Learning to generalize stimulus-specific learning across contexts

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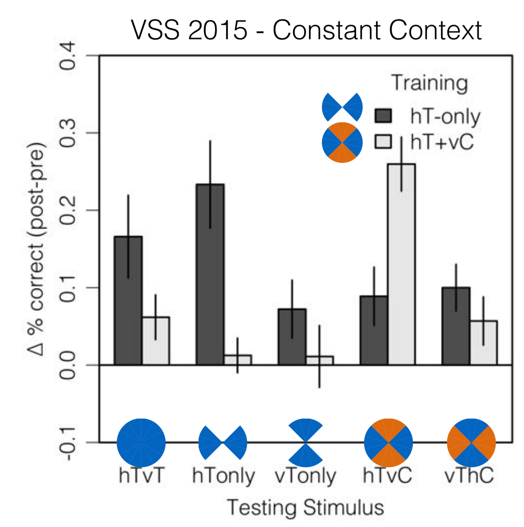
Introduction

Perceptual Learning (PL) in a texture identification task reflects observers becoming more sensitive to diagnostic stimulus components, and the learned components vary across observers[1].

Discrimination of a particular orientation component is difficult when orthogonal, uninformative orientation components (i.e., context) are visible[2].

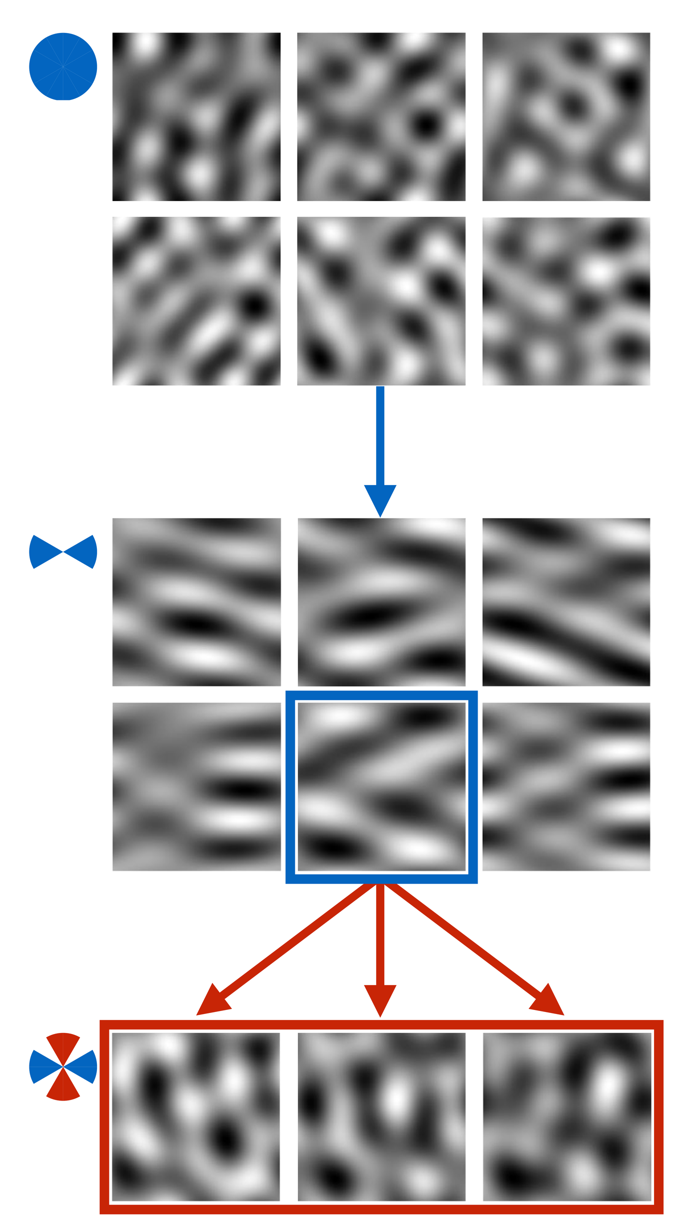
Learning to discriminate particular orientation components in a texture identification task is highly specific to the context presented during training[3].

