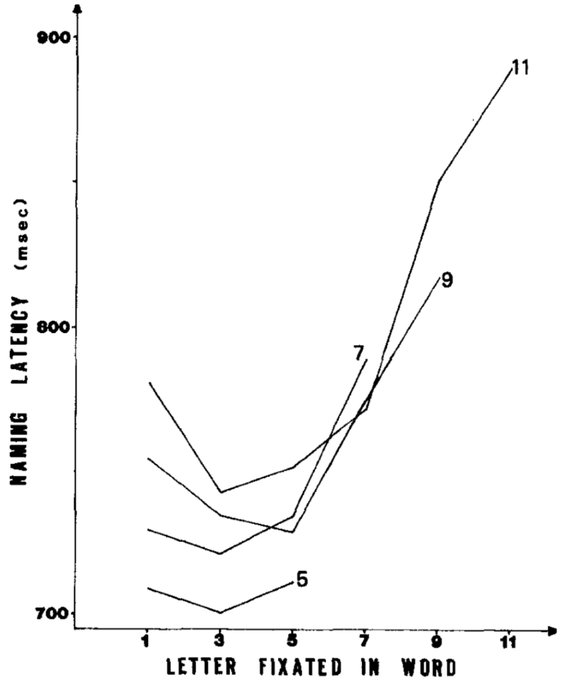
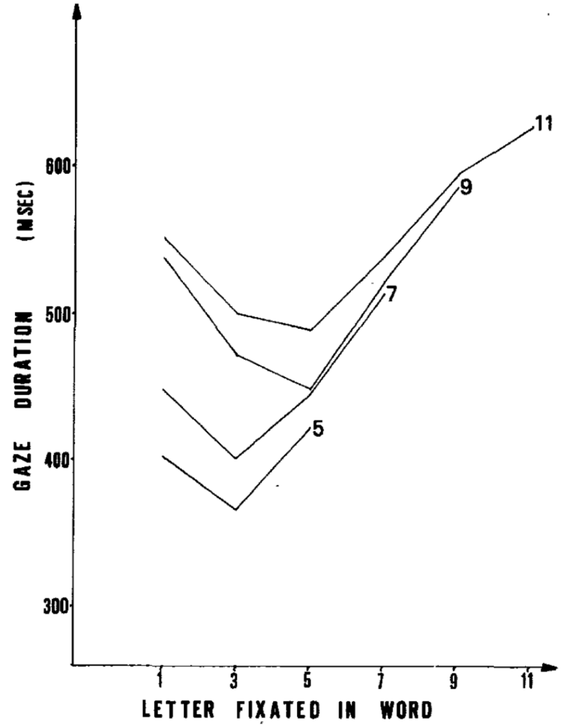
Efficient eye movements in visual word recognition: Sensitivity to the structure of the lexicon

Jon W. Carr, Monica Fantini and Davide Crepaldi
International School for Advanced Studies, Trieste, Italy

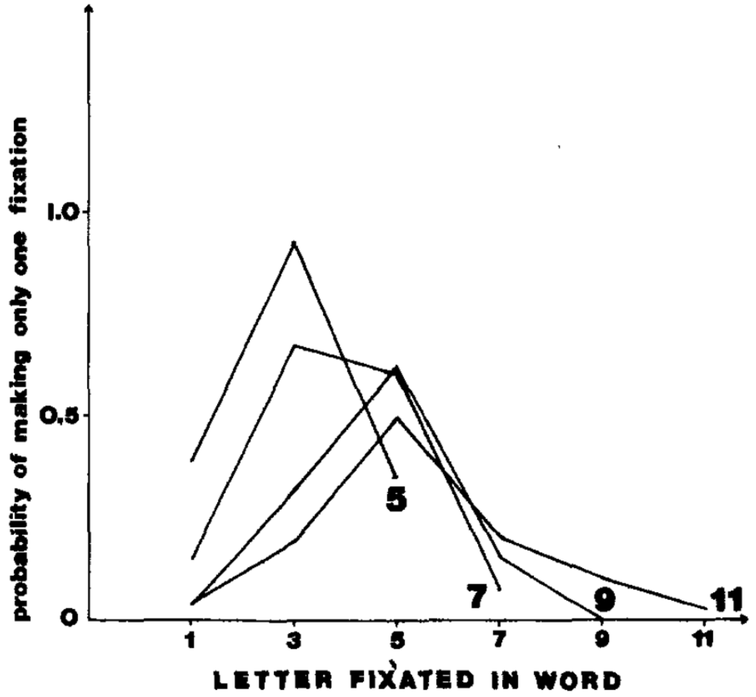
Naming latency



Gaze duration

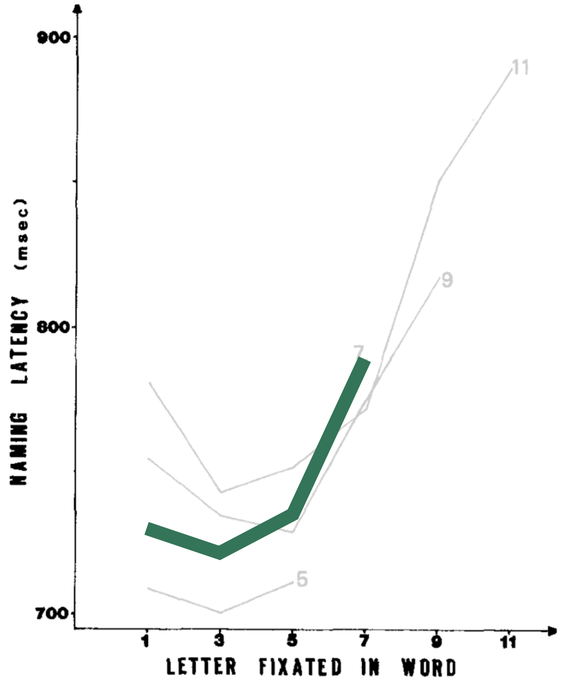


Probability of one fixation

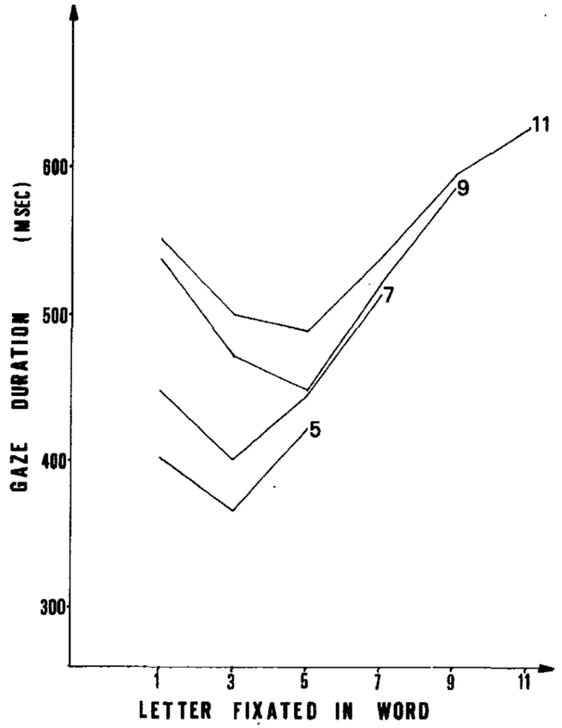


O'Regan et al. (1984)

Naming latency



Gaze duration



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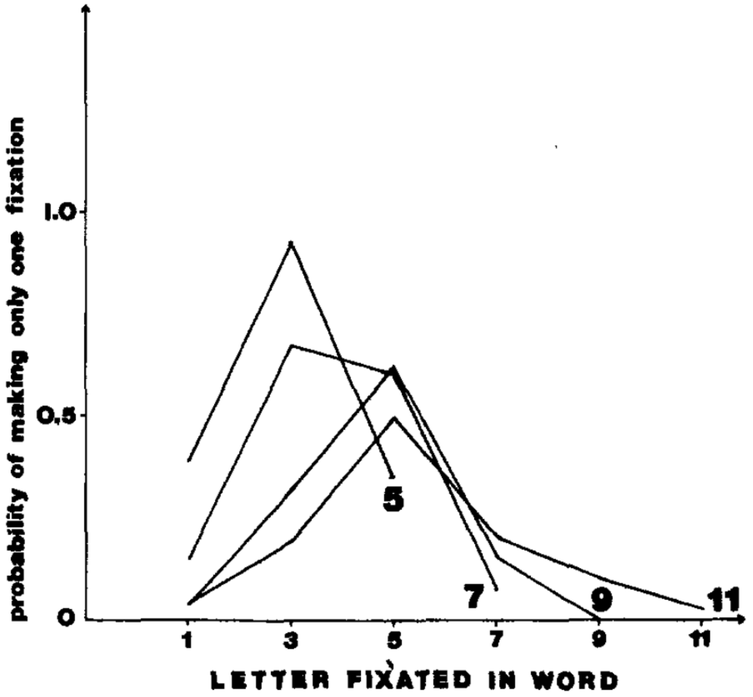
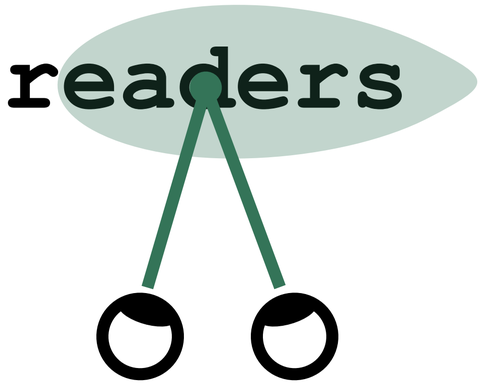


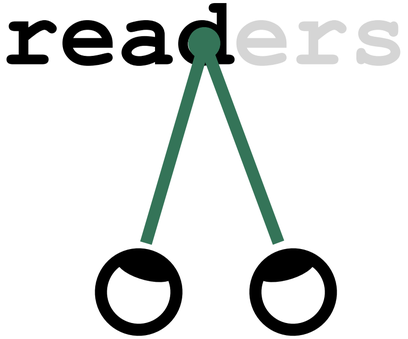
O'Regan et al. (1984)

