .001 uncorrected

Visual modality – Phonemic similarity

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

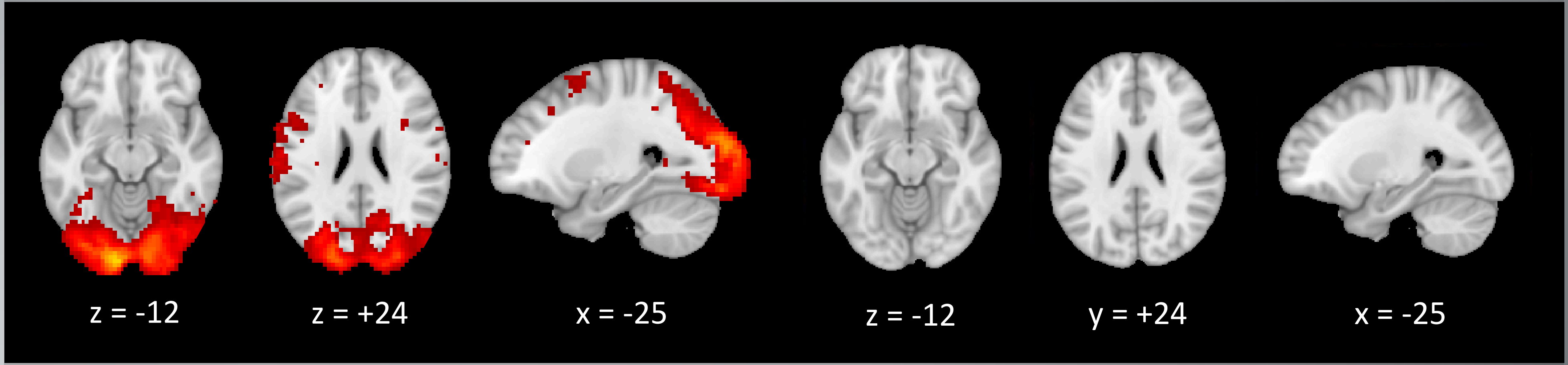
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Alphabetic > 0 | Logographic > 0



Phonemically structured representations found in both regions that have been associated with written language processing and spoken language processing areas for alphabetic. No phonemic structure exhibited by representations evoked by the logographic language.

$p < .001$ uncorrected

Auditory modality – Phonemic similarity

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

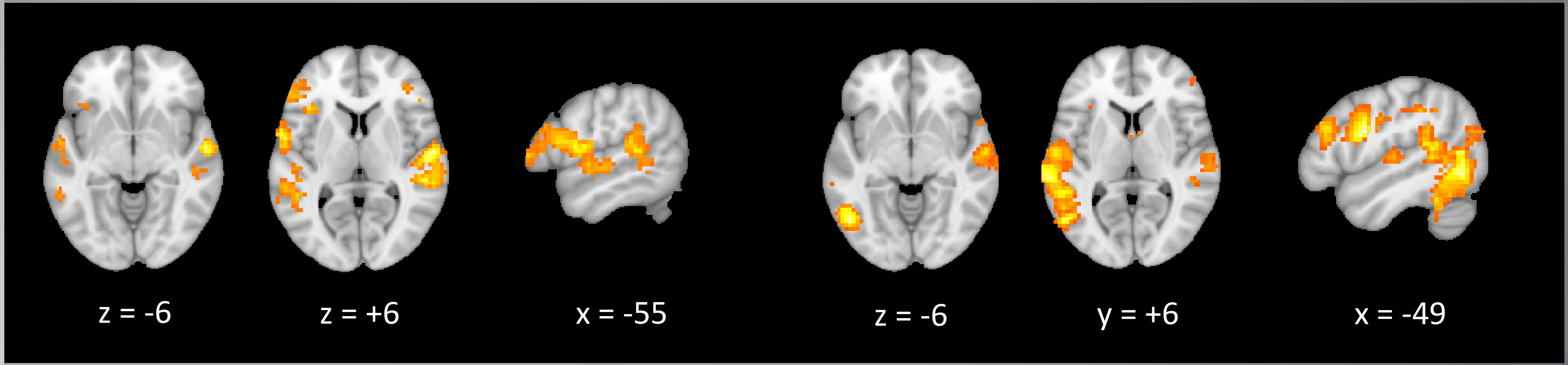
fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Alphabetic > 0 | Logographic > 0



Phonemically structured representations found in regions that have been associated with spoken language processing for the alphabetic language, and both regions that have been associated with spoken and written language processing for the logographic language.