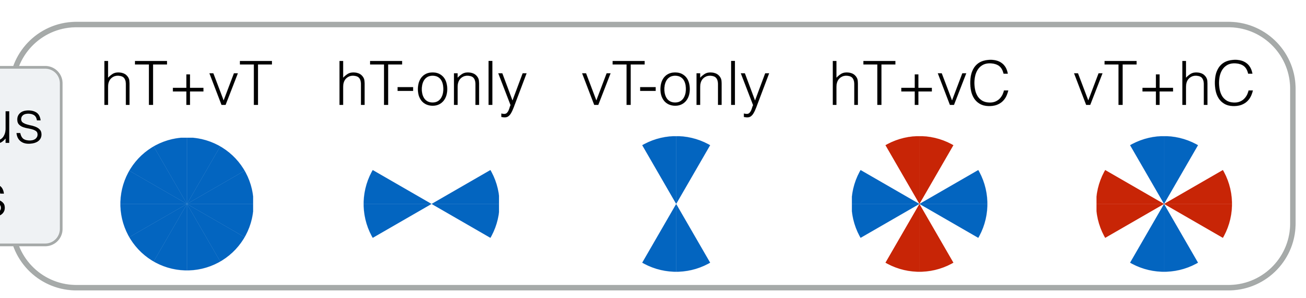
Can we reduce the influence of context on learning to discriminate particular orientation components in a texture identification task?



Methods

- 4.6 x 4.6 deg band-limited noise textures (2-4 cycles/image).
- 150 ms stimulus duration; 6-AFC response screen (matched to sample of the target component only).
- 60 deg orientation filter isolated orientation components.
- Target-only contained 60 deg of horizontal or vertical components.
- Target+Context contained 60 deg of target components, and the perpendicular 60 deg contained uninformative context components.
  - ↳New context was generated on each trial.
  - ↳Remaining 60 deg left empty to aid in separating orientations.
- E1 & E2: target and context contrast (c_{RMS}) equated and fixed.
- E3: target c_{RMS} fixed, context c_{RMS} varied with 1up/1down staircase.





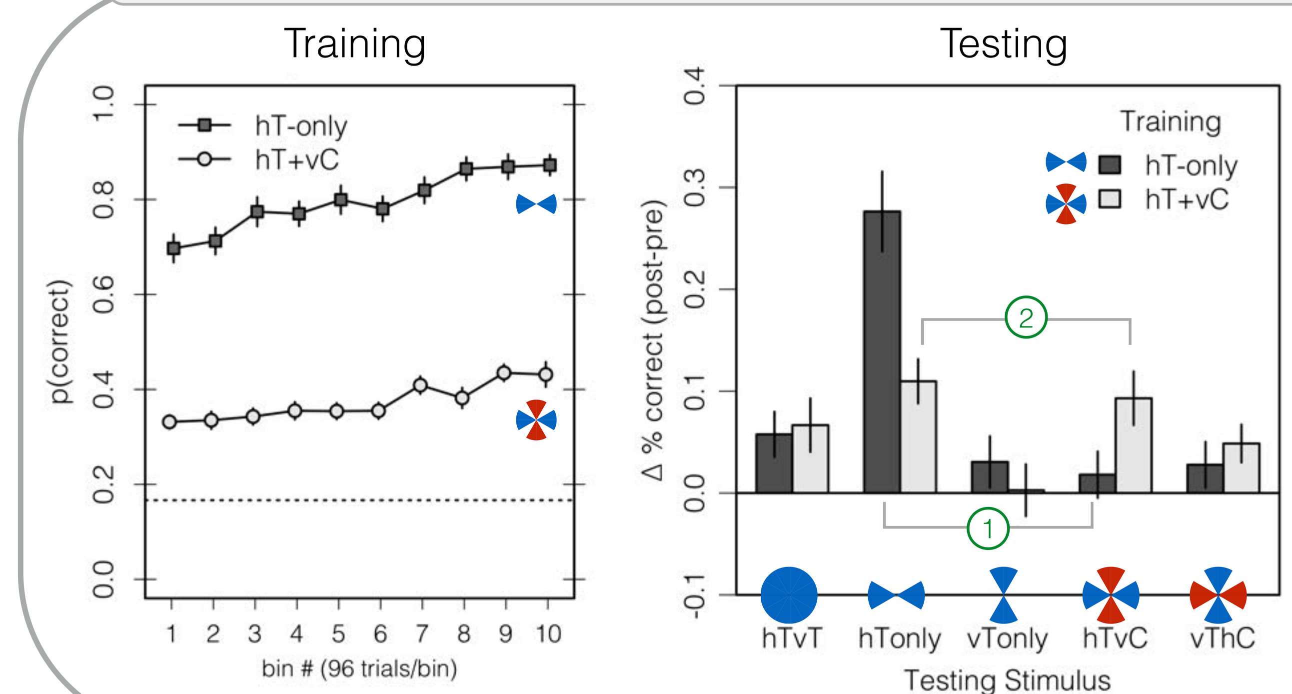
Design - Experiments 1 & 2:

- **Training**: 2 sessions with 480 trials/session.
- **Testing**: 2 blocks with 240 trials/block ( ) & ( ).
- In E1, we manipulated training between-subjects (n=12 & n=12 training).
- In E2, everyone was trained on , but in testing target novelty varied between-subjects (n=9 same T & n=9 novel T).

