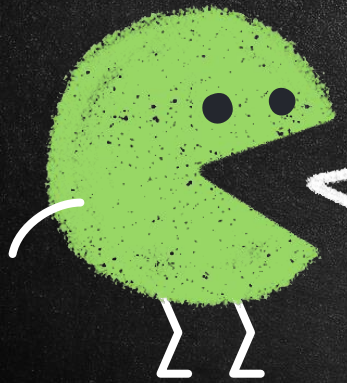
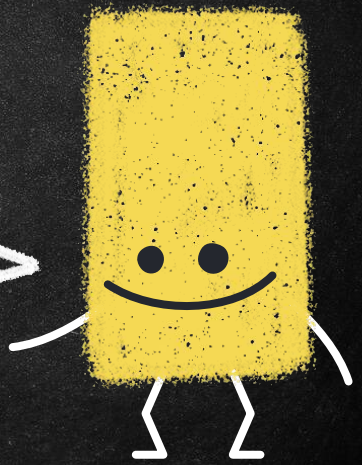
Survival of the Synesthesia Gene: Why Do People Hear Color and Taste Words?

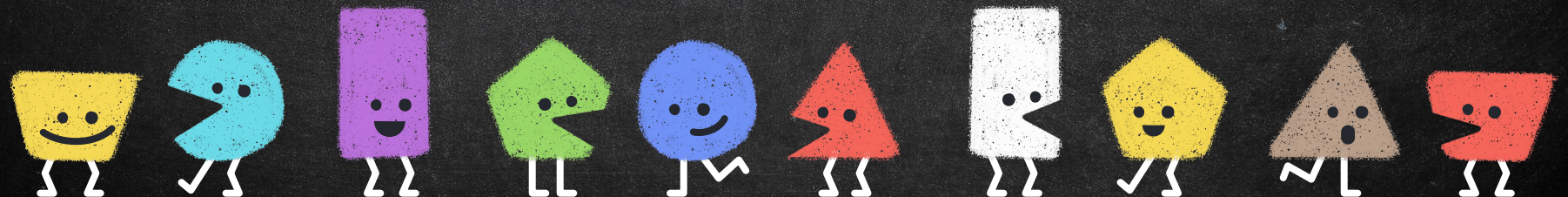
By David Brang and V. S. Ramachandran





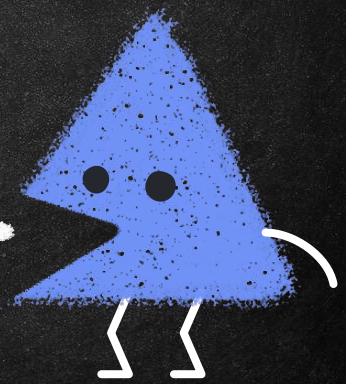
Hello!

Presented by: Danielle Huerta, Olivia Li, Calvin Cho



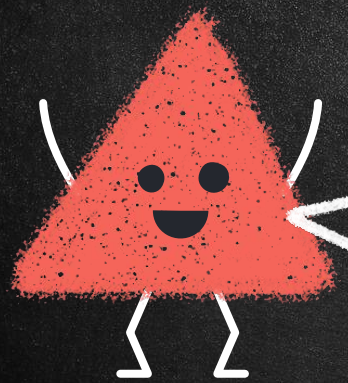
Background: What is synesthesia?

