What can synesthesia teach us about sound symbolism?

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What can synesthesia teach us about sound symbolism?

Linguistics Background

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Arbitrariness

(de Saussure, 1959; Hockett, 1977; Gasser, 2004)

LINGUISTICS BACKGROUND

Arbitrariness

dog

cane

chien

ferro

kelb

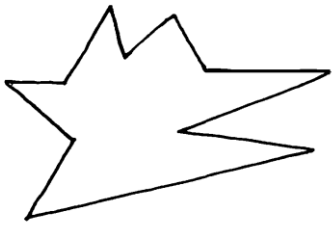
(de Saussure, 1959; Hockett, 1977; Gasser, 2004)

Sound Symbolism

Crossmodal correspondences between word form and meaning

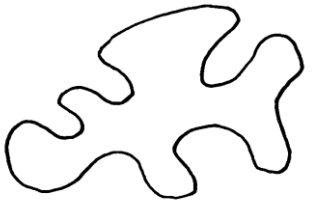
SOUND SYMBOLISM

Crossmodal correspondences between word form and meaning



‘kiki’

‘bouba’



(e.g., Maurer, Pathman, & Mondloch, 2006, Brown, Black, & Horowitz, 1955; DeFife, Nygaard, & Namy, 2014; Klank, Huang, & Johnson, 1971, Köhler, 1929; Kunihira, 1971)

SOUND SYMBOLISM

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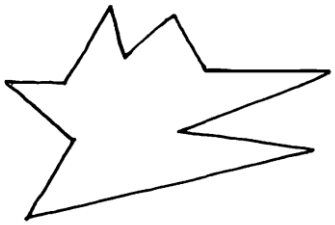

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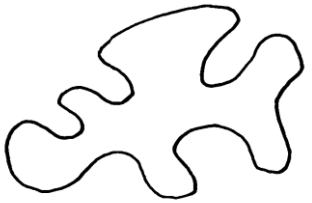

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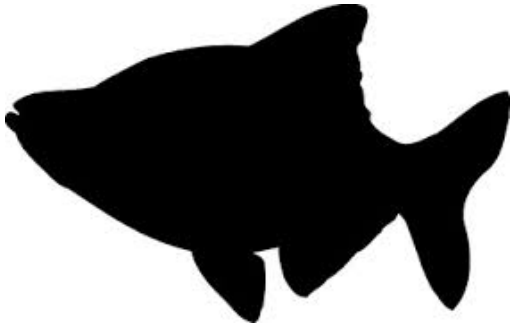
Sound Symbolism

Crossmodal correspondences between word form and meaning

robin
sparrow
cardinal

trout
salmon
bass



(Berlin, 1994)

Sound Symbolism

Crossmodal correspondences between word form and meaning

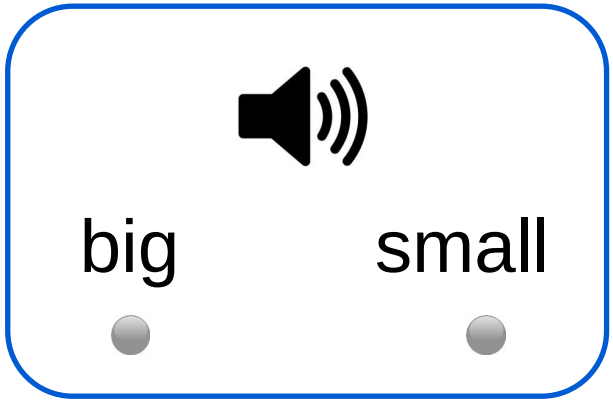
Albanian

Mandarin

Dutch

Romanian

Gujarati



Tamil

Indonesian

Yoruba

Turkish

Korean

(DeFife, Nygaard, & Namy, in prep; Kunihira, 1971; Nygaard, Cook, & Namy, 2009)

SOUND SYMBOLISM

Crossmodal correspondences between word form and meaning

- increases learnability for adults and children (e.g., Nygaard, Cook, & Namy, 2009; Imai et al., 2008)

- increases online language processing speed (Farmer, Christiansen, & Monaghan, 2006)

SOUND SYMBOLISM

Crossmodal correspondences between word form and meaning

- What are the cognitive mechanisms?

Sound Symbolism

Crossmodal correspondences between word form and meaning

- What are the cognitive mechanisms?
- Do crossmodal neural connections between sensory areas underlie sound symbolism?

(e.g., Revill, Namy, DeFife, & Nygaard, 2014; Ramachandran & Hubbard, 2001)

What can synesthesia teach us about sound symbolism?

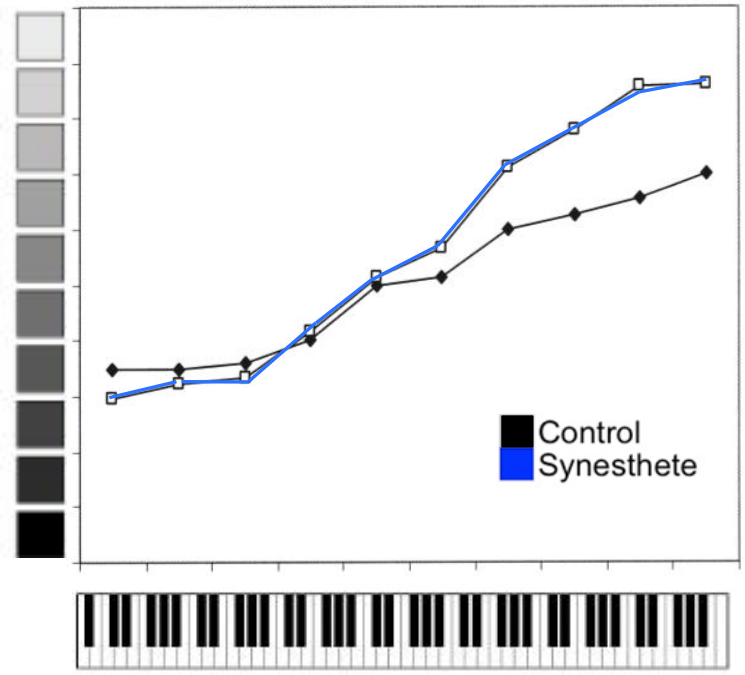
SYNESTHESIA

sensory or cognitive stimuli consistently cause additional sensory or cognitive experiences

jail

SYNESTHESIA

- nonsynesthetes' implicit associations match underlying patterns of synesthetes' explicit associations (e.g., Simner et al., 2005; Ward et al., 2006)



SYNESTHESIA

- nonsynesthetes' implicit associations match underlying patterns of synesthetes' explicit associations (e.g., Simner et al., 2005; Ward et al., 2006)

- arises from additional and/or uninhibited neural connections (see Rouw, Scholte, & Colizoli, 2011 for a review)

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Synesthesia is an exaggerated form of normal crossmodal processing? (e.g., Brang et al., 2011)

What can synesthesia teach us about sound symbolism?