Design - Experiment 3 (n=12):

- **Training**: 2 sessions with 2 blocks/session; 3 interleaved staircases/block; 160 trials/staircase.
- **Testing:** 2 blocks with 240 trials/block (same T / novel T /) & (same T / novel T /).
- In E3, everyone was trained on ; hT c_{RMS} was fixed, and vC c_{RMS} varied (0.0035-0.35). Target novelty was manipulated within-subjects.

E1: Training with a variable context makes learning context-generalizable.



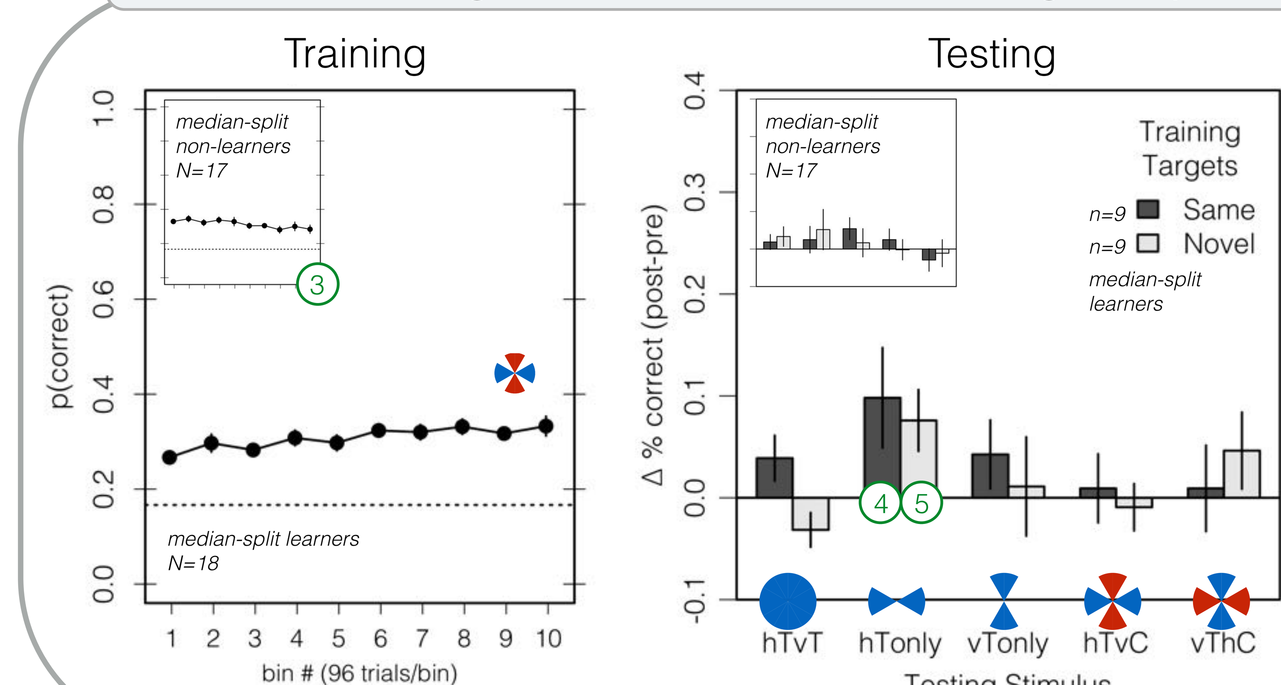
hT-only training led to highly context-specific learning. (1)

Context x Orientation, $F_{(1,11)}=46.4$, $p<0.001$
hT-only > vT-only, $t_{(11)}=6.25$, $p<0.001$
hTvC > vThC, $t_{(11)}=-0.415$, $p=0.657$

hTvC training led to small, but context-generalizable learning. (2)

Orientation, $F_{(1,11)}=5.90$, $p=0.033$
Context x Orientation, $F_{(1,11)}=1.79$, $p=0.208$

E2: Context-generalizable learning *may* also transfer to novel targets.

