Search efficiency scales with audiovisual semantic relatedness

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Can semantics guide audiovisual search?

Semantic information is curcial to understanding real world environments[1]

Sounds speed search for "perfect match" images (e.g., meow, cat)[2,3]

Is the attentional benefit from sounds to semantically related images specific to "perfect match" relationships?

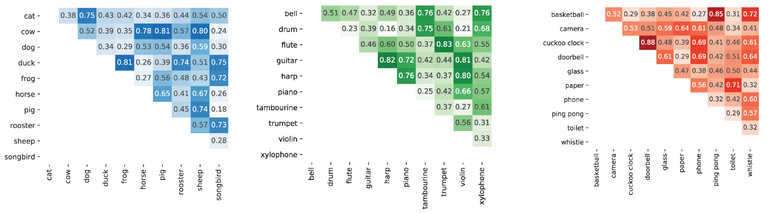
Is it generalizable to other semantic relationships?

Is it automatic or task-dependent?

Quantifying semantic relatedness

Sight-Sound Semantics Database[4]: (Available on OSF!)

- Crossmodal
- Continuous
- Uses human judgements



Animals

Instruments

Household items

Measuring semantic influence on attention

Top down: Where is the image for the target word?

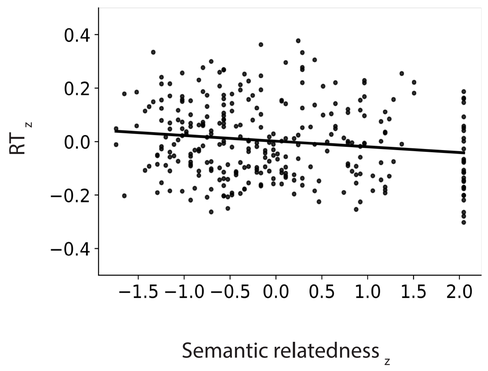
- 109 participants
- 90 sound/image pairs (all possible pairs from database)

Bottom up: Where is the unique colored circle?

- 23 participants (preliminary data)
- 42 sound/image pairs (2 pairs per 3 categories per 7 relatedness bins)
- Circle location is randomized orthogonally images and sounds

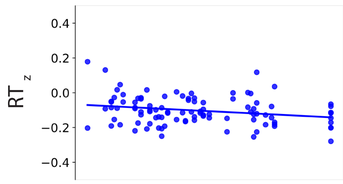
As semantic relatedness increases, search speeds decrease

All categories r= -0.27, p=0.009

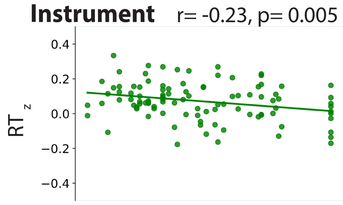


- Each point is a sound/image pair
- RT is z scored for each participant
- Relatedness is z scored across all categories

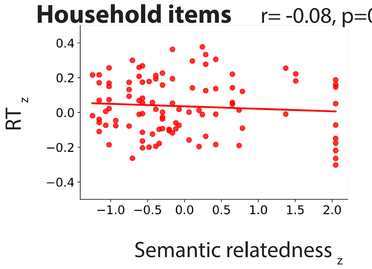
Animal r= -0.27, p = 0.01



Instrument r= -0.23, p= 0.005

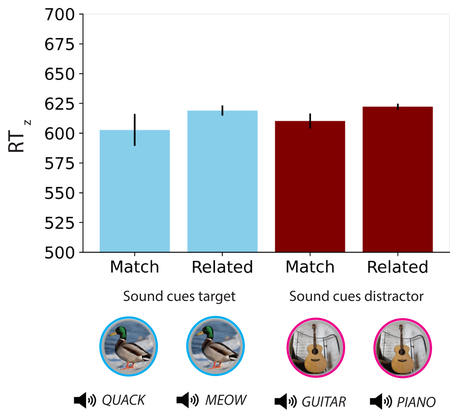


Household items r= -0.08, p=0.4



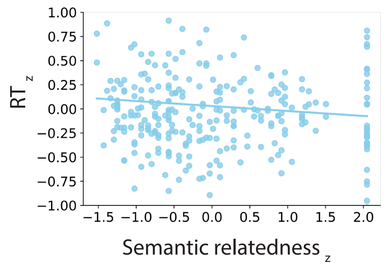
Audiovisual semantics may influence low level search

Perfect matches vs semantically related

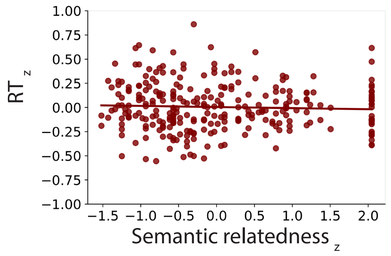


- To keep the sound and image orthogonal from the pop out task, categories have different numbers of trials

Sound cues target r= -0.09; p= 0.12



Sound cues distractor r= -0.04; p= 0.44



Conclusions

Sounds speed search for semantically related images in scale to the strength of the relationship between sound & image

The audiovisual semantic benefit is:

- not specific to "perfect matches" that were both caused by the same source (e.g., cat & meow)
- sensitive to categorical factors such as the prototypicality within the category
- potentially modulate low level "bottom up" attentional processes

These findings suggest:

- Semantics modulate attentional prioritization in a generalizable manner
- Semantics may modulate attentional prioritization rapidly and automatically

Future questions

What neural mechanisms underpin attentional prioritization for semantically related sounds & images?

Are attentional prioritization maps multisensory in nature?

Can visual information modulate attentional priority for auditory signals?

References (1) Malcolm, et al 2016 (2) Iordanescu, et al 2008 (3) Kvasova, et al 2019 (4) Wegner-Clemens, et al, 2022

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