Research Questions

Is there a link between synesthesia and sound symbolism?

1. Are synesthetes more sensitive to sound symbolism than nonsynesthetes?

2. Is sound symbolism found within synesthetic associations?

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EXPERIMENT 1

Auditory 2AFC task with 400 foreign words

(DeFife, Nygaard, & Namy, in prep)

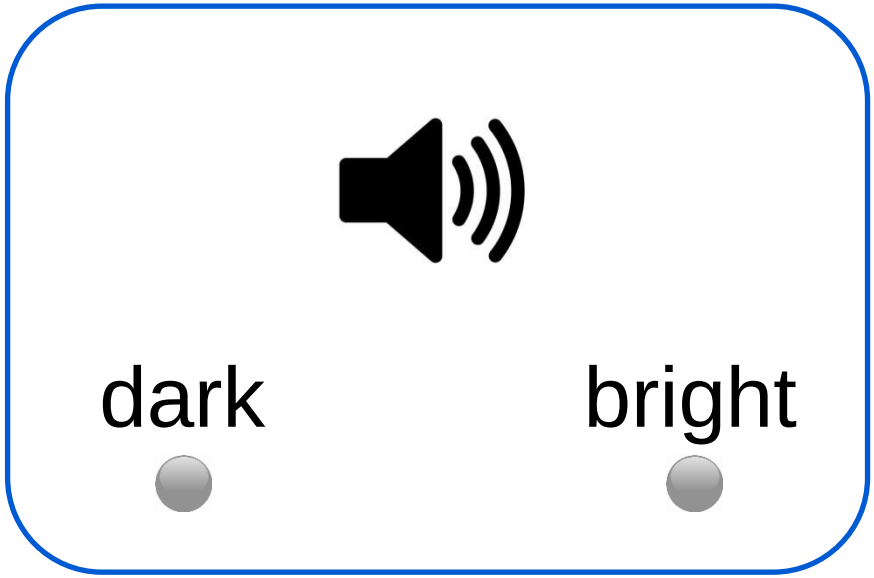
- 10 languages
  - Albanian, Dutch, Gujarati, Indonesian, Korean, Mandarin, Romanian, Tamil, Turkish, and Yoruba
- 4 antonym pairs
  - big/small, bright/dark, up/down, loud/quiet

19 grapheme-color synesthetes

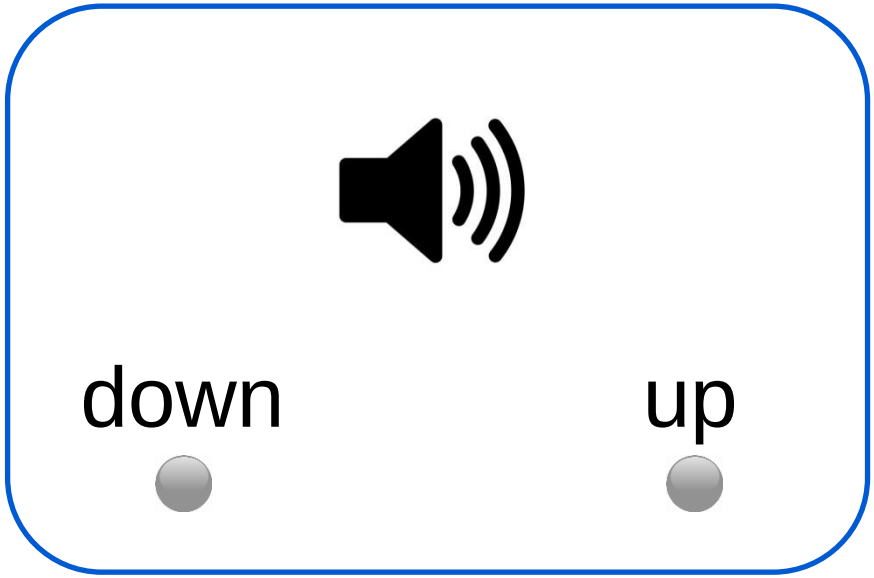
57 controls

(Bankieris & Simner, under review)