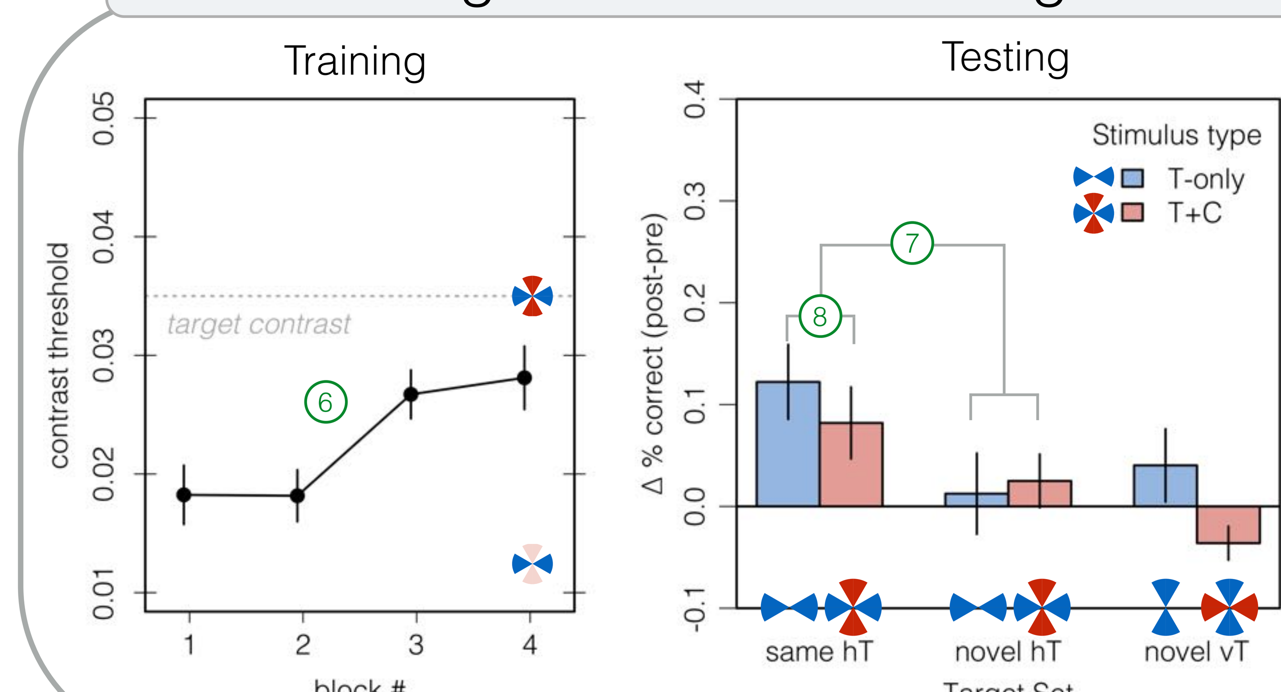


hTvC training was difficult and led to improvements in only ~half of the participants, so data was median-split. (3)

In those who learned, there was a hint of context- and target-generalization. (4) (5)

Context x Orientation, $F_{(1,16)}=5.09$, $p=0.038$
Context x Orientation x Training, $F_{(1,16)}=0.69$, $p=0.418$
hT-only > vT-only, $t_{(17)}=1.96$, $p=0.034$
hTvC > vThC, $t_{(17)}=-0.99$, $p=0.833$

E3: Context-generalizable learning does not transfer to novel targets.



Increasing context contrast with a staircase aided in increased tolerance of the context when identifying targets. (6)

Training led to target-specific, but context-generalizable learning. (7) (8)

Target set, $F_{(2,22)}=7.07$, $p=0.0043$
Target set x Context, $F_{(2,22)}=1.10$, $p=0.351$
Same hT > Novel hT, $t_{(23)}=2.51$, $p=0.013$
Same hT > Novel vT, $t_{(23)}=3.55$, $p<0.001$

Conclusions

Learning to identify particular orientation components in an uninformative, variable context is very difficult, but generalizes to novel contexts and not novel targets.

PL is slow but target-generalizable when the targets are variable[4]. How do context-variability and target-variability affect PL differently?

References

1. Gold et al., (2004), *Cog Sci*
2. Olzak & Thomas, (1991), *Vis Res*
3. Hashemi et al. *(VSS 2015)*
4. Hussain et al. (2012), *Vis Res*

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