p < .001 uncorrected

Auditory modality – Orthographic similarity

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

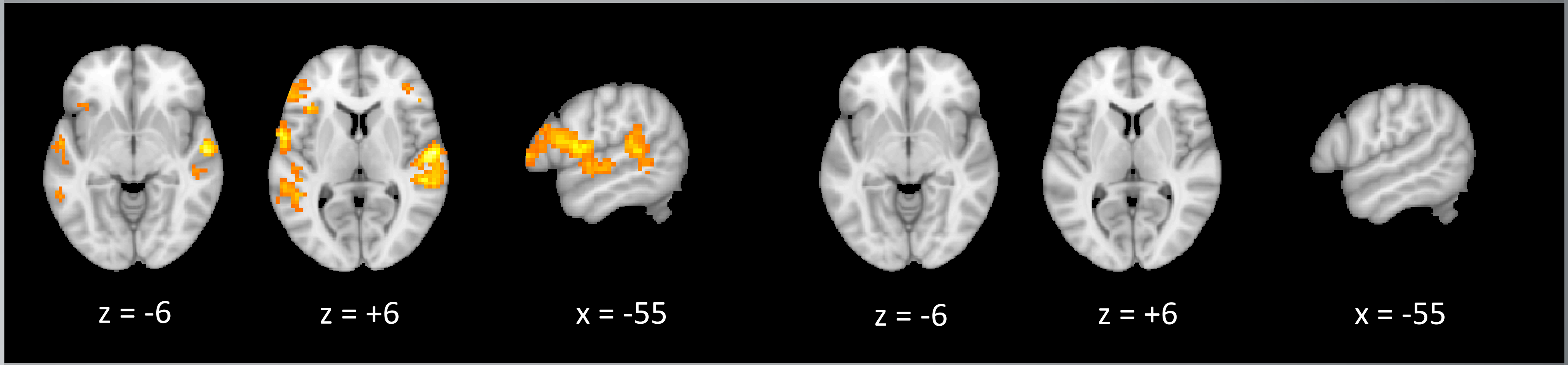
Univariate contrasts

Representational Similarity Analysis

Summary

Alphabetic > 0

Logographic > 0



Orthographically structured representations found in regions that have been associated with spoken language processing for the alphabetic language. No orthographic structure exhibited by representations evoked by the logographic language.

$p < .001$ uncorrected

Behavioural data

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

2. Rastle et al. (2011)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Behavioural data

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

1

High orthographic transparency strengthens orthography–phonology mapping

- O-P mappings acquired and recalled more efficiently for alphabetic system
- Significantly higher accuracy and faster RT for O-P tasks, slower RT for O-S tasks

Behavioural data

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

1

High orthographic transparency strengthens orthography–phonology mapping

- O-P mappings acquired and recalled more efficiently for alphabetic system
- Significantly higher accuracy and faster RT for O-P tasks, slower RT for O-S tasks

2

Low orthographic transparency strengthens orthography–semantics mapping

- O-S mappings recalled more efficiently for logographic writing system
- Significantly faster RT for O-S tasks, lower accuracy and slower RT for O-P tasks

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Behavioural data

1

High orthographic transparency strengthens orthography–phonology mapping

- O-P mappings acquired and recalled more efficiently for alphabetic system
- Significantly higher accuracy and faster RT for O-P tasks, slower RT for O-S tasks

2

Low orthographic transparency strengthens orthography–semantics mapping

- O-S mappings recalled more efficiently for logographic writing system
- Significantly faster RT for O-S tasks, lower accuracy and slower RT for O-P tasks

3

Orthographic transparency does not appear to affect spoken language processing

- No differences between alphabetic/logographic when orthography not present
- Does not support orthographic effect on speech perception [2]

2. Rastle et al. (2011)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Neuroimaging data

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Neuroimaging data

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

1 **Left PrG and SPL more active for alphabetic languages when orthography present**

- Increased phonological processing for alphabetic writing system [5]

5. Taylor et al. (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

Neuroimaging data

1 **Left PrG and SPL more active for alphabetic languages when orthography present**

- Increased phonological processing for alphabetic writing system [5]

2 **Bilateral AnG and MOG more active for logographic system when orthography present**

- Increased semantic/phonological lexicon processing for logographic [5]

5. Taylor et al. (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Neuroimaging data

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

1. **Left PrG and SPL more active for alphabetic languages when orthography present**
   - Increased phonological processing for alphabetic writing system [5]

2. **Bilateral AnG and MOG more active for logographic system when orthography present**
   - Increased semantic/phonological lexicon processing for logographic [5]

3. **No difference in activation for spoken language tasks where orthography not present**

5. Taylor et al. (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Neuroimaging data

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

1 **Left PrG and SPL more active for alphabetic languages when orthography present**