EXPERIMENT 1



Experiment 1



EXPERIMENT 1

Mixed-effects logistic regression

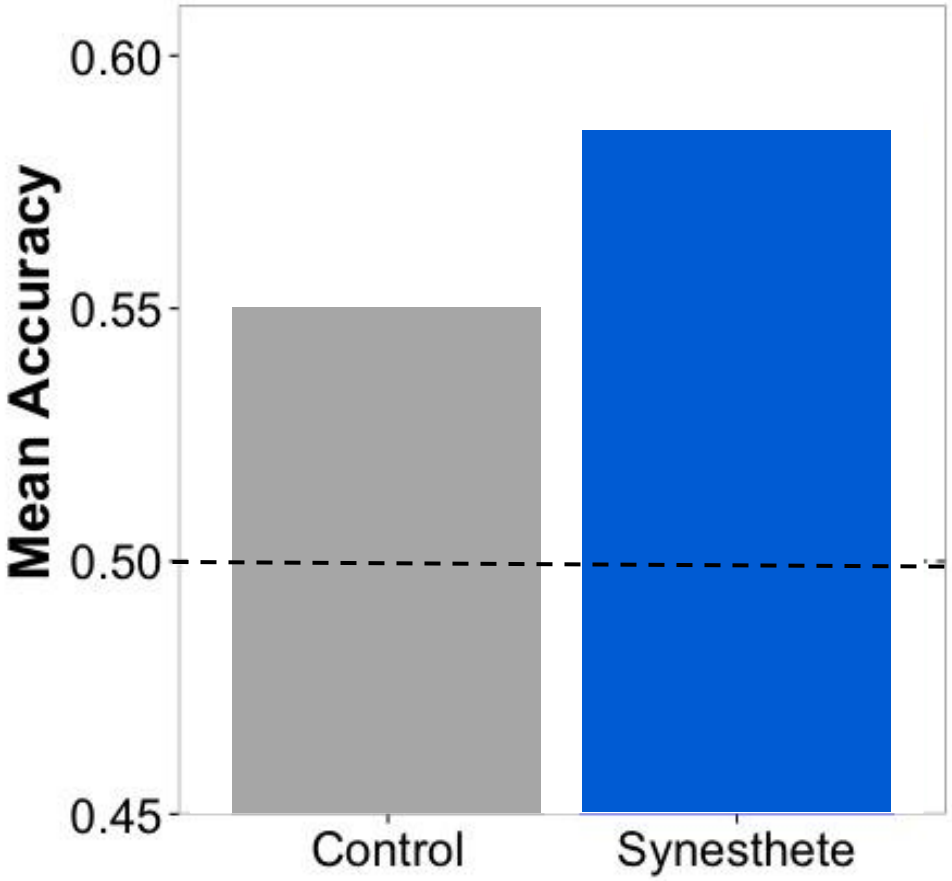
Mean accuracy ~ group * domain

(synesthete, control)

(BigSmall, LoudQuiet, DownUp, BrightDark)

EXPERIMENT 1 PREDICTIONS

GLOBAL



EXPERIMENT 1 PREDICTIONS

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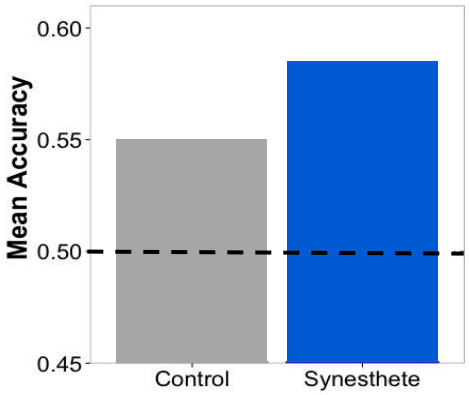
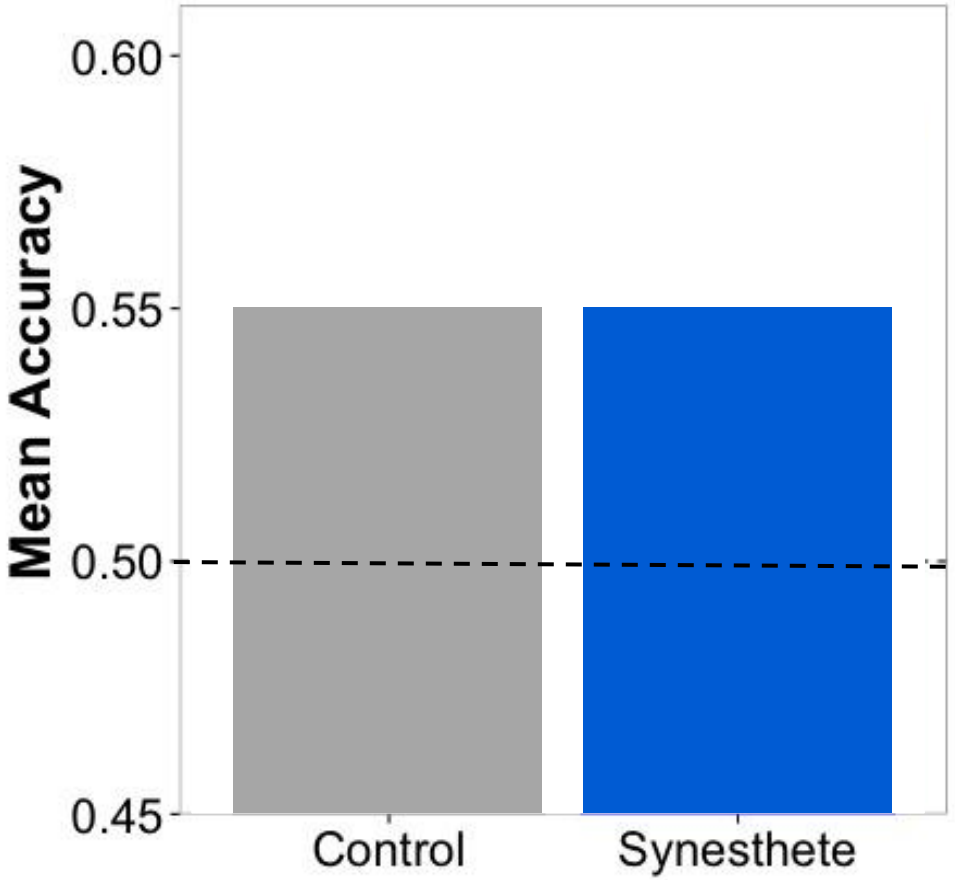


SPECIFIC



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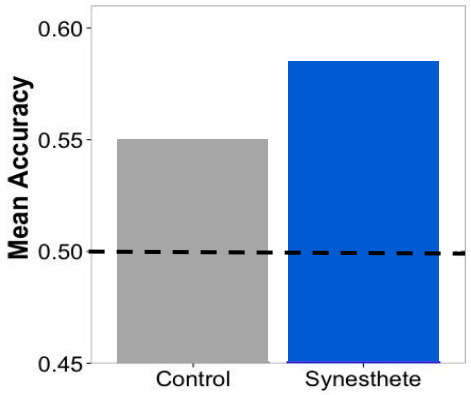