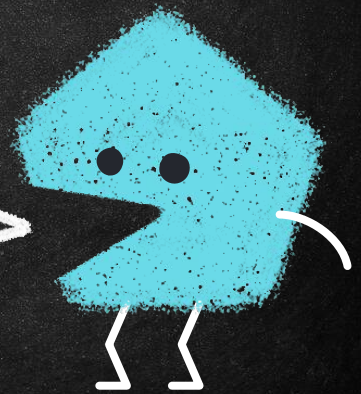
- Perceptual experience where stimuli is presented to one sense will evoke sensations in an unrelated sense
- Due to increased communication between sensory regions
- Involuntary, automatic and stabilizes over time
- Can bind any 2 senses
  - Most common: auditory tones and achromatic (colorless) numbers
- Effect ~2-4% of the population



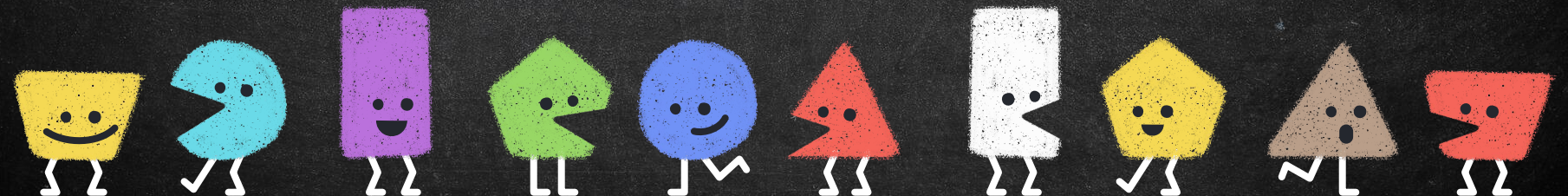
Problem/Motivation

What is the genetic basis of synesthesia and why is has been conserved?



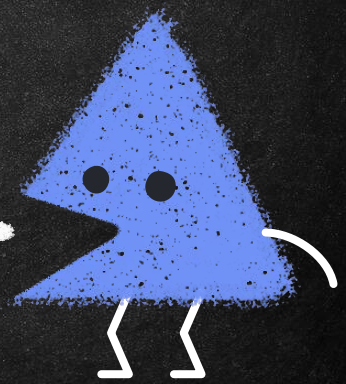


Genetic Basis



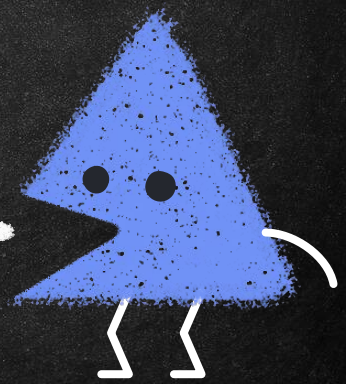
Neural Basis (Known)

- Psychophysical and functional imaging show grapheme-color synesthesia have simple achromatic graphemes activate both grapheme and color area V4 region of visual cortex
  - Believed to be high-level cognitive associations



Neural Basis: Cross-activation

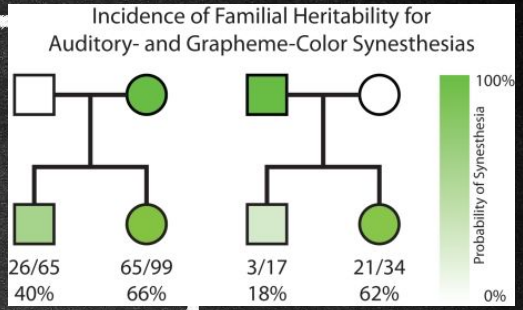
- Result from excess of neural connections between associated modalites from decreased neural pruning when fetus
  - Anatomical difference in inferior temporal lobe (multiple studies)
  - Brang: synesthetic colors have similar time-course in brang as colors evoke in retina
- Bottom-up and top-down effect results and researchers wonder how they occur