Perceptual bias



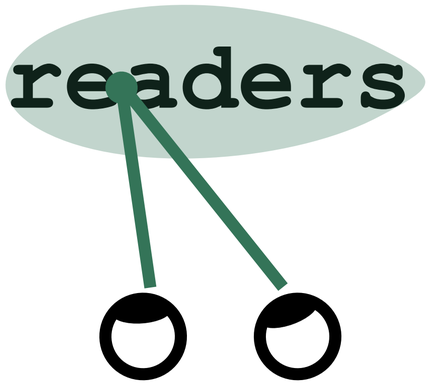
Visual span is asymmetric (right-visual-field advantage), so fixating left-of-center maximizes how much of the word is in view

Informational bias



Words are typically more informative at the beginning, so fixating left-of-center places greater constraint on the possible words

Perceptual bias



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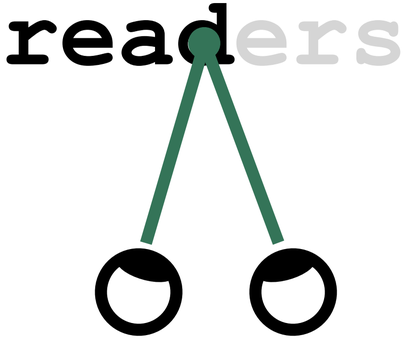

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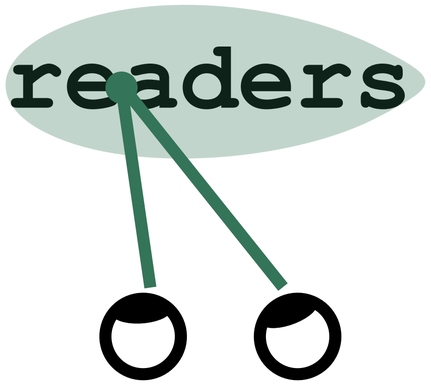

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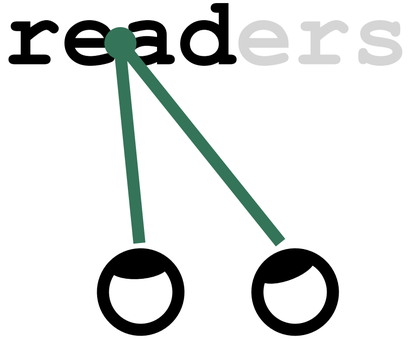

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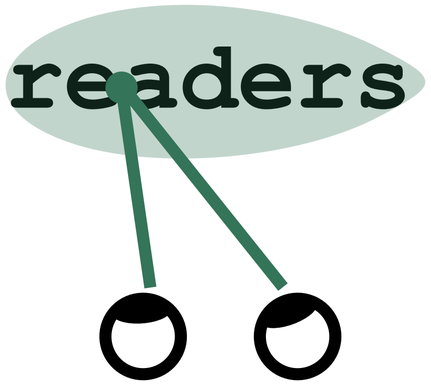
Perceptual bias

The human factor



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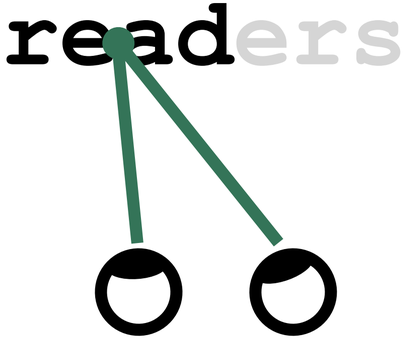
Informational bias



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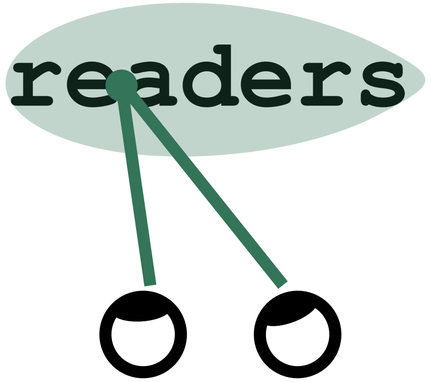
Perceptual bias

The human factor



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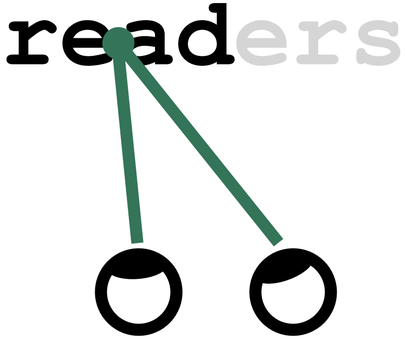
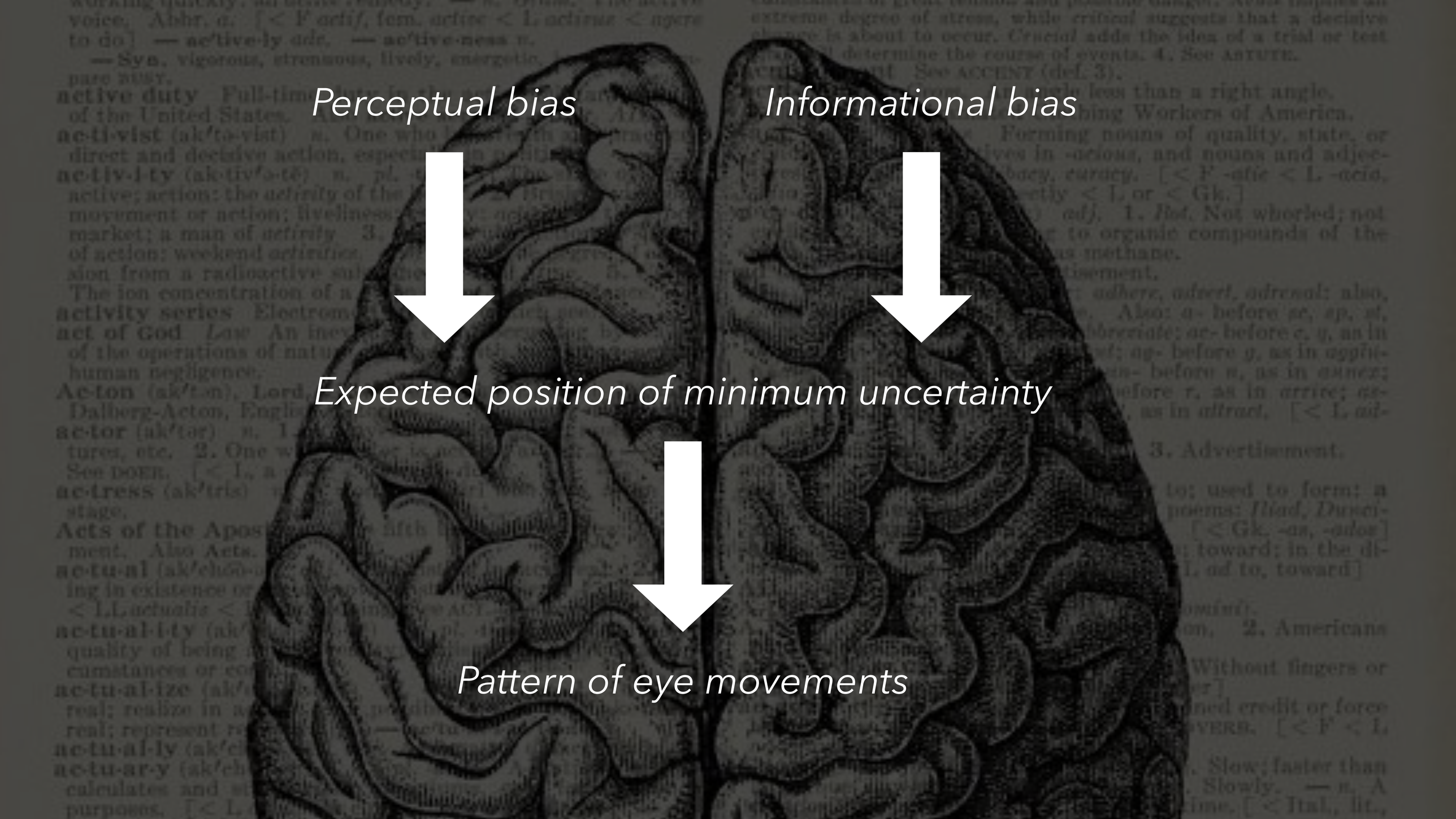
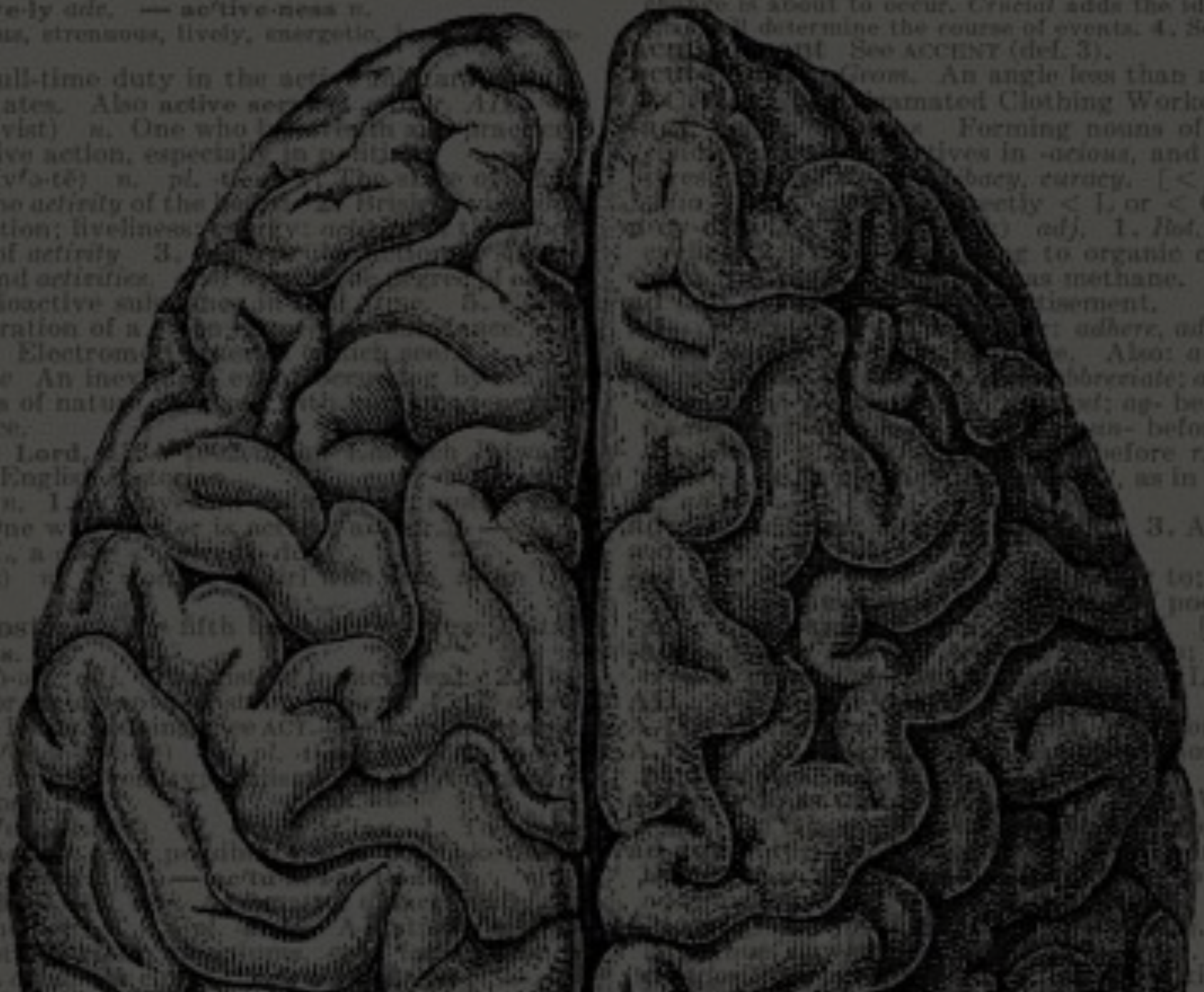
Informational bias