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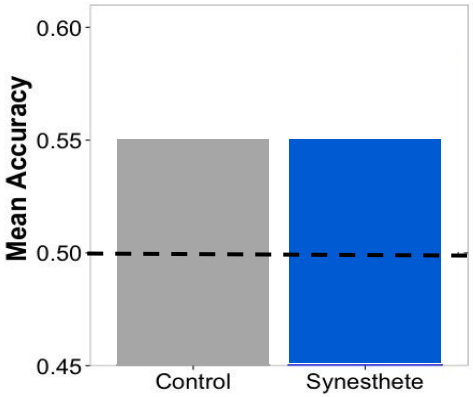
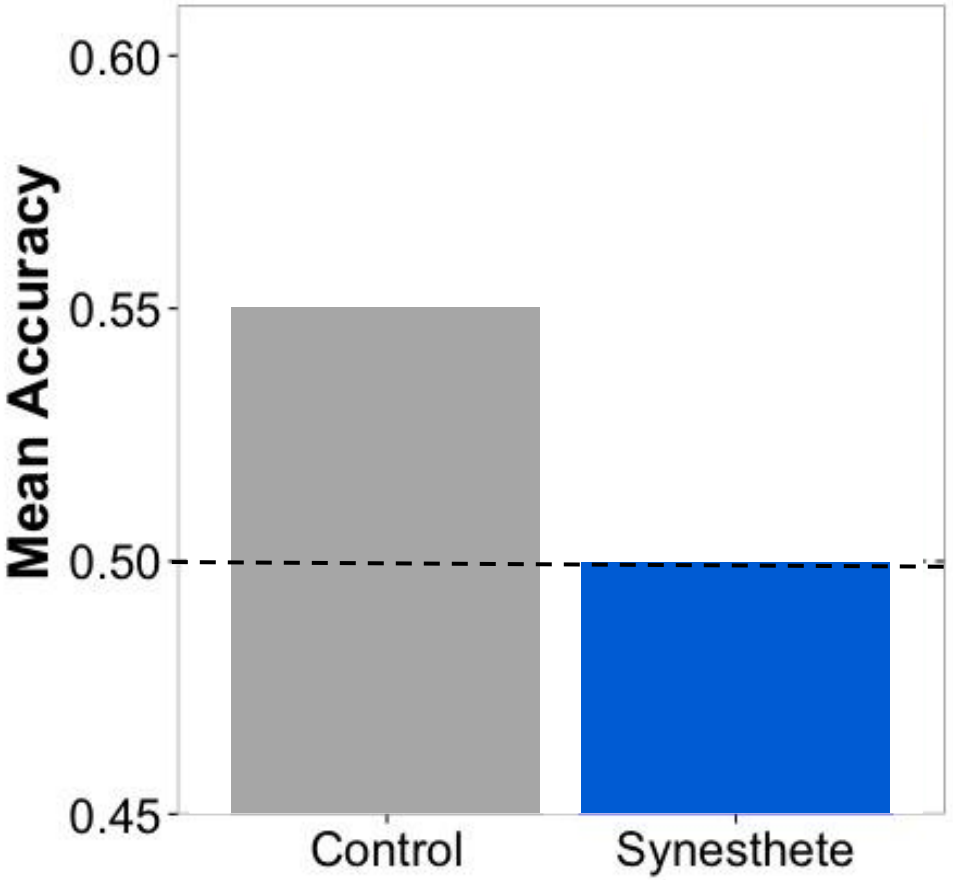
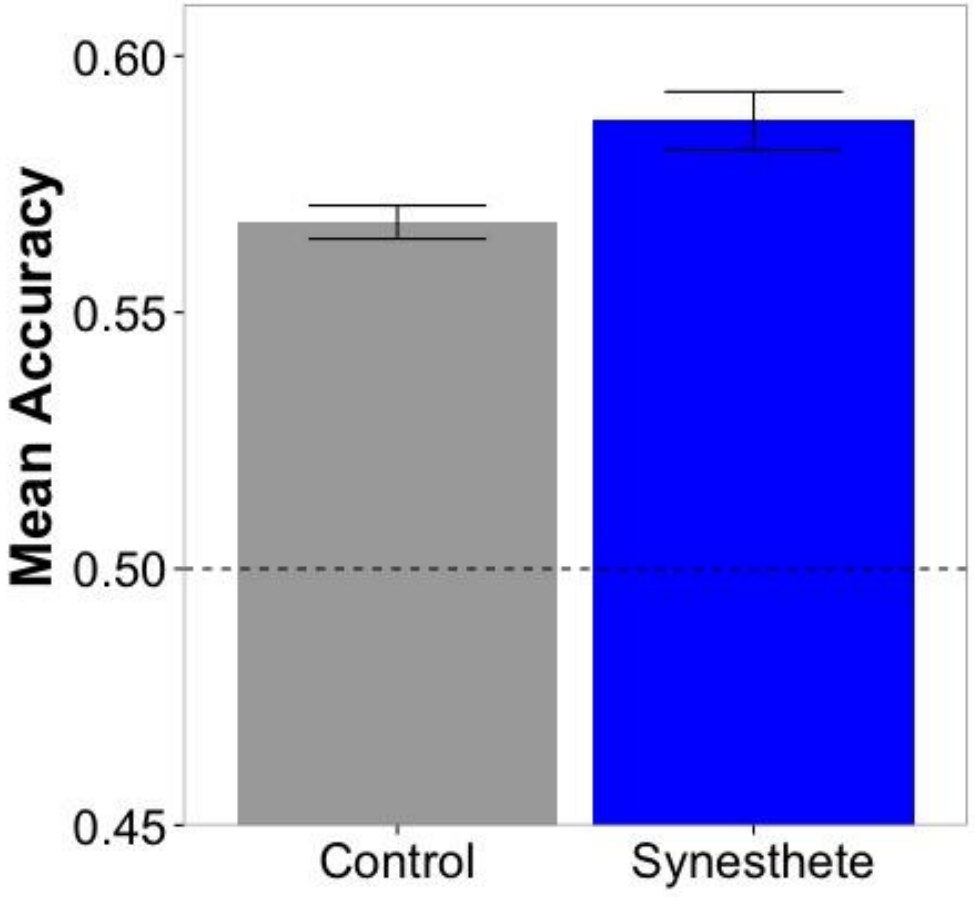


