

# **Symbol discriminability models for improved flight displays**

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# Acknowledgements

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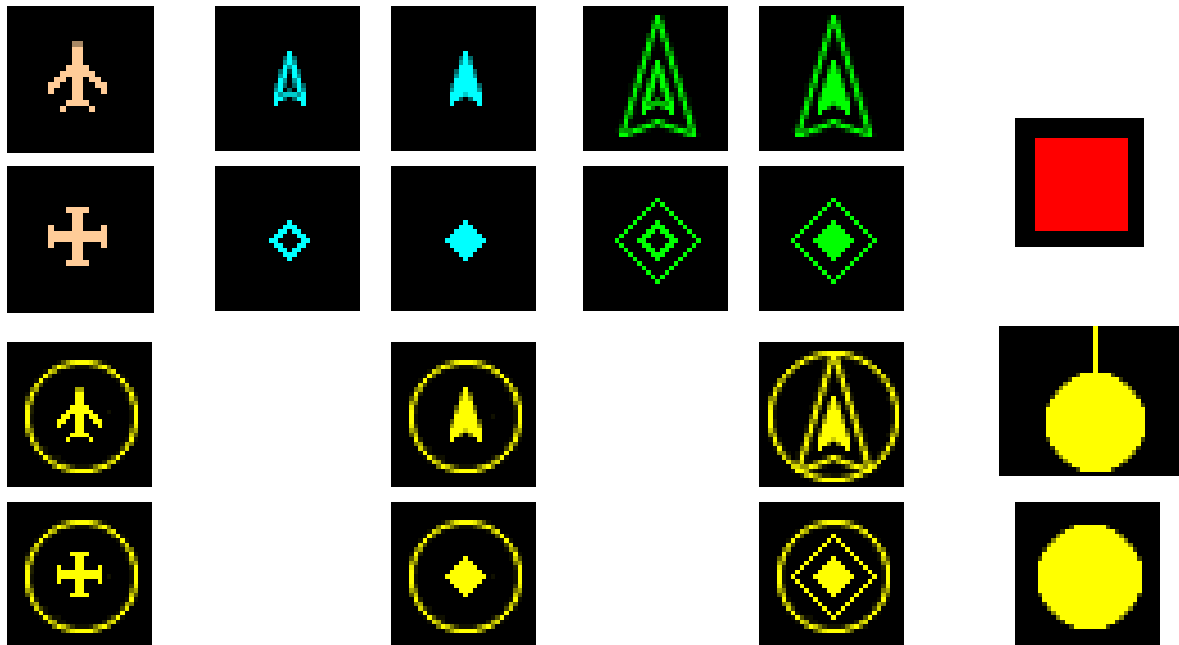
# An airplane cockpit



# Flight Situation Display



# Proposed symbols



# Project goal

Computational model to predict  
discriminability of symbols

# Project Plan

- Analyze human discriminability data already collected on these symbols
- Construct model to predict data
- Collect more data to test model

# DOT Volpe Center Experiment




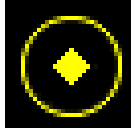



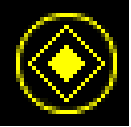

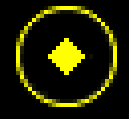


- 10 pilot observers
- Avidyne flight situation display
- 19 symbols
- 4 viewing distances: 22, 44, 66, 88 in
- 6 replications per distance



# Observer Errors

<b>Distance\</b>	<b>Observer</b>									
<b>(in)</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>
<b>22</b>	4	1	6	11	7	1	3	0	0	3
<b>44</b>	4	3	3	21	10	2	8	0	0	2
<b>66</b>	19	11	28	31	58	45	4	25	6	27
<b>88</b>	42	33	31	56	86	70	46	47	33	51
<b>Col 88</b>	8	1	0	6	36	8	7	4	2	6

# yellow symbol confusions

						
	38	0	1	0	2	11
	10	29	1	6	11	3
	1	1	14	5	33	4
	0	2	2	28	13	12
	4	2	2	12	34	13
	4	0	0	1	4	39