Heredity

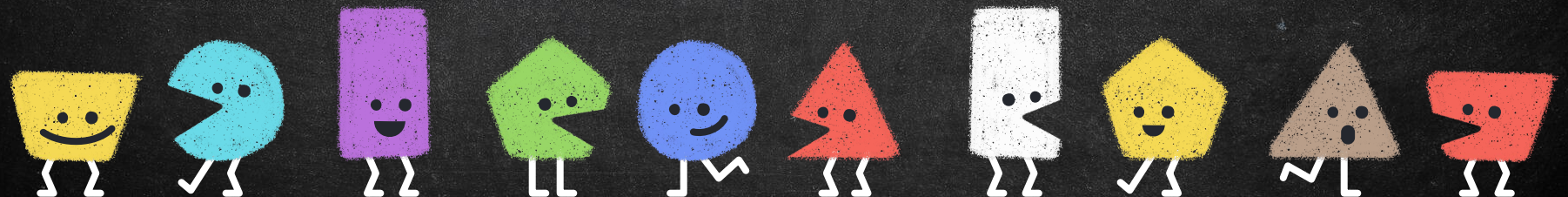
- Pedigree analysis suggest high transmissibility from parent to offspring
- Genetic undertone has predisposition but not expression
  - Form of synesthesia expressed can vary within family
- Defective pruning gene(s) confer general propensity to link unrelated sensations/concepts (Ramachandran and Hubbard)
  - Individual with a type of synesthesia morel likely to have another

Heredity (cont.)



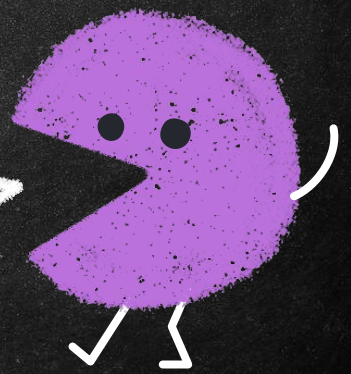
- Some variants co-occur with great frequency
  - Suggest some highly related and common origin
  - non-cluttering forms imply theories of single genetic makes and notion if independence among different forms
- Believed to be X-linked
  - 6:1 ratio of females and males
  - New studies: even distribution from random sampling
- Brang and Ramachandran believe might be an over expression of chromosome 13

Why the Gene was Conserved?



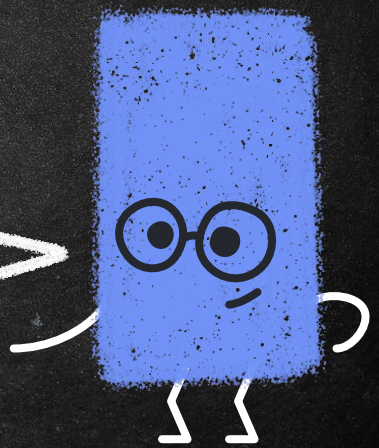
Epiphenomenal

- Could be effect of an gene with a different purpose
- Gene(s) retained as not worth energy to get rid of
- End of normal distribution of cross-modality interaction in general population
- Sensory deprivation and deafferentation lead to synesthetic-like experiences



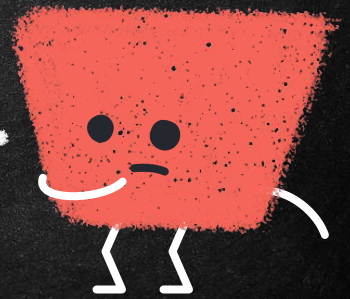
Creativity and Metaphor

- Many speculate that synesthesia may help with improving one's creativity.
  - Studies have shown that there is an increased incident of synesthesia for artists and creativity-requiring jobs.
  - Those with synesthesia spend more time engaged in creative recreation.
- The link remains prevalent and many believe this to be true but research has yet to prove this hypothesis.



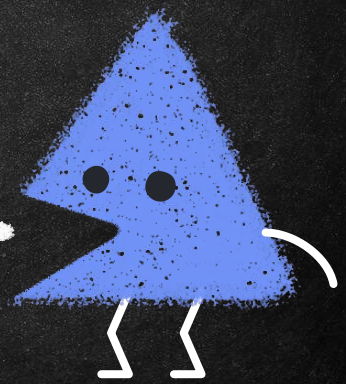
Sensory Processing and Cognitive Abilities

- Those with synesthesia demonstrate higher levels of memory.
  - One example showcase that Daniel Tammet utilized synesthetic association to memorize pi to 22,514 digits.
- Studies suggest that synesthesia boosts the processing of color information.
- Synesthesia may help as a tool for “detection, processing, and retention of critical stimuli in the world.”