INTERFERENCE



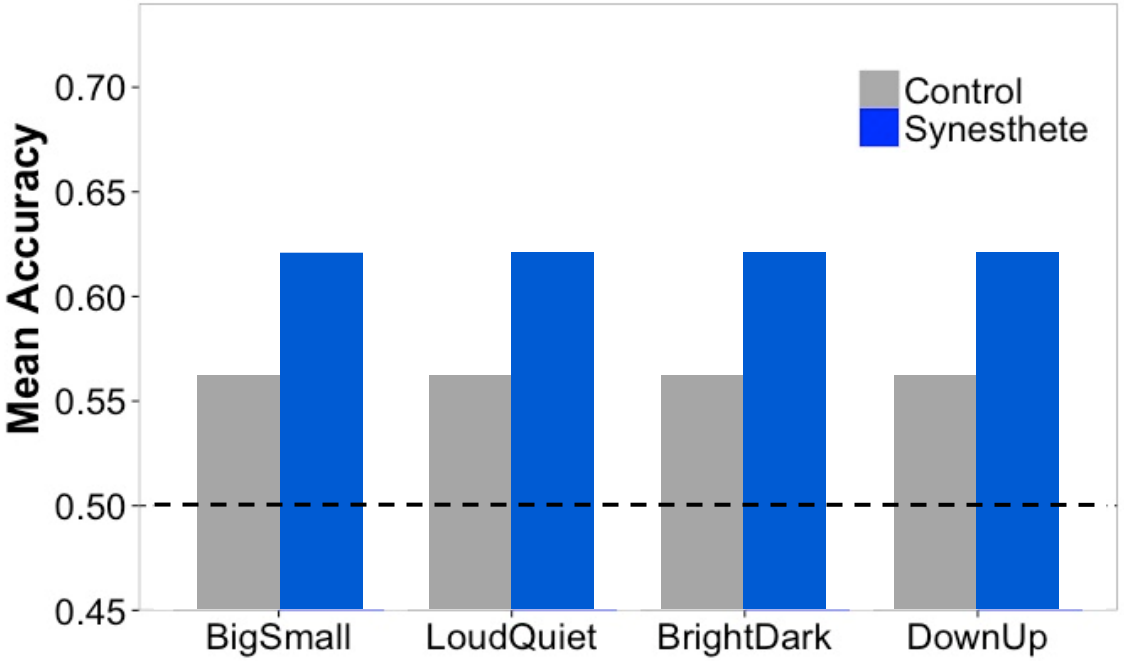
Experiment 1 Results



Significant group effect *ß* = .05, *z* = 2.19, *p* < .05

EXPERIMENT 1 PREDICTIONS

GLOBAL



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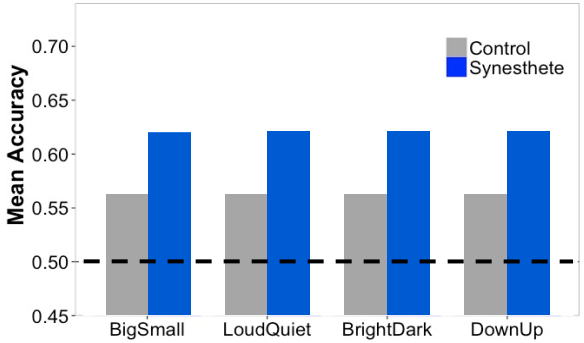

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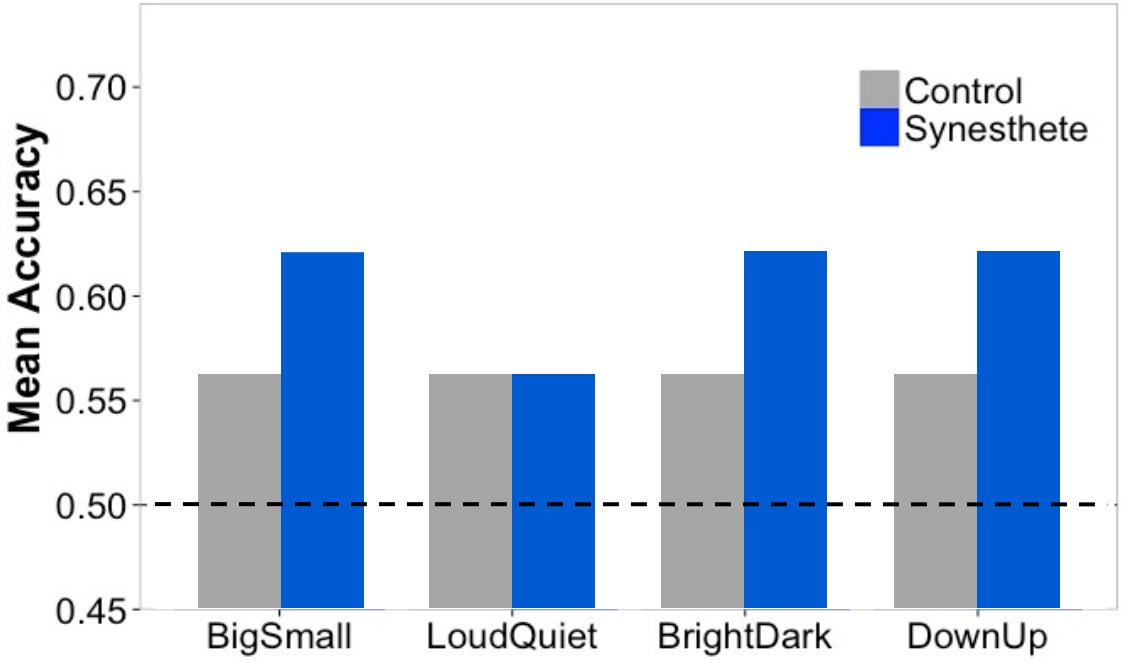

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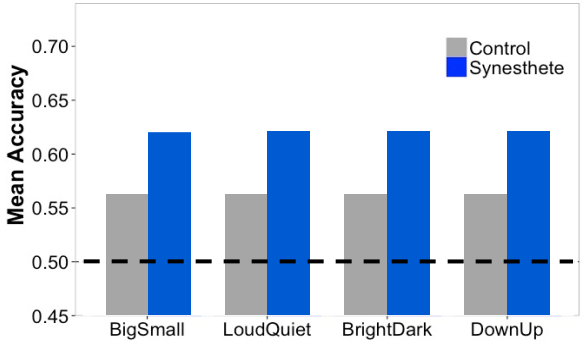

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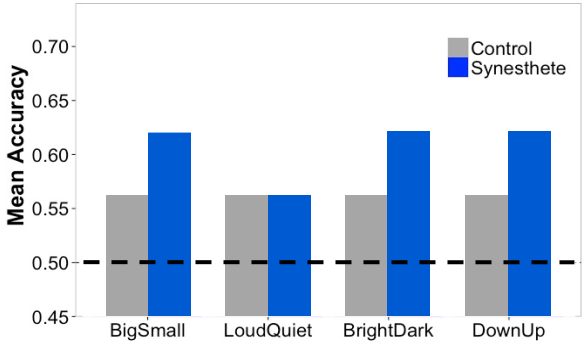