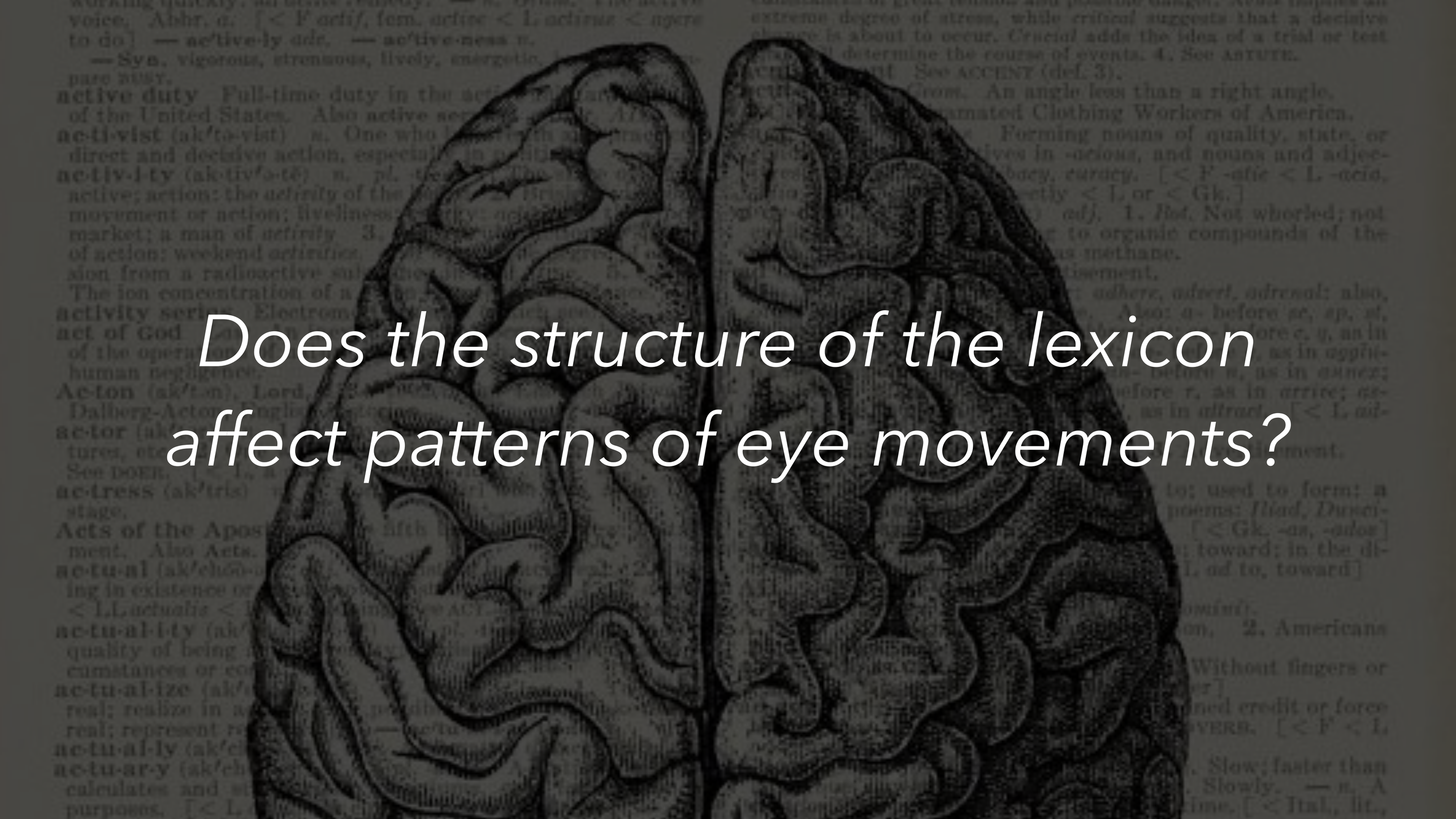
The language factor



Words are typically more informative at the beginning, so fixating left-of-center places greater constraint on the possible words

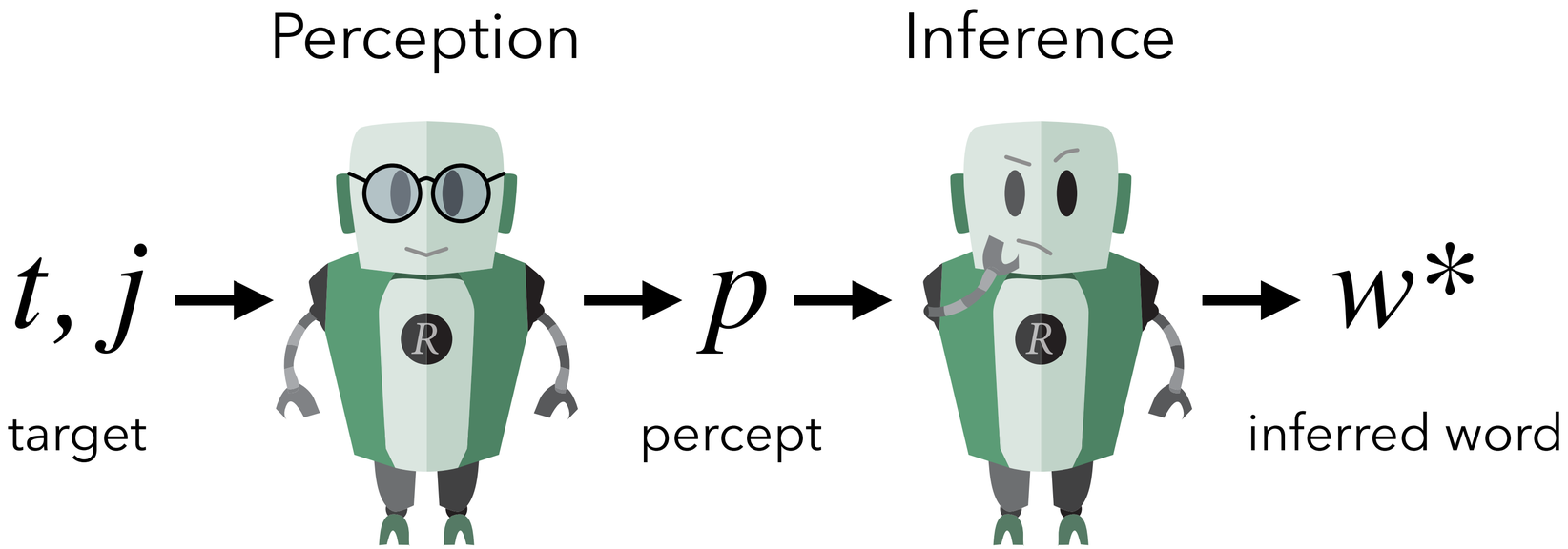

Perceptual bias
Informational bias
Expected position of minimum uncertainty
Pattern of eye movements