- Increased phonological processing for alphabetic writing system [5]

2 **Bilateral AnG and MOG more active for logographic system when orthography present**

- Increased semantic/phonological lexicon processing for logographic [5]

3 **No difference in activation for spoken language tasks where orthography not present**

4 **Next steps: Paired-samples t-tests and ROIs analyses on RSA searchlight maps**

5. Taylor et al. (2013)

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

THANK YOU

Dr Joanne Taylor
Dr Angelika Lingnau
Dr Tibor Auer
Professor Kathy Rastle

Royal Holloway, University of London




ROYAL HOLLOWAY UNIVERSITY OF LONDON

References

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

1. Harm, M. W., & Seidenberg, M. S. (2004). Computing the Meanings of Words in Reading: Cooperative Division of Labor Between Visual and Phonological Processes. *Psychol Rev, 111*(3), 662-720.

2. Rastle, K., McCormick, S. F., Bayliss, L., & Davis, C. J. (2011). Orthography influences the perception and production of speech. *J Exp Psychol Learn Mem Cogn, 37,* 1588-94.

3. Taylor, J. S. H., Davis, M. H., & Rastle, K. (2017). Comparing and validating methods of reading instruction using behavioural and neural findings in an artificial orthography. *J Exp Psychol Gen, 146*(6), 826-858.

4. Mei, L., Xue, G., Lu, Z., Chen, C., Zhang, M., He, Q., et al. (2014). Learning to read words in a new language shapes the neural organization of the prior languages. *Neuropsychologia, 65,* 156-168.

5. Taylor, J. S. H., Rastle, K., & Davis, M. H. (2013). Can cognitive models explain brain activation during word and pseudoword reading? A meta-analysis of 36 neuroimaging studies. *Psychol Bull, 139,* 766-779.

6. Kriegeskorte, N., & Kievit, R. A. (2013). Representational geometry: integrating cognition, computation, and the brain. *Trends Cogn Sci, 17*(8), 401-412.

ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

fMRI paradigm

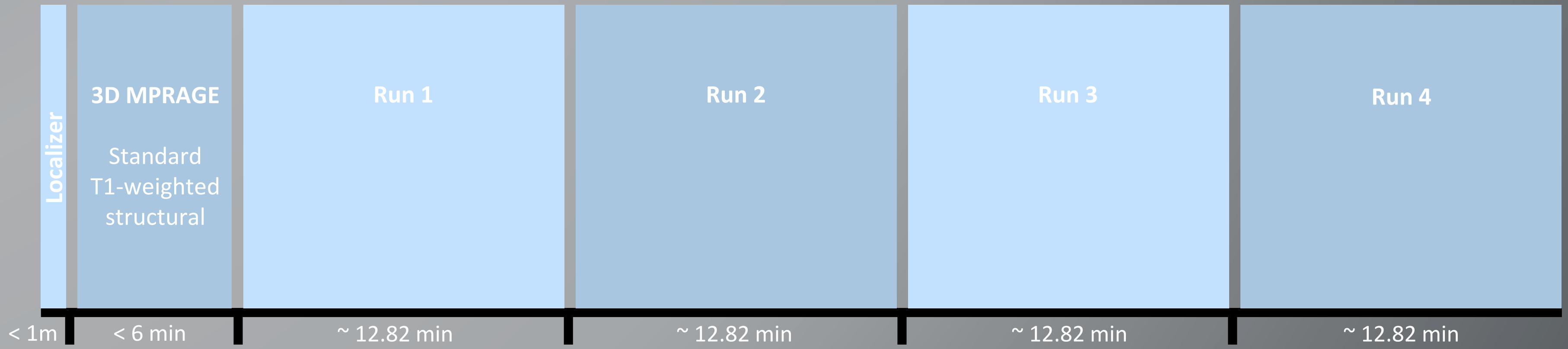
3T Siemens scanner

192 trials per run

Languages include 24 items
Each item presented 4 times

Block-related design

2 sessions including 8 alternating runs
4 runs per session: 2 visual / 2 auditory
12 blocks per run = 16 trials per block
2 languages alternating between blocks
4 target categories x 3 = one per block
2500ms stimuli + 500ms ITI per trial



ROYAL HOLLOWAY UNIVERSITY OF LONDON

Contents

Background

Methods

Stimuli

Procedure

Behavioural data

fMRI paradigm

Univariate contrasts

Representational Similarity Analysis

Summary

fMRI paradigm

Visual Semantic Monitoring

Continuous imaging
TR = 2000ms
TA = 2000ms

Auditory Semantic Monitoring

Sparse imaging
TR = 3000ms
TA = 2000ms