Working towards a solution

- Synesthesia is associated a range of conceptual and perceptual benefits, the main being tha gene(s) involved may have been selected for because of a hidden agenda beyond cognitive and sensory benefits
- There is no strong asymmetry in the distribution of synaesthesia across the sexes.
- Synesthesia intrigues us and offers an experimental lever for examining high-level mental processes because it appears to occupy a puzzling space between fundamental sensations and higher level abstractions like gender and personality, and even emotions. For instance, sandpaper can evoke the sensation of jealousy.



Questions we may still ask ourselves?

Can synesthesia actually enhance sophisticated and abstract mental abilities?

Does synesthesia enhances sensory and intersensory processing?

Unidirectional or bidirectional, research suggests that synesthesia may be unconsciously bidirectional?

numbers evoke colors but do colors evoke numbers?

Particularly, what aspects of synesthesia are based on pharmacology and how does changing these neurotransmitters influence the involvement of synesthesia of a population as well as in synesthetes; does a synesthete who ingests LSD improve their current synesthesia?

What is the relationship between inherited synesthesias?

This problem can be partially addressed by testing whether family members of synesthetes who themselves are not synesthetic

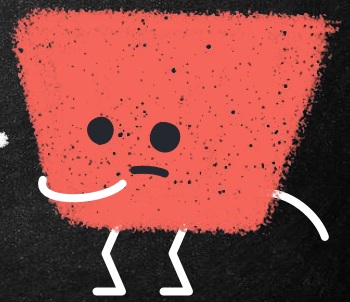
genes: sensory or cognitive enhancements?

Does synesthesia exist in animals?

The idea that synesthesia developed to promote metaphor and creativity in the population may be discarded if synesthesia is a phylogenetically old trait. Considering that synesthesia is characterized as the conscious perception of feeling, the requirements for effectively developing an animal model of the condition are debatable.

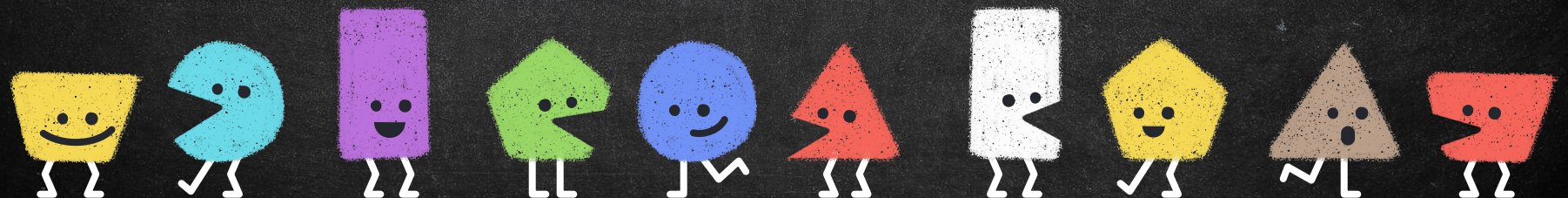
number-form, weekday-form?

Occupies a specific location in space; we have barely scratched the surface and that synesthesia might give us insights into basic sensory codes used by the brain to represent time and space.



In conclusion

- Studying synesthesia has reached a stage where knowledge of the mechanisms behind the phenomena and the reasons for its selection might help us better comprehend cognitive and perceptual functions in the general population.
- Research shows that synesthesia, is no longer conceptual but can now provide us with critical hints for understanding some of the physiological mechanisms underlying some of the most elusive yet cherished aspects of the human mind.
- It will need contributions from experts in all branches of biology to fully comprehend this condition and how it relates to cognitive function as a whole.



Thanks!

Any questions?