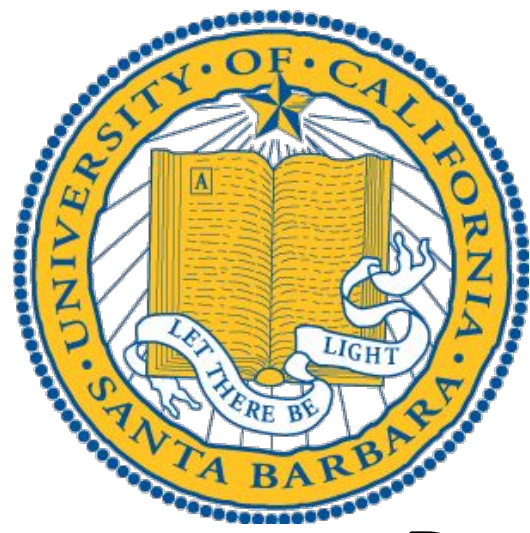# Visual and Auditory Stimuli Pairings During Recognition Memory

Grace Liu

Michael Miller, Ph.D., Evan Layher, Ph.D.

Department of Psychological & Brain Sciences, University of California, Santa Barbara

Introduction

- Dual-coding theory: information is encoded via two channels – verbal and nonverbal (Clark & Paivio, 1991). Pairing a visual image with an auditory cue can create a strong cognitive bridge in associative memory (Paivio, 1969).
- Previous research found that auditory-visual interactions occur early in perceptual processing in the primary visual cortex, which was previously thought to be only responsible for visual information (Thesen et al., 2004). Visual stimuli occurring with sounds enhanced the brain's response to sounds.
- Auditory recognition memory is weaker than visual recognition memory (Cohen et al., 2009).
- Signal detection theory (SDT): analyzes decision-making performance when interference is present (Swets et al., 1961), showing how one discriminates between signal vs. noise assuming neither is perfectly independent.
- Measuring recognition accuracy across visual/auditory stimuli pairings can reveal how multisensory experiences may affect recognition memory, aiding research in recognition memory strategies, education, and memory-related disorders.
- The study aims to discern if familiar/unfamiliar visual stimuli paired with familiar/unfamiliar auditory stimuli can improve recognition, creating a memory recognition hierarchy based on stimulus familiarity.

Hypotheses

H1: Pairing visual face images with sounds will lead to more robust memory encoding than exposure to only one sense stimuli.

H2: Pairing familiar faces with sounds will lead to higher recognition accuracy for the sounds than pairing unfamiliar faces with sounds.

H3: Recognition accuracy for faces will be higher than audios across all three conditions.

Methods

Participants: 72 participants (53 = female, 17 = male, 2 = non-binary) between the ages of 18 and 30 ($M = 20.44$, $SD = 1.943$), recruited from UCSB SONA.