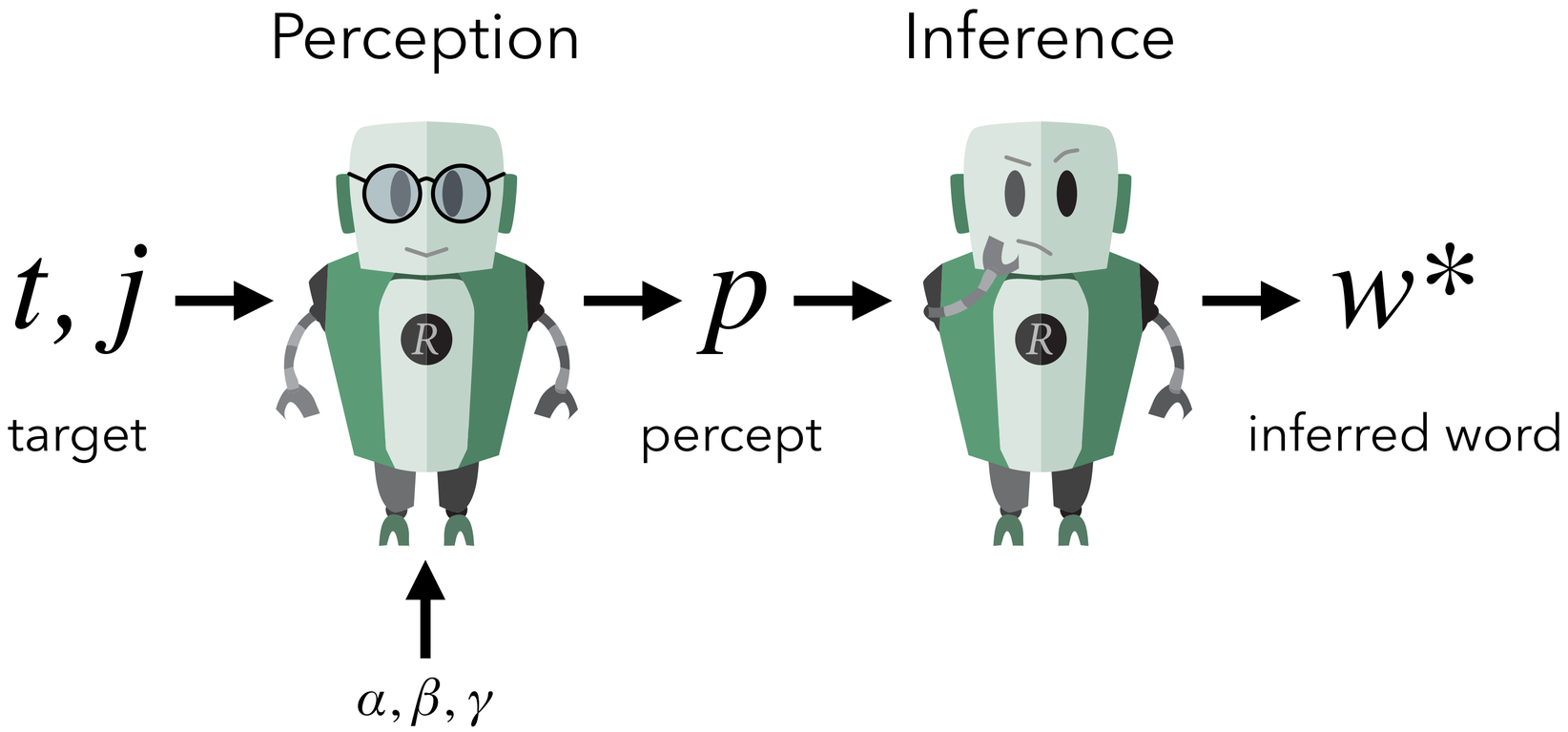


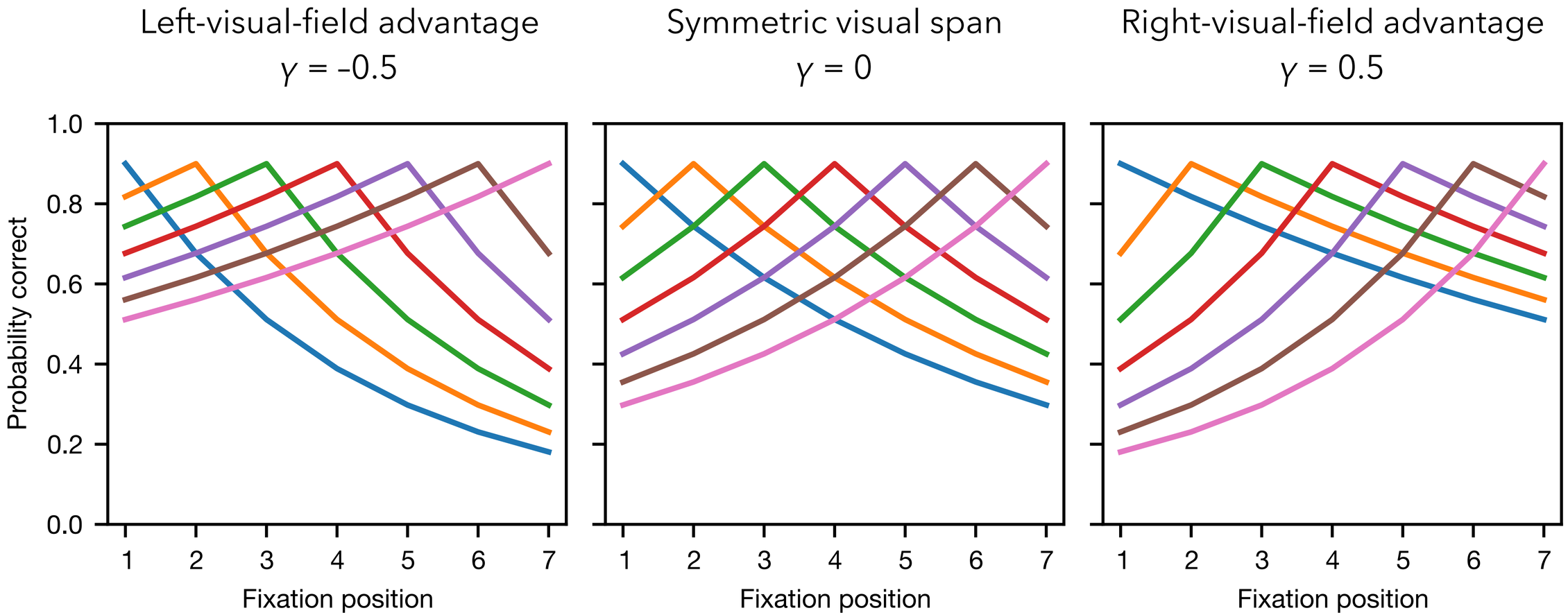


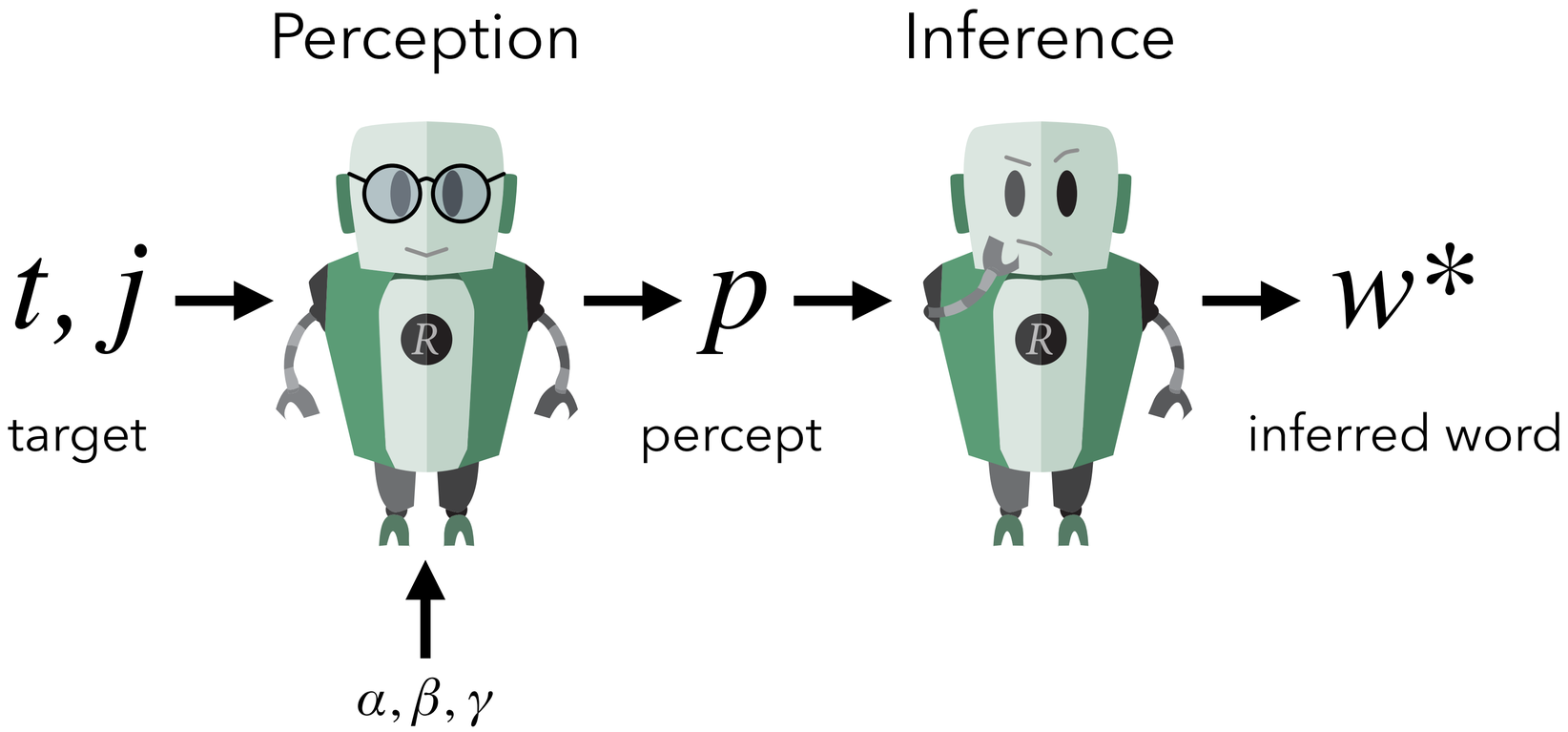
Does the structure of the lexicon affect patterns of eye movements?