# Observer symbol discriminability

Discriminability measure for 2 symbols and 2 responses

$$d' = z(\Pr(r1|s1) - z(\Pr(r2|s1)))$$

Information transmitted for 2 symbols and 19 responses

$$H(s:r) = H(s) + H(r) - H(s,r)$$

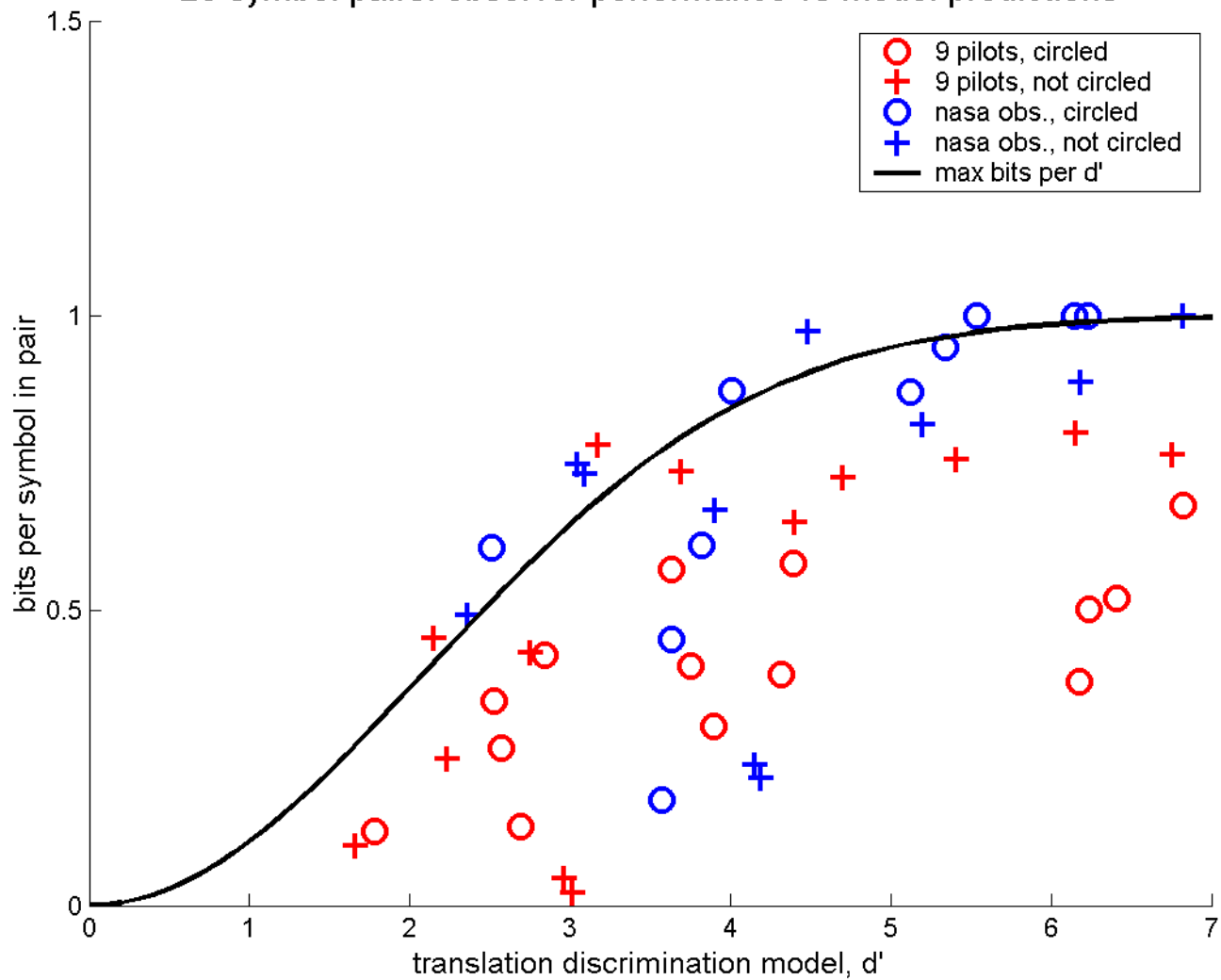
$$H(s) = - ( p1 \log_2(p1) + p2 \log_2(p2)),$$

where  $p1 = \Pr(s1)$ ,  $p2 = \Pr(s2)$

# Model parameters

- 'optical' blur filter cutoff : 16 cpd
- luminance spread filter cutoff: 2 cpd
- proportion of image vs. background determining local luminance: 0.7
- masking spread filter cutoff: 2 cpd
- masking contrast threshold : 5%
- contrast sensitivity: pilots 500, nasa obs. 707
- pixel replication factor: 4

28 symbol pairs: observer performance vs model predictions



# Work in progress

- Size invariance
- Rotational invariance
- Contrast invariance
- Color differences

# Summary

- Despite a lack of feature extraction, categorization, and memory process simulation,
- Image discrimination models with transformational invariances show promise as a computational tool for predicting symbol discrimination.