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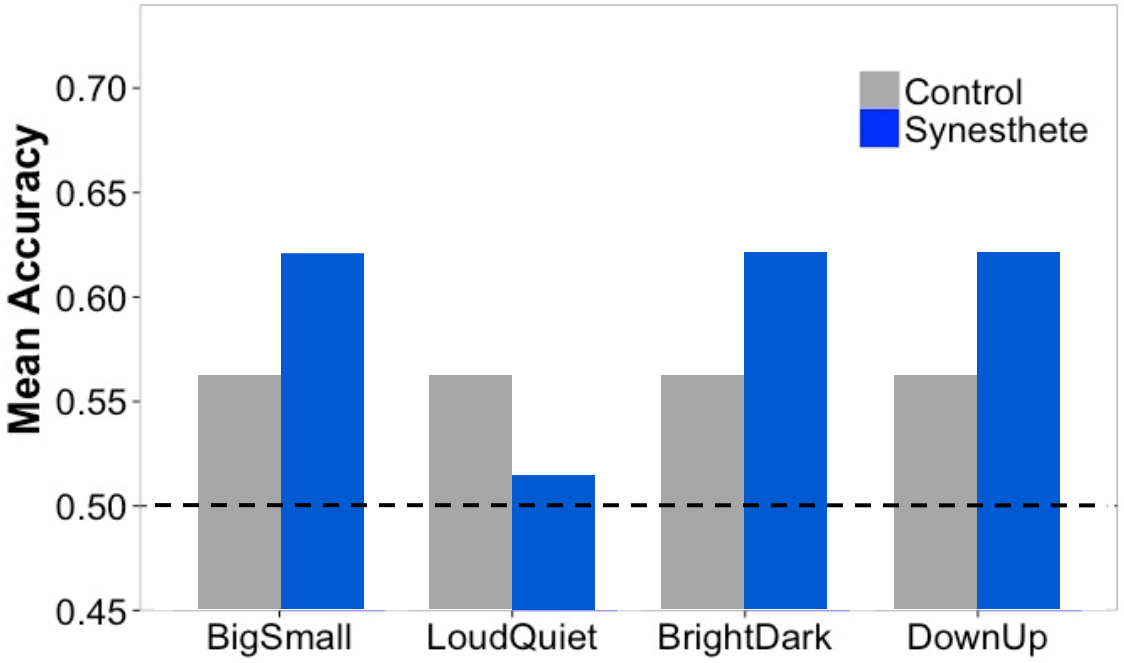