- ■ 5 participants were excluded due to below chance performance.
- Participants were exposed to six study/test phase cycles with visual and auditory stimuli pairing conditions and asked to recognize a set of stimuli.
- **Conditions:** [1] visual stimuli only [2] visual stimuli with unfamiliar audio [3] visual stimuli with familiar audio [4] auditory stimuli only [5] auditory stimuli with unfamiliar images [6] auditory stimuli with familiar images.
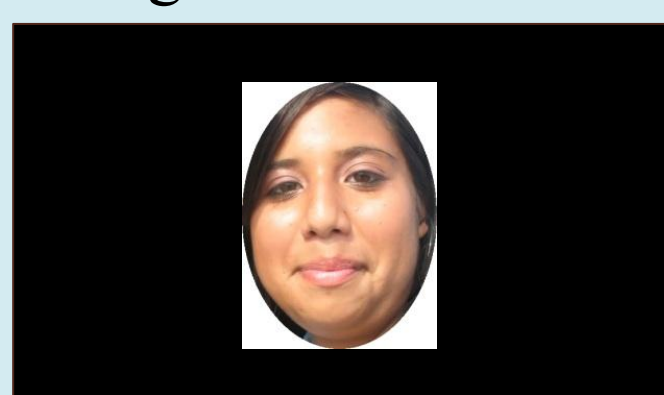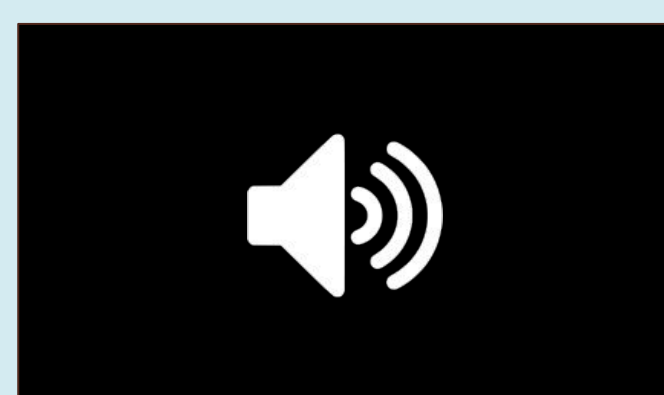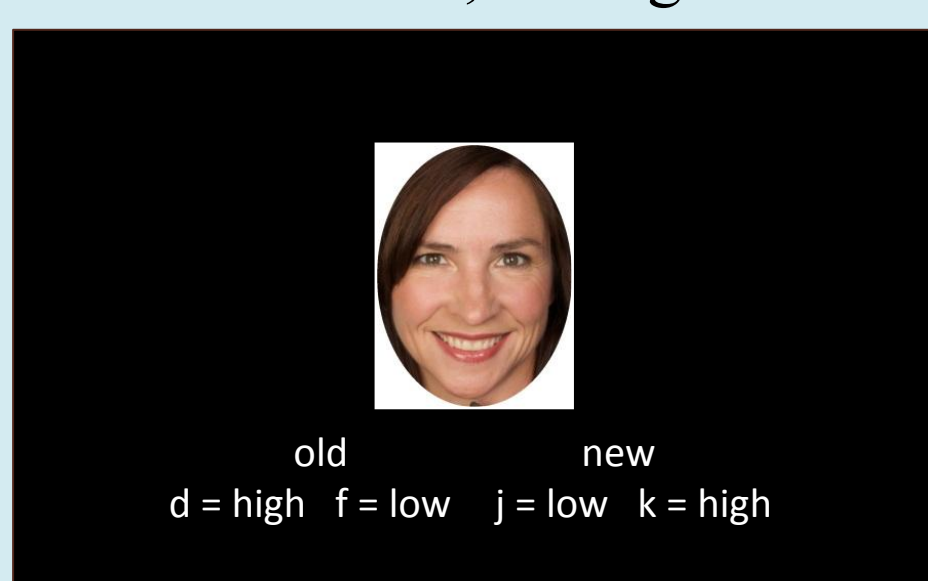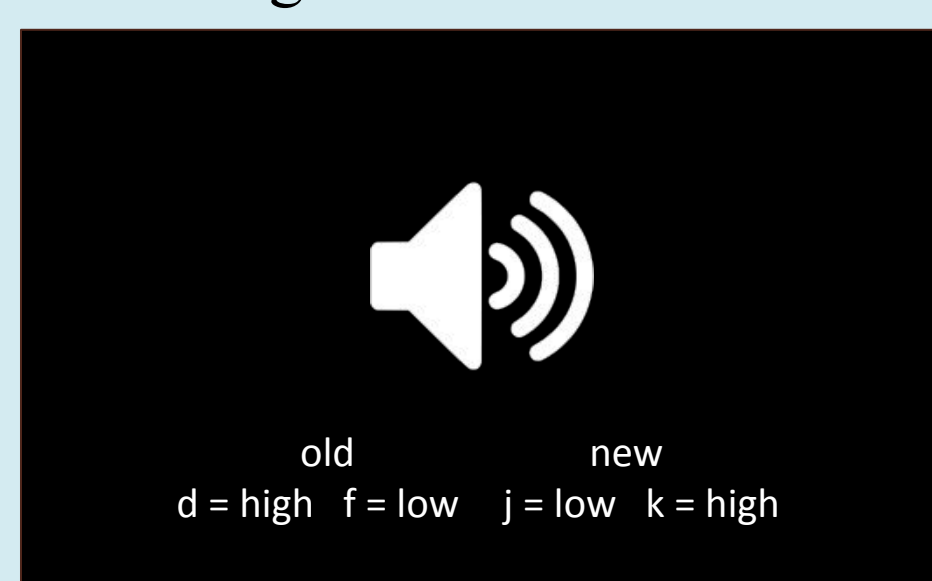
Condition [1]   *Paired conditions*   *Condition [4]*

- Test phases presented participants with a studied image/audio or a foil image/audio, and are then asked to determine whether the image/audio is "old" or "new," along with confidence ratings.

Test phase: Image   *Test phase: Audio*

- A SDT curve measures how well signal vs. noise (familiar vs. unfamiliar stimuli) is discriminated (d'). A greater d' means a person can more accurately differentiate between the two (Banks, 1970).

Results

- Of the six conditions, there was only a significant effect on recognition memory in condition [1] (p = 0.0238).
- Condition [1] had the greatest d' (1.829).
  - The visual stimuli condition had a greater average d' (1.678) than the auditory stimuli condition d' (0.743) (Figure 1).