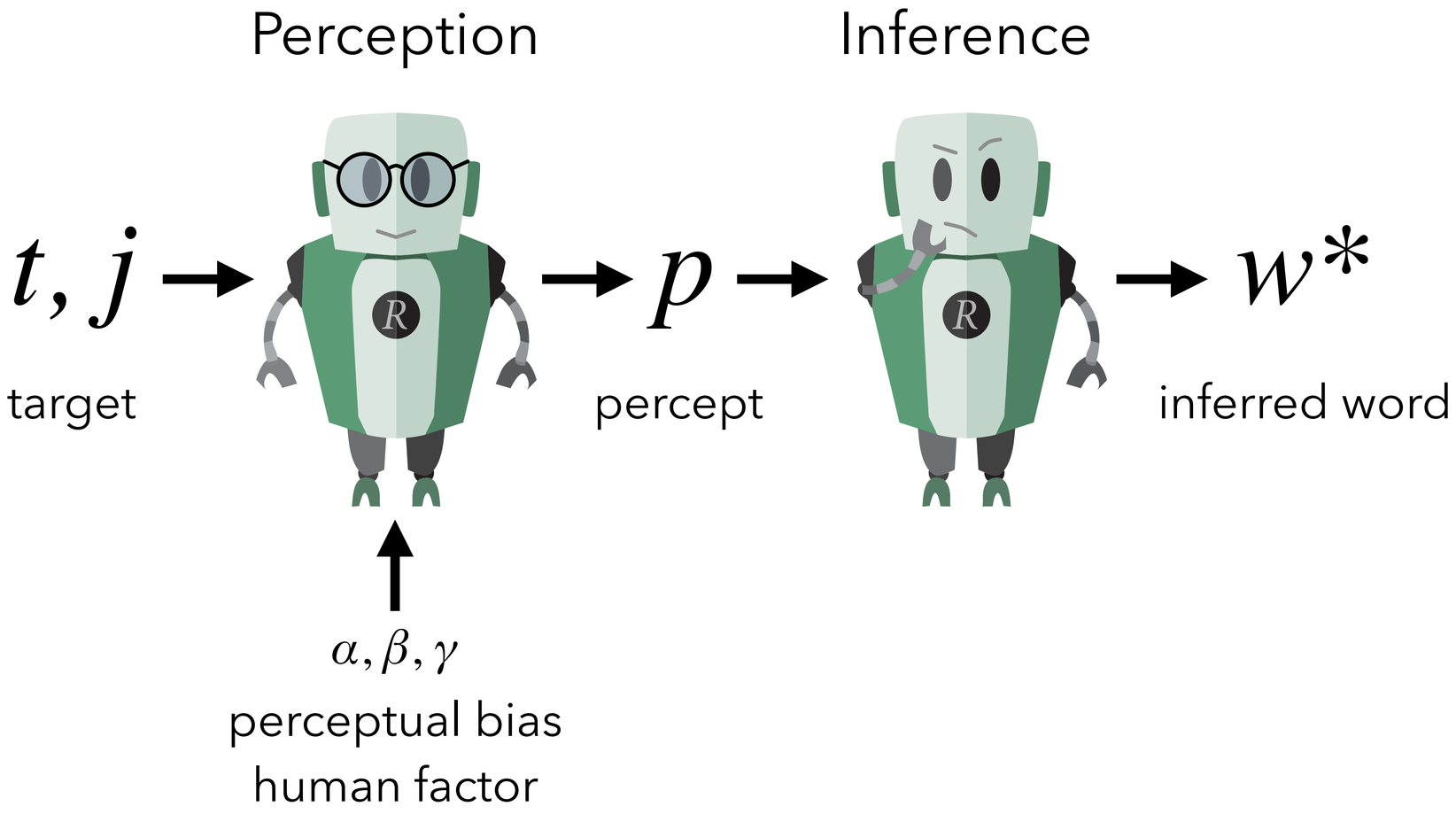
Cognitive model

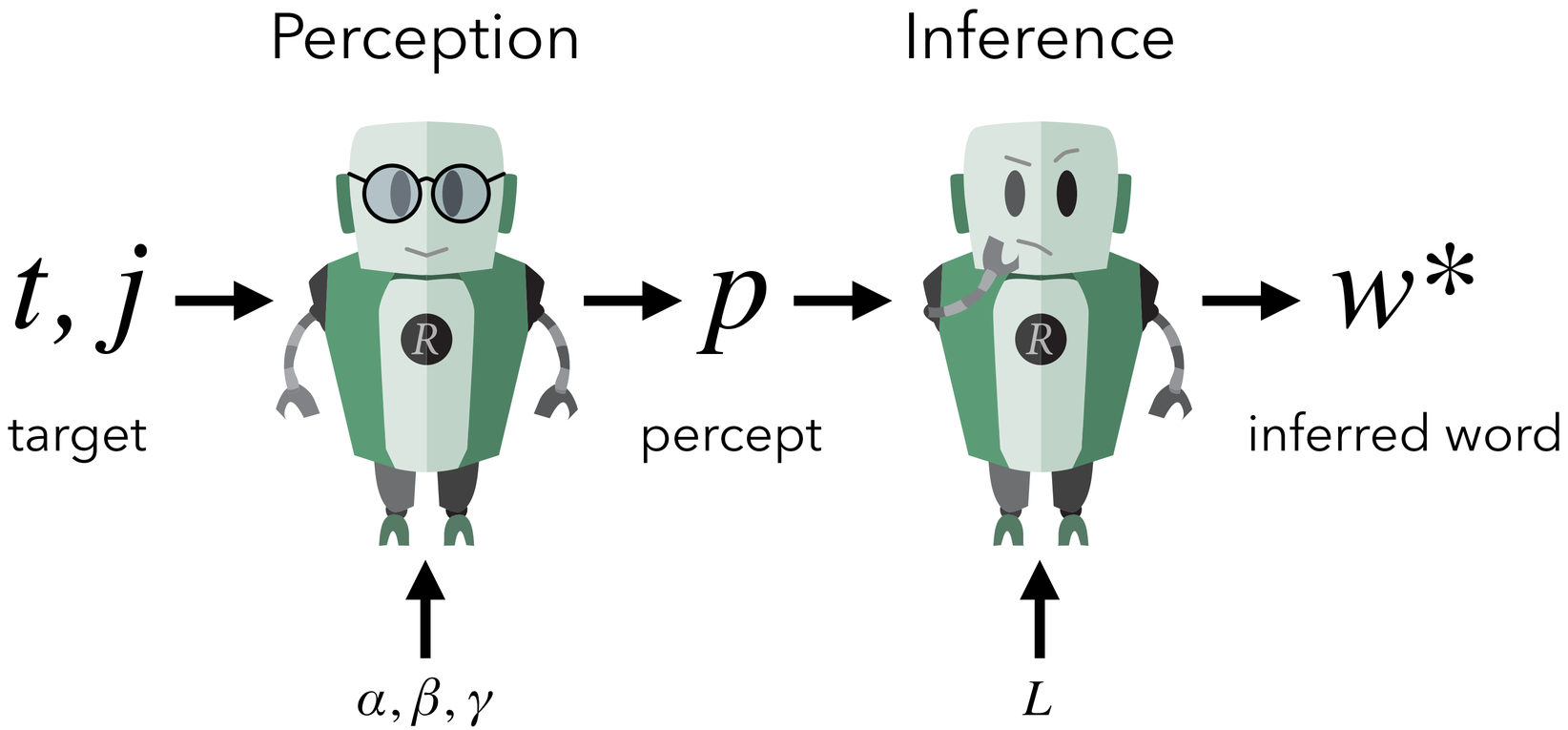

Perception
Inference
t, j
target
p
percept
w^*
inferred word

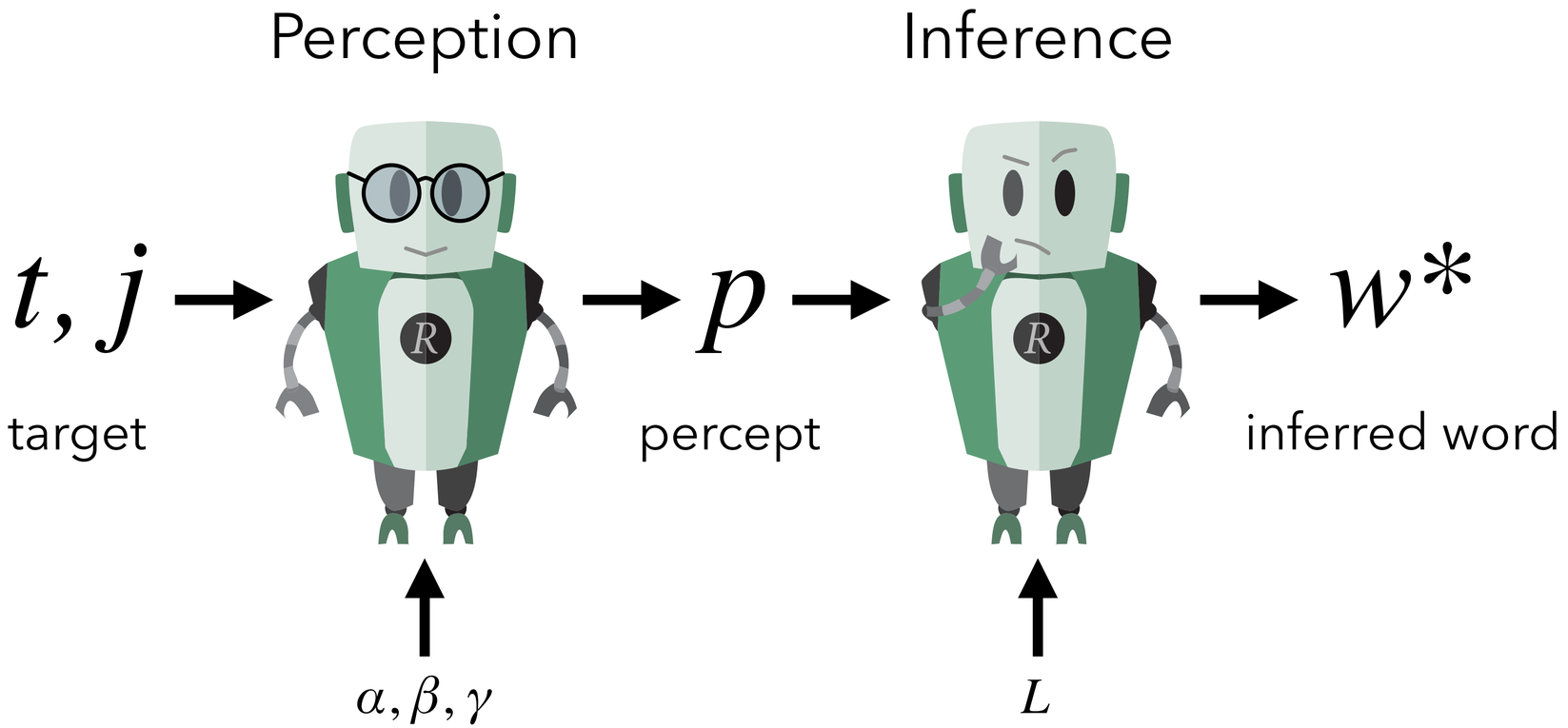

Perception
Inference
t, j
target
p
percept
w^*
inferred word
α, β, γ

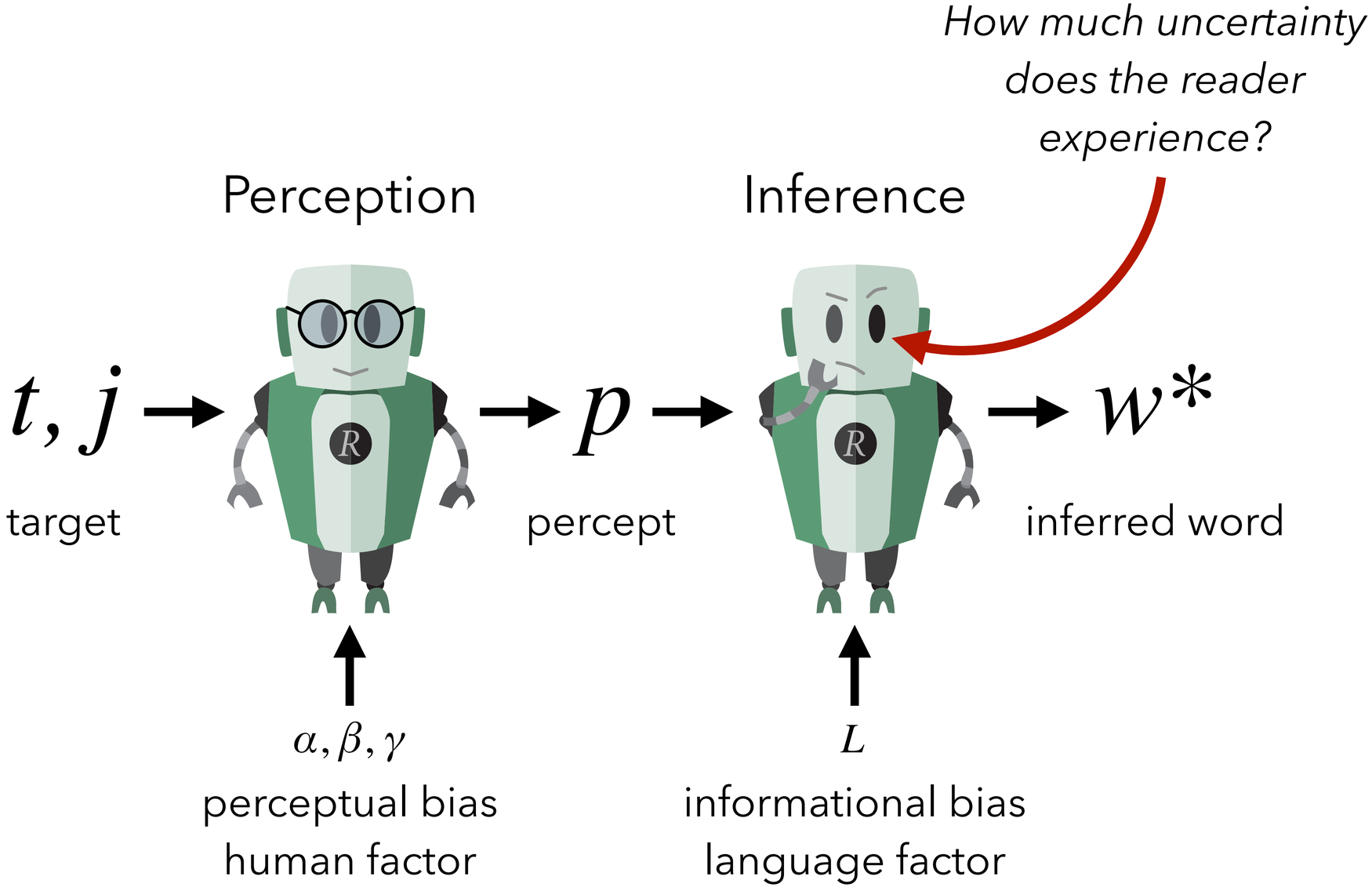

Left-visual-field advantage
γ = -0.5
Symmetric visual span
γ = 0
Right-visual-field advantage
γ = 0.5
Probability correct
1.0
0.8
0.6
0.4
0.2
0.0
1
2
3
4
5
6
7
Fixation position


Perception
Inference
t, j
target
p
percept
w^*
inferred word
α, β, γ

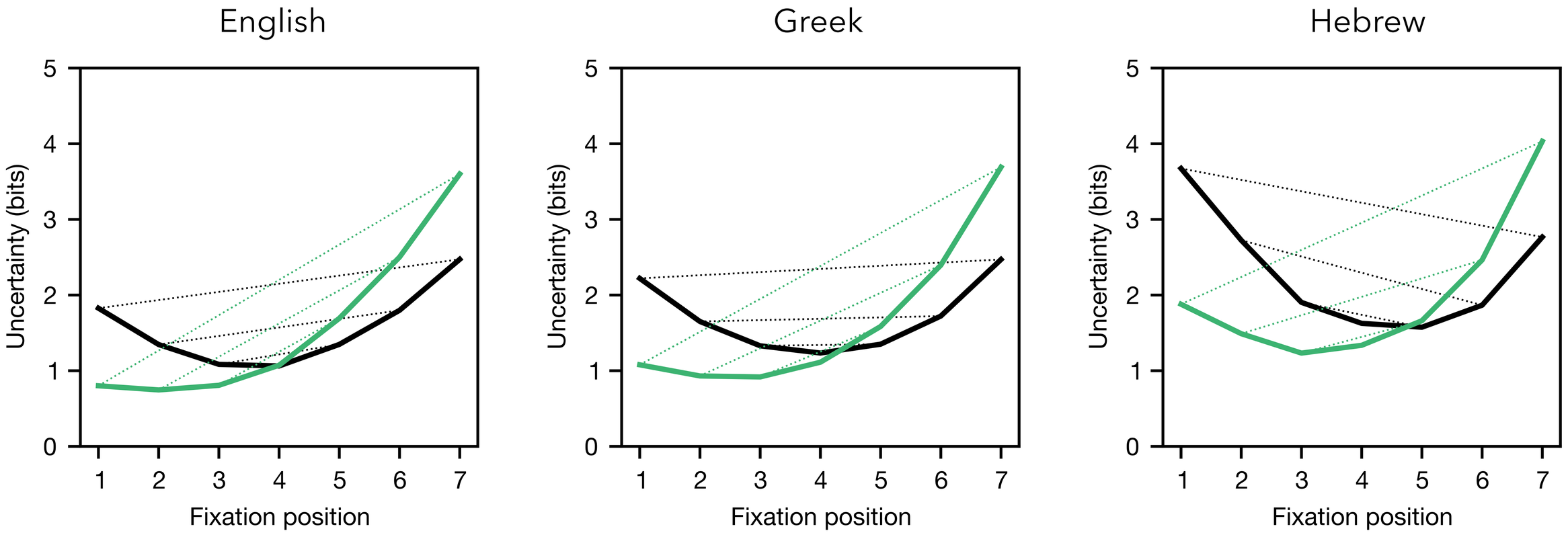

Perception
Inference
t, j
target
p
percept
w^*
inferred word
α, β, γ
perceptual bias
human factor


Perception
Inference
t, j
target
p
percept
w^*
inferred word
α, β, γ
perceptual bias
human factor
L


Perception
Inference
t, j
target
p
percept
w^*
inferred word
α, β, γ
perceptual bias
human factor
L
informational bias
language factor


How much uncertainty does the reader experience?
Perception
Inference
t, j
target
p
percept
w^*
inferred word
α, β, γ
perceptual bias
human factor
L
informational bias
language factor

informational bias alone (symmetric visual span; $\gamma = 0$)



informational bias alone ($\gamma = 0$)

informational bias + perceptual bias ($\gamma = 0.5$)