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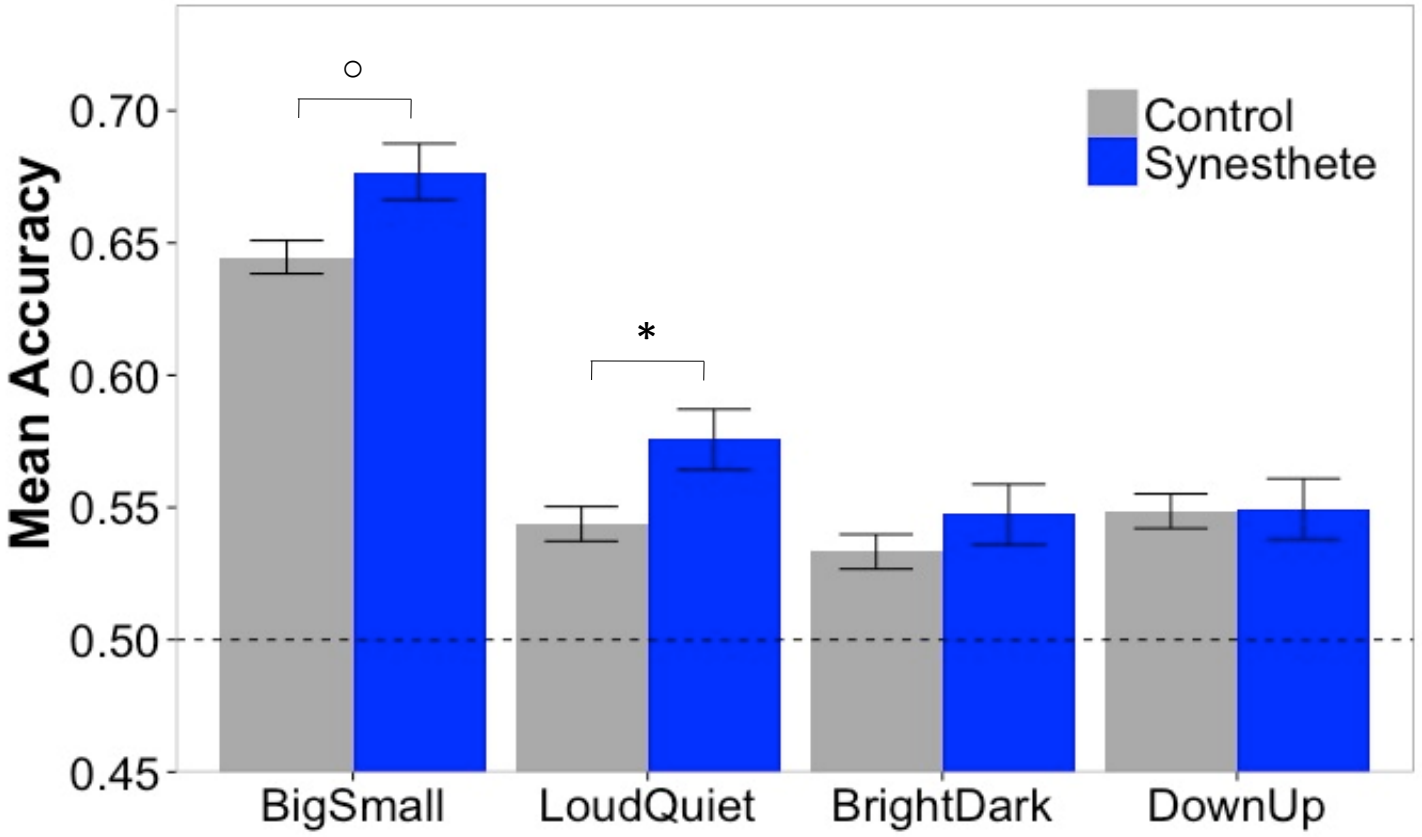
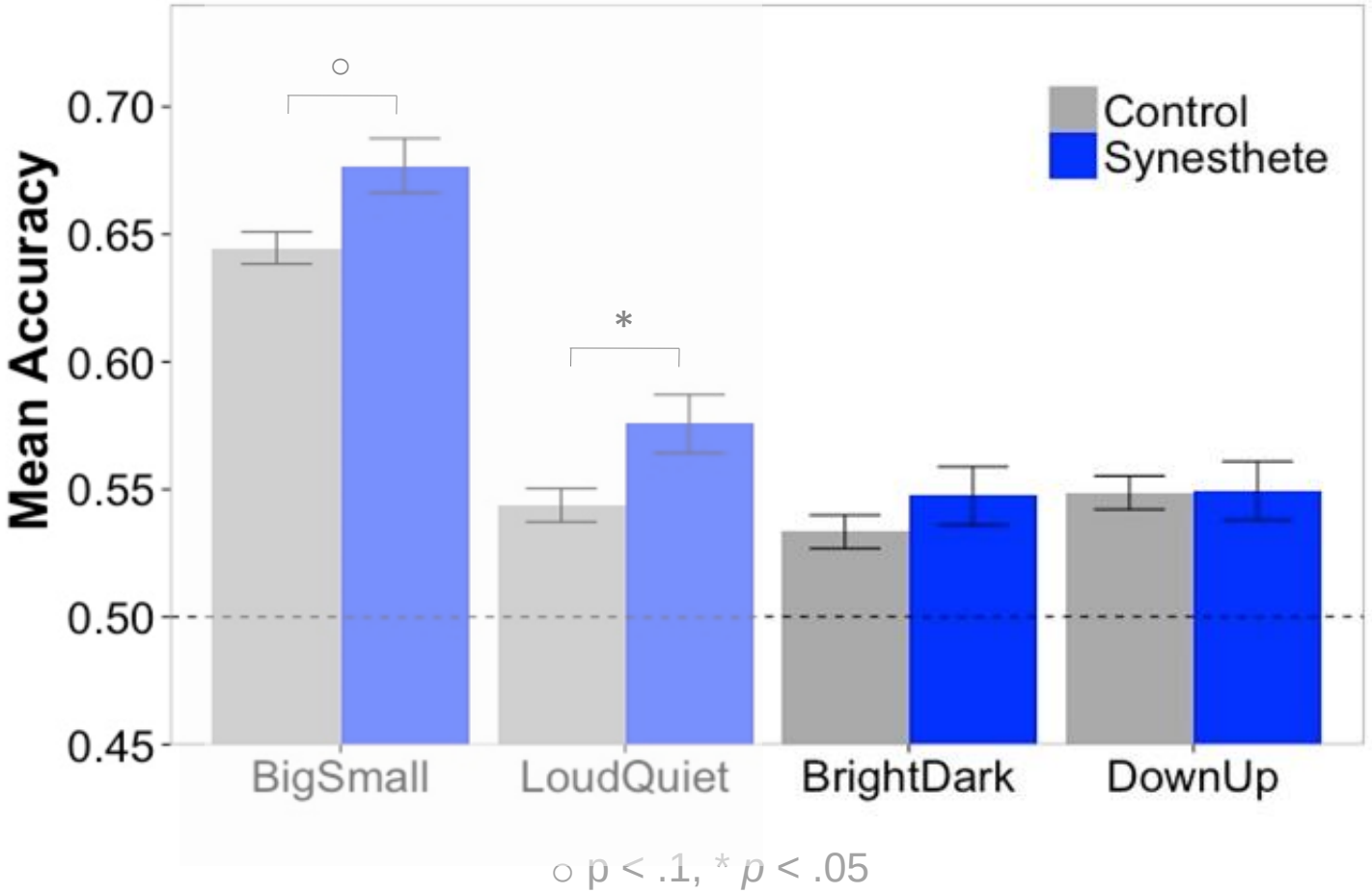


○ p < .1, * *p* < .05

Experiment 1 Results



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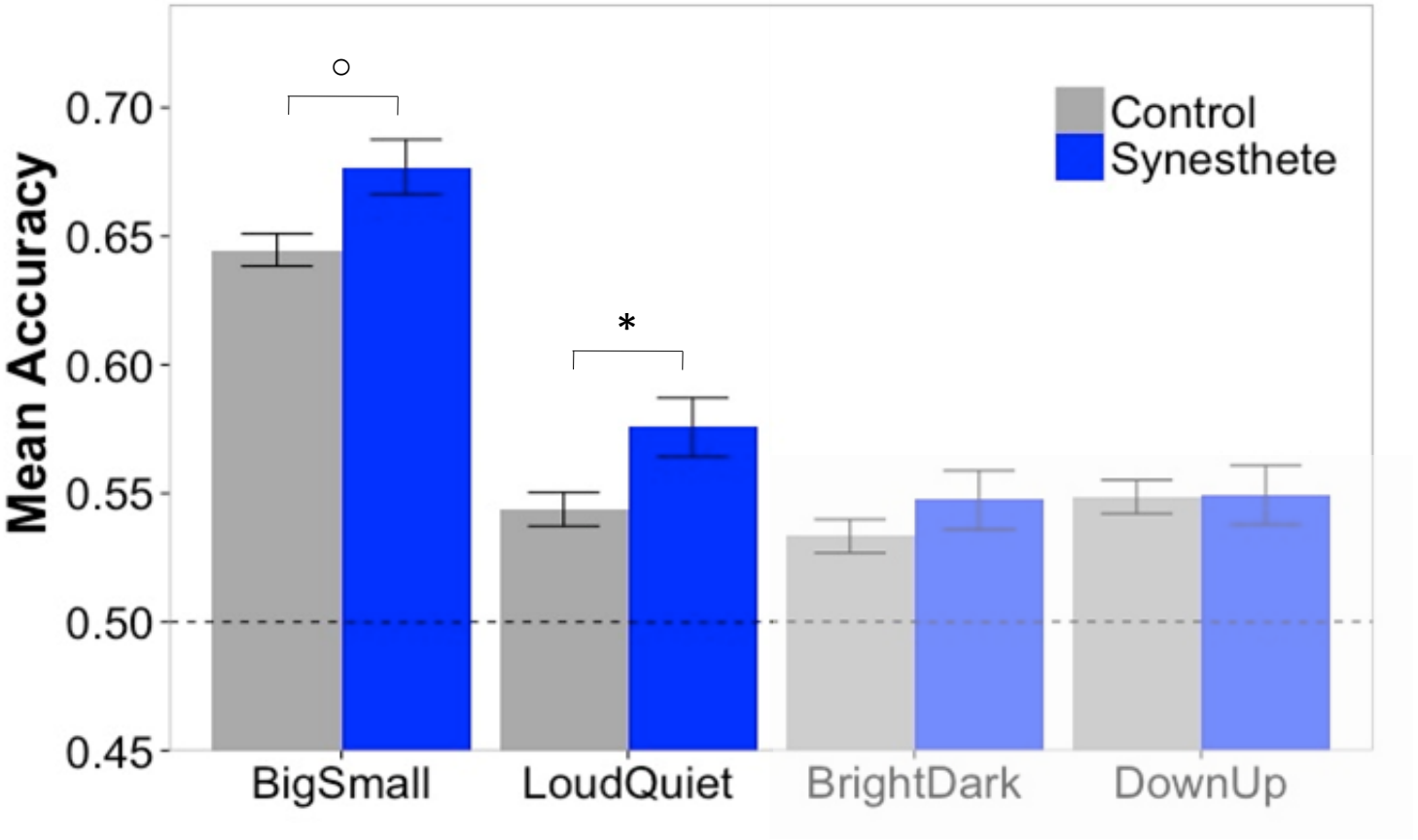
Experiment 1 Results



