

COLOR AND LUMINANCE DISCRIMINATION BY NON-LINEAR PCA

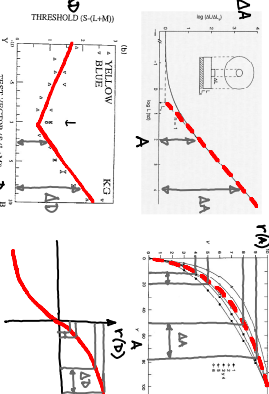
1 INTRODUCTION

PSYCHOPHYSICAL FACTS

⊗ Achromatic and chromatic mechanisms (ATD) are **NON-LINEAR**

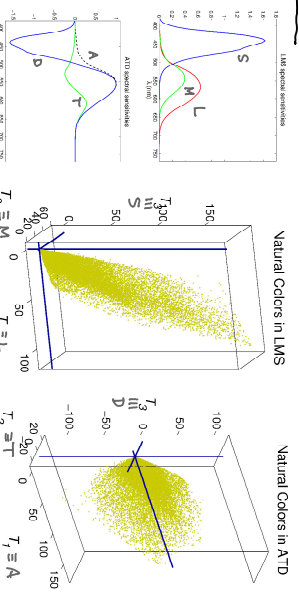
- Achromatic (A)
Weber law
(eg. Wyszecki & Stiles 82)

- Chromatic (r x s)
(Kruskopf & Gegenfurther 92)
(Powers et al. 93)



STATISTICAL FACTS & EFFICIENT ENCODING (eg. Small & Kuberski 01)

⊗ Linear LMS to ATD transform is similar to linear PCA



⊗ HOWEVER: ATD non-linearities still have to be statistically derived!

② **GOAL:** Derivation of ATD non-linearities (and/or incremental thresholds) from natural color statistics using local-to-global non-linear PCA

③ **PROPOSED TECHNIQUE:**

LOCAL-TO-GLOBAL NON-LINEAR PCA

STIMULUS

$$X \xrightarrow{F^{-1}} r$$

RESPONSES

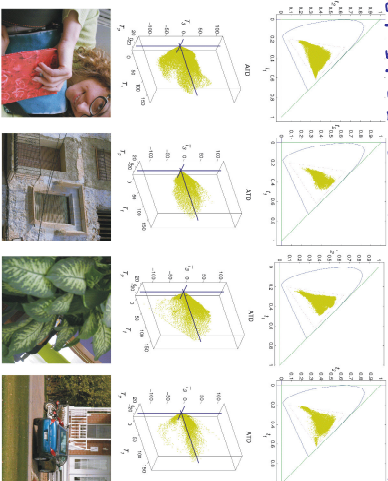
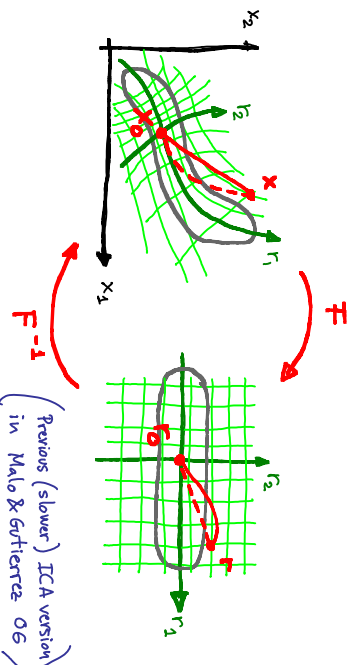
$$r \xrightarrow{F} X$$

$$F(x) = r = r_0 + \int_{x_0}^x B_k(x) dx$$

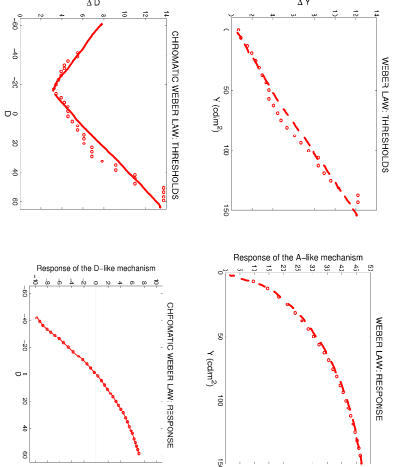
(where $B_k(x) \equiv$ local PCA in x^k)

4 RESULTS & DISCUSSION

DATA SET I: COLORS OF NATURAL OBJECTS UNDER DAY LIGHT

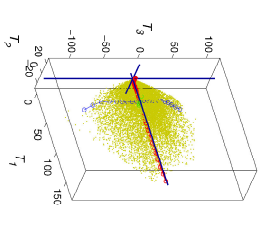


RESULTS I



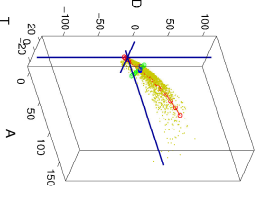
RESULTS I

NL-PCA for day light illumination in ATD

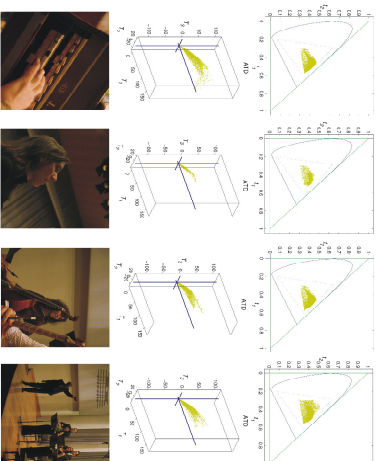


RESULTS II

NL-PCA for concert hall in ATD



DATA SET II: COLORS IN THE CONCERT HALL



5 CONCLUSIONS

- * Classical luminance and color discrimination results may be approx. reproduced using non-linear PCA with a big enough data-base
- * Specific environments/adaptation conditions may induce more markedly non-linear behavior

6 REFERENCES

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[3] Romero, J., Valero, J., & Malo, J. "Image denoising, LUTs, HSL, E, HSV, A, volume 10, Issue 5, pp.827-837, May 1991

[4] E. P. Simoncelli and B. Olshausen, "Natural image statistics and neural representation," *Annual Review of Neuroscience*, 28: 1199-1216, 2005.

[5] J. Malo and J. Gopferich, "A non-linearities emerge from local-to-global non-linear PCA," *Neural Comp.*, 20(11): 3123-3135, 2008.

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