Condition	Test	Pair	d'
[1]	Image	No audio	1.829
[2]	Image	Unfamiliar audio	1.615
[3]	Image	Familiar audio	1.589
[4]	Audio	No image	0.767
[5]	Audio	Unfamiliar image	0.680
[6]	Audio	Familiar image	0.781

Figure 1. Mean d' values of each condition

- The ROC curve illustrates participants' recognition accuracy performance across all six conditions at different confidence ratings.
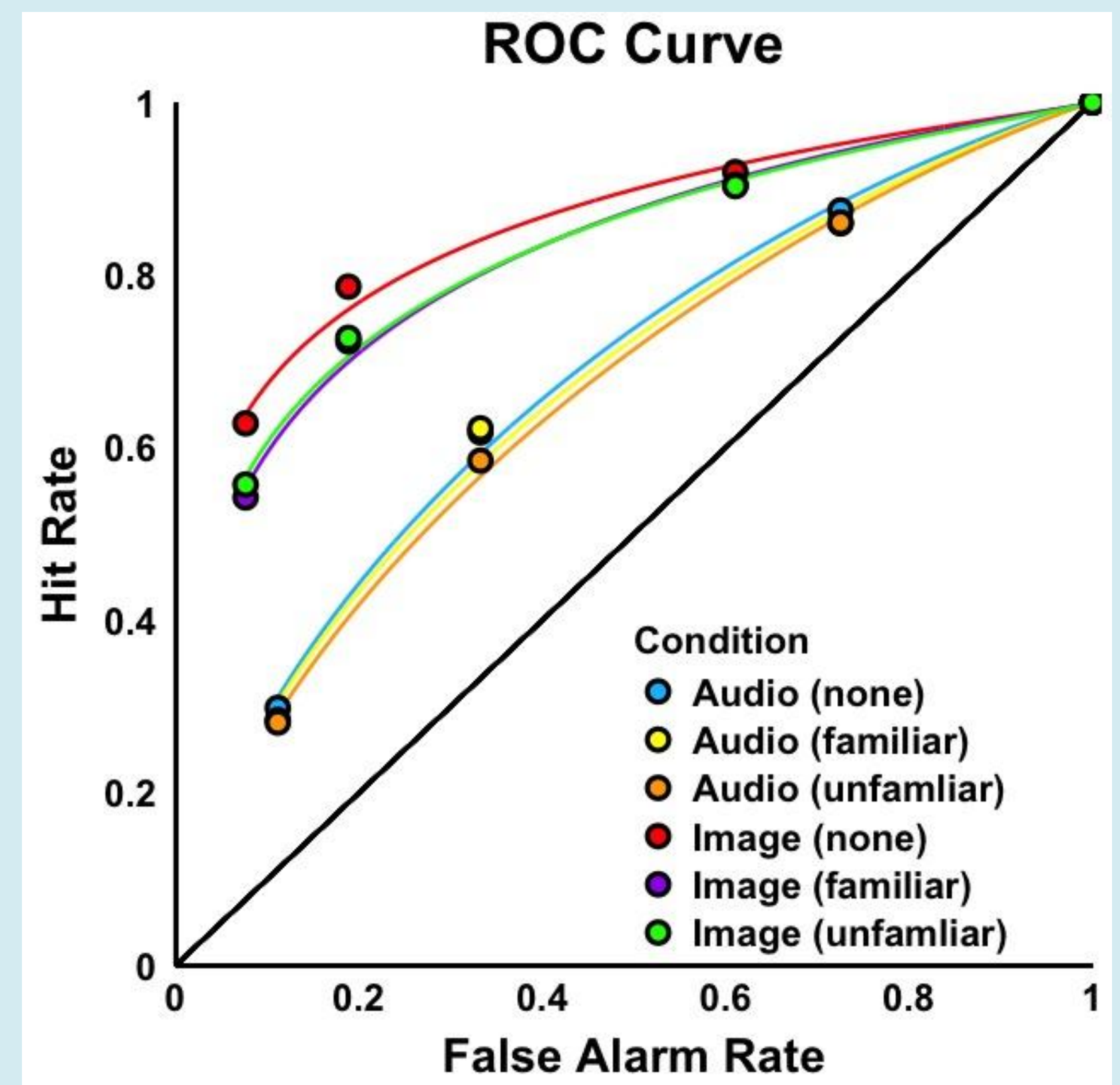

Figure 2.

Discussion

- **H1**: Pairing visual face images with sounds did not improve memory performance, but instead decreased visual stimuli performance.
- **H2**: Pairing familiar faces with sounds had no significant effect on recognition accuracy for the sounds compared to pairing unfamiliar faces with sounds.
  - Conditions that had a pairing, instead of just one stimuli, had lower recognition accuracy than conditions with no pairing.
- **H3**: Recognition memory for images is stronger than recognition memory for audios, supporting previous findings.

References

1. Banks, W. P. (1970). Signal detection theory and human memory. Psychological bulletin, 74(2), 81.
2. Clark, J. M., & Paivio, A. (1991). Dual coding theory and education. Educational psychology review, 3, 149-210.
3. Cohen, M. A., Horowitz, T. S., & Wolfe, J. M. (2009). Auditory recognition memory is inferior to visual recognition memory. Proceedings of the National Academy of Sciences, 106(14), 6008-6010.
4. Paivio, A. (1969). Mental imagery in associative learning and memory. *Psychological review, 76*(3), 241.
5. Swets, J. A., Tanner Jr, W. P., & Birdsall, T. G. (1961). Decision processes in perception. Psychological review, 68(5), 301.
6. Thesen, T., Vibell, J. F., Calvert, G. A., & Österbauer, R. A. (2004). Neuroimaging of multisensory processing in vision, audition, touch, and olfaction. Cognitive Processing, 5, 84-93.

Acknowledgements