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EXPERIMENT 2

Case study of a lexical-gustatory synesthete

- **479 word-flavor pairs**

TRIGGER WORD	FLAVOR
cavalry	*dark chocolate*

(Bankieris & Simner, 2013)

EXPERIMENT 2

TRIGGER WORD

cavalry

FLAVOR

dark chocolate

Coded:

- vowel
  - height
  - backness
  - roundedness
- consonant
  - manner of articulation
  - place of articulation
  - voicing
- consonants vs. vowels

EXPERIMENT 2

TRIGGER WORD

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FLAVOR

dark chocolate

Coded:

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EXPERIMENT 2

TRIGGER WORD

cavalry – /kæ.vəl.ri/

Consonant	Voicing

EXPERIMENT 2

TRIGGER WORD

cavalry – /kæ.vəl.ri/

Consonant	Voicing
k	
v	
l	
r	

EXPERIMENT 2

TRIGGER WORD

cavalry – /kæ.vəl.ri/

Consonant	Voicing
k	**unvoiced**
v	**voiced**
l	**voiced**
r	**voiced**

EXPERIMENT 2

TRIGGER WORD

cavalry – /kæ.vəl.ri/

Consonant	Voicing
k	**unvoiced**
v	**voiced**
l	**voiced**
r	**voiced**

$$\frac{(\text{total voiced} * 1) + (\text{total unvoiced} * -1)}{\text{total consonants}}$$

EXPERIMENT 2

TRIGGER WORD

cavalry – /kæ.vəl.ri/

Consonant	Voicing
k	**unvoiced**
v	**voiced**
l	**voiced**
r	**voiced**

$$\frac{\textbf{(total voiced * 1) + (total unvoiced * -1)}}{\textbf{total consonants}}$$

$$\frac{(3*1) + (1*-1)}{4} = .5$$

EXPERIMENT 2

TRIGGER WORD

cavalry

FLAVOR

dark chocolate

Coded:

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cavalry

FLAVOR

dark chocolate

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20 controls rated:

- sweet
- sour
- bitter
- salty
- umami

EXPERIMENT 2

TRIGGER WORD

cavalry

FLAVOR

dark chocolate

Coded:

- vowel
  - height
  - backness
  - roundedness
- consonant
  - manner of articulation
  - place of articulation
  - voicing
- consonants vs. vowels

20 controls rated:

- sweet .37
- sour -.23
- bitter 0.05
- salty -.27
- umami -.19

1 2 3 4 5

not at all **extremely**

EXPERIMENT 2

TRIGGER WORD

cavalry

FLAVOR

dark chocolate

Coded:

- vowel
  - height
  - backness
  - roundedness
- consonant
  - manner of articulation
  - place of articulation
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20 controls rated:

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5 step-wise linear regression models

Experiment 2 Results

TRIGGER WORD

cavalry

FLAVOR

dark chocolate

Coded:

- vowel
  - height
  - backness
  - roundedness
- consonant
  - manner of articulation
  - place of articulation
  - voicing
- consonants vs. vowels

high vowels p<.001

obstruents p<.05

20 controls rated:

- sweet
- sour
- bitter
- salty
- umami

5 step-wise linear regression models

Experiment 2 Results

Phonemic trigger	Taste
high vowels*	sour
obstruents	umami

*** matches nonsynesthetes' associations**

(Crisinel & Spence, 2009, 2010a, 2010b; Simner et al., 2010; Whalen & Levitt, 1995)

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Synesthesia and sound symbolism may emerge from common crossmodal mechanisms

- left superior parietal cortex

(Brang et al., 2013; Revill et al., 2014; Rouw & Scholte, 2007)

Conclusions & Future Directions

Synesthesia is a useful tool for investigating general cognition

-Statistical learning
-Ideal cue integration

THANKS!

Jools Simner

Dick Aslin

SUPPLEMENTARY SLIDES

EXPERIMENT 2

SAUSAGE

	MT1	MT2	MT3
bitter	1	2	1
salty	4	1	3
savory	4	2	3
sour	1	1	1
sweet	1	3	1

Normalize by individual participants' mean and SD

Take overall mean

Flavor profile	
bitter	-0.57
salty	0.85
savory	0.7
sour	-0.58
sweet	-0.04

EXPERIMENT 2

‘acid’ → **warheads**

Proportions	
close	.5
mid	0
open	.5
back	0
central	1
front	1
rounded	0

Proportions	
labial	0
coronal	1
dorsal	0
glottal	0
sonorant	0
voiced	.5
vowel	.5

Flavor profile	
bitter	-0.15
salty	-0.38
savory	-0.33
sour	1.09
sweet	0.46

Control Task

WAIS vocabulary subtest

- Define 35 words via telephone interview
- Each response scored 0-2 for correctness and completeness of definition
- Raw scores converted to scaled scores based on age (Wechsler, 1981)

RESULTS: CONTROL TASK