Experiment 1

SNYBEVS

STOBEVS

SGUPEVS

SKAPEVS

SGYDIVS

SNODIVS

SKUMIVS

STAMIVS

High information content

Low information content

Left-heavy lexicon

SNYBEVS

STOBEVS

SGUPEVS

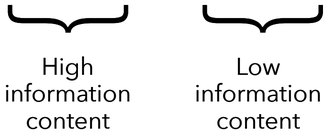
SKAPEVS

SGYDIVS

SNODIVS

SKUMIVS

STAMIVS



Left-heavy lexicon

SNYBEVS

STOBEVS

SGUPEVS

SKAPEVS

SGYDIVS

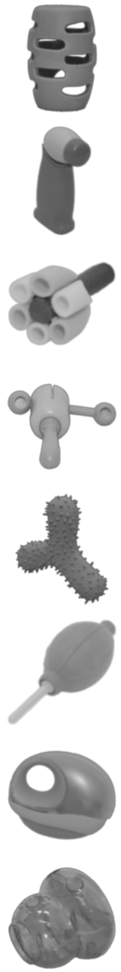
SNODIVS

SKUMIVS

STAMIVS

High information content

Low information content



Right-heavy lexicon

SVEBYNS

SVEBOTS

SVEPUGS

SVEPAKS

SVIDYGS

SVIDONS

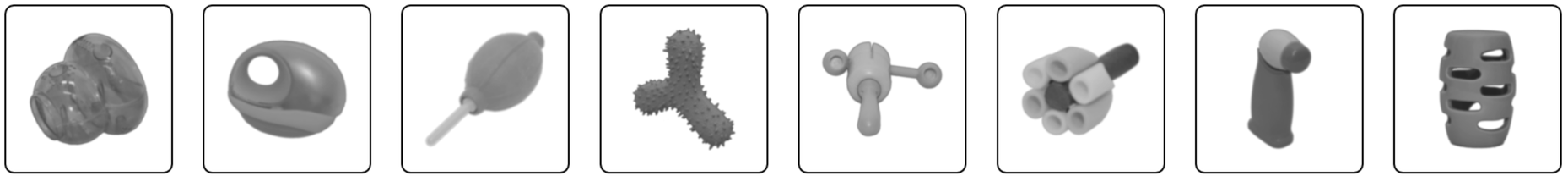
SVIMUKS

SVIMATS

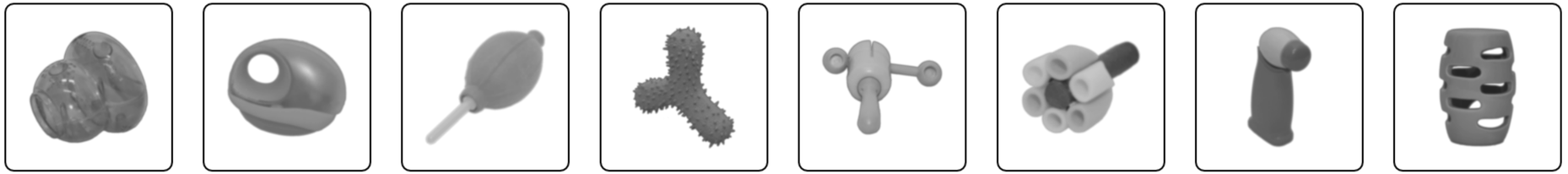
Low information content

High information content

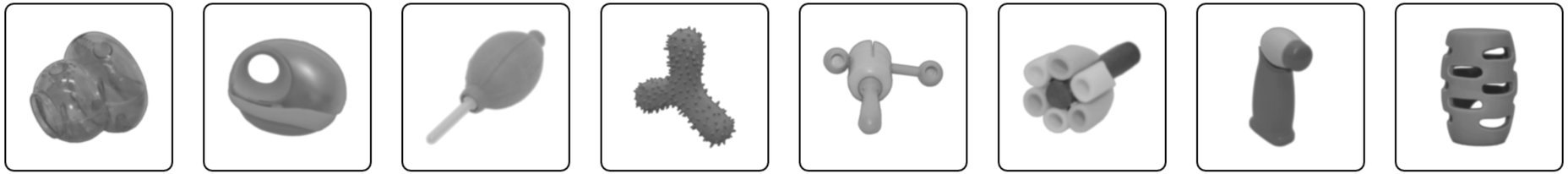
+



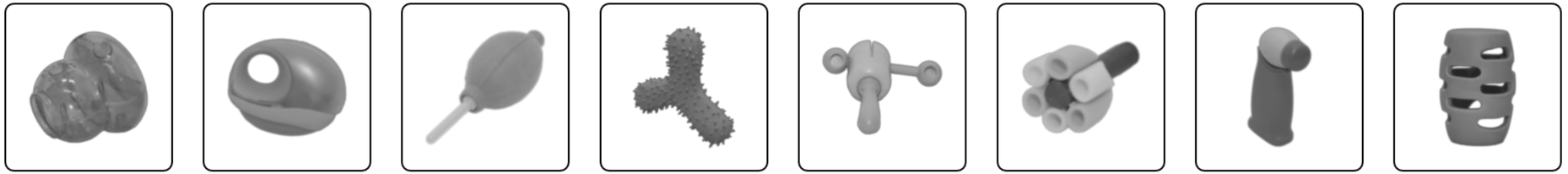
SNYBEVS

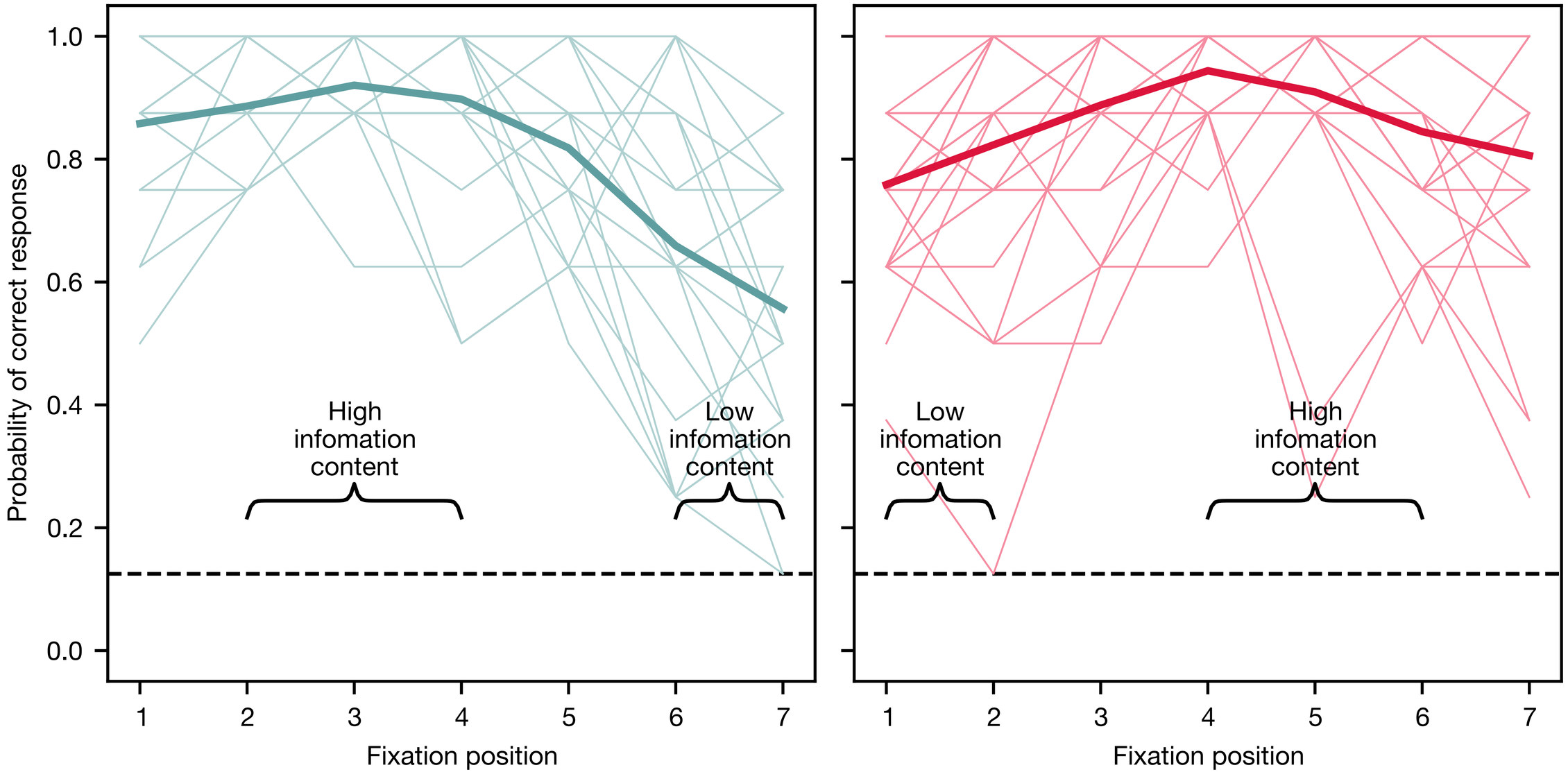


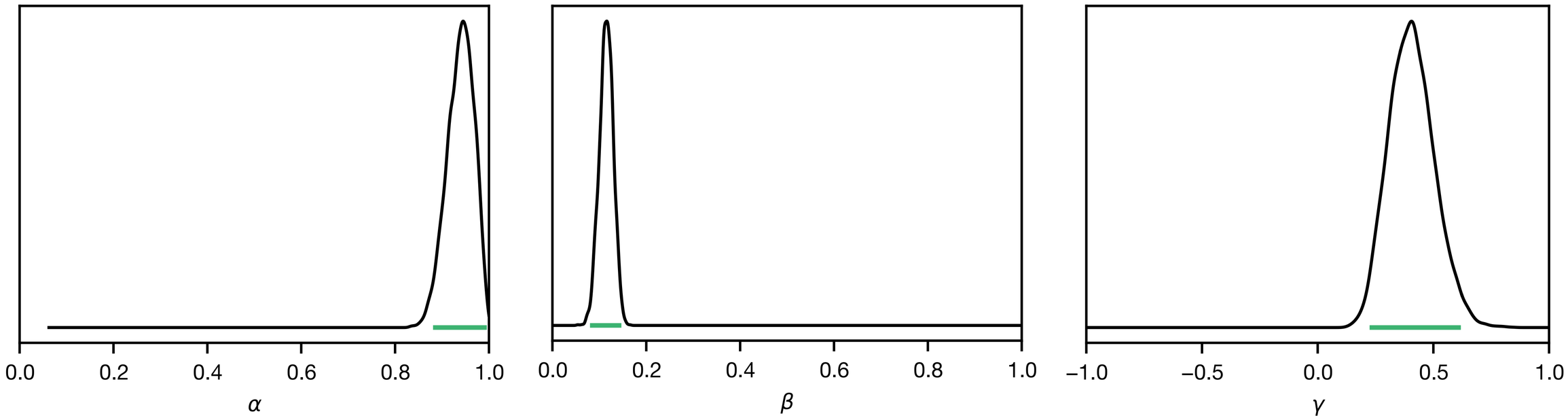
$KUMIVS

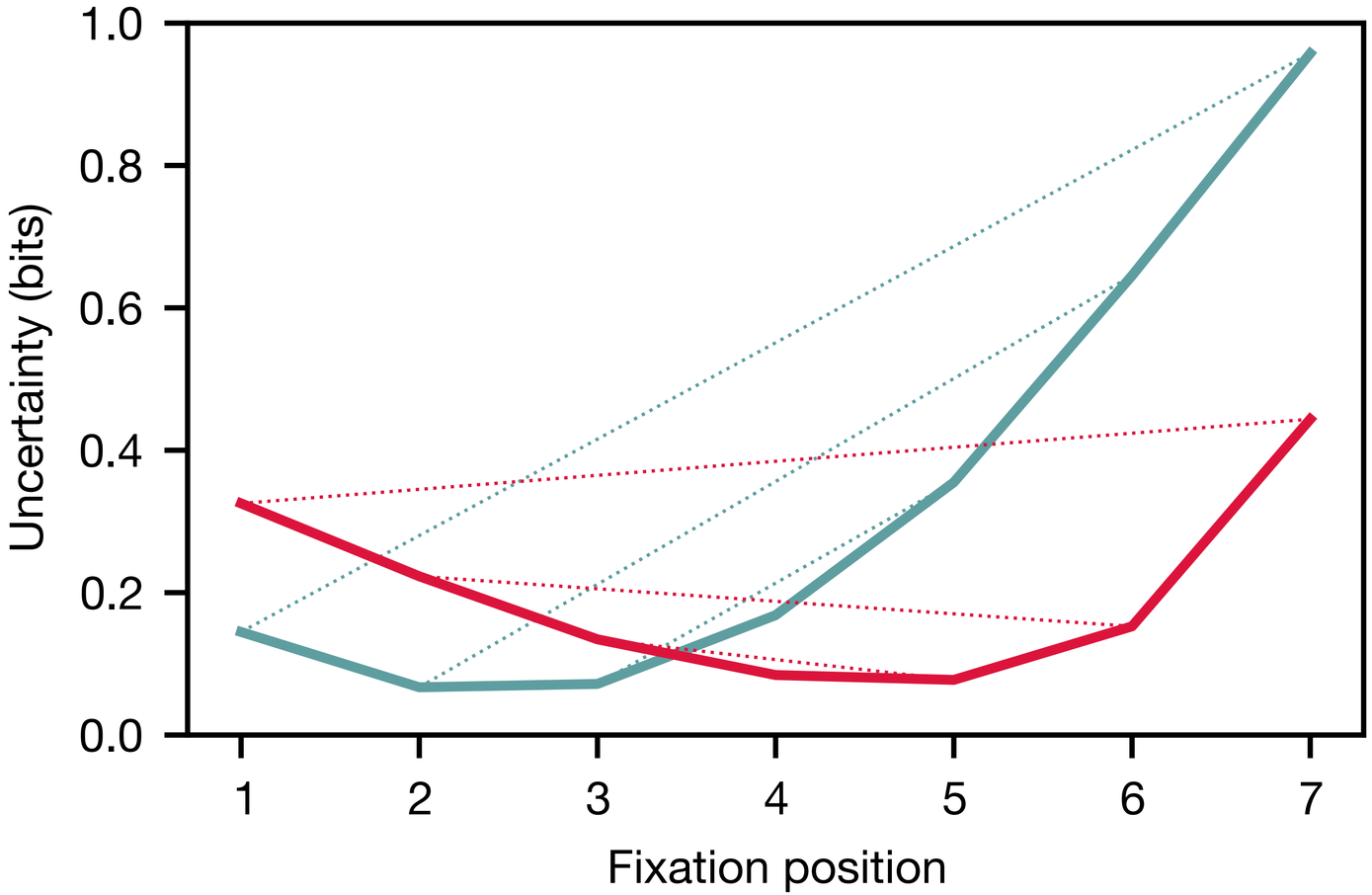


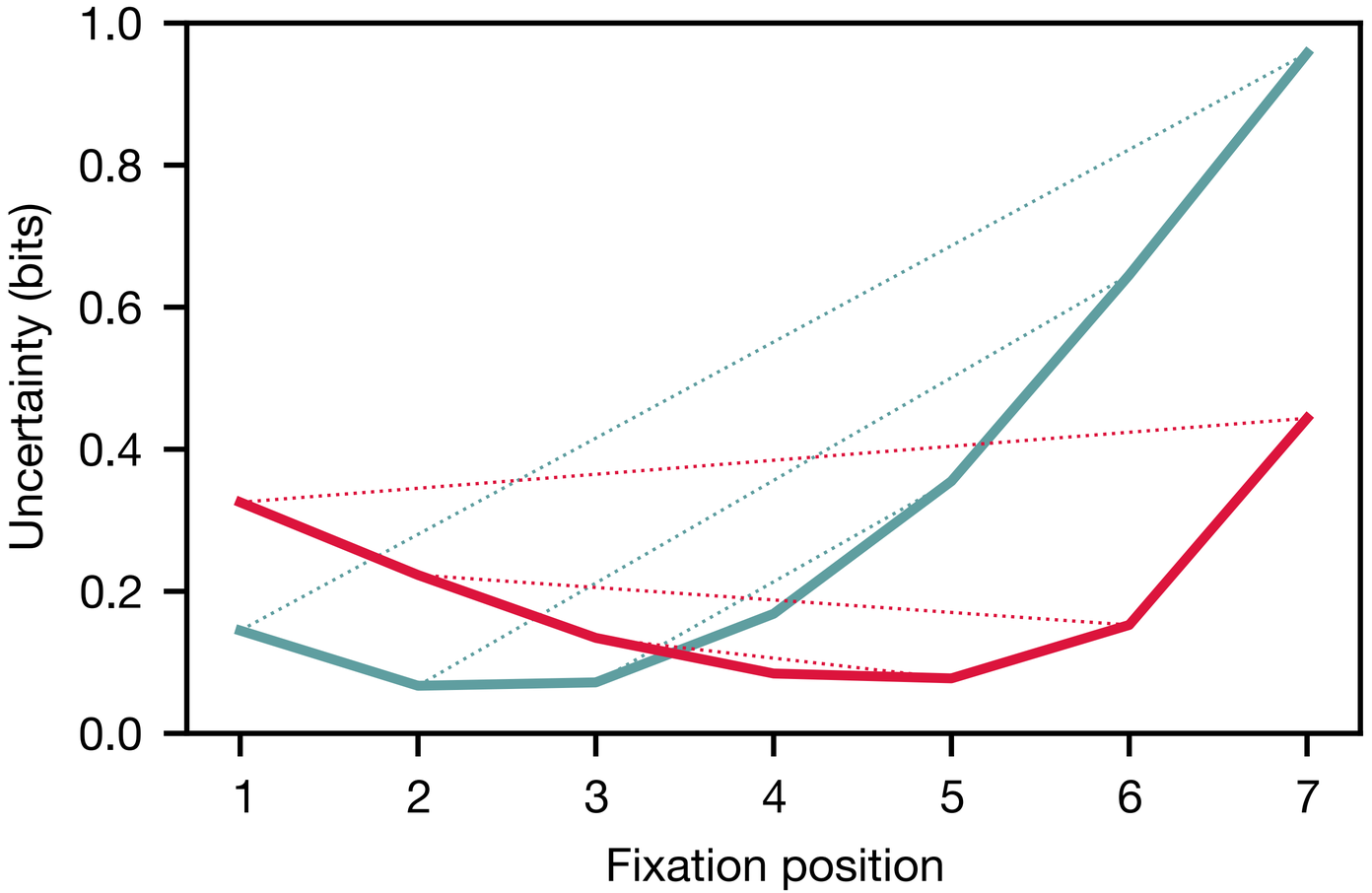
STOBEV$



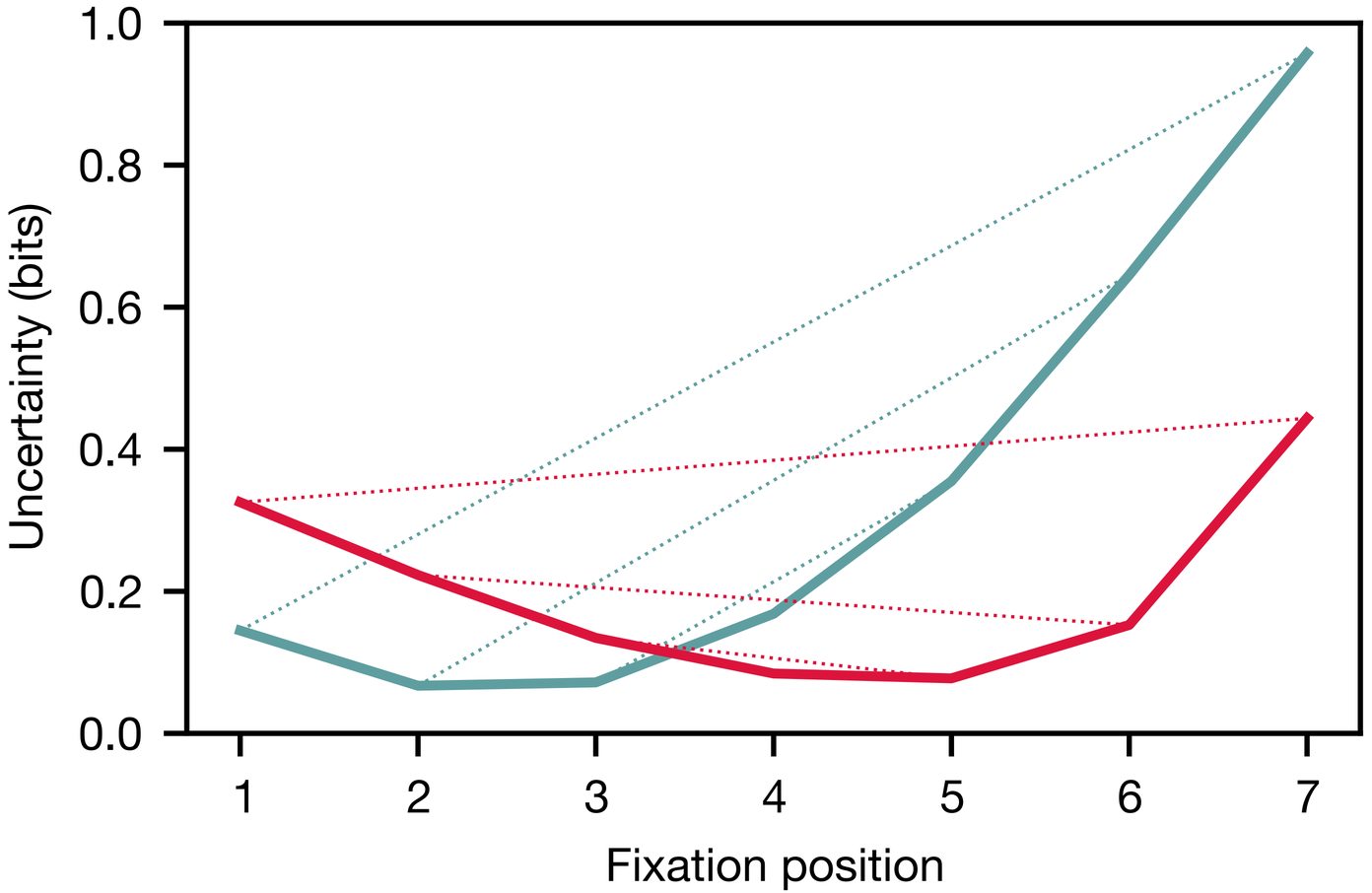

Probability of correct response
1.0
0.8
0.6
0.4
0.2
0.0
High infomation content
Low infomation content
1
2
3
4
5
6
7
Fixation position
Low infomation content
High infomation content
1
2
3
4
5
6
7
Fixation position


0.0
0.2
0.4
0.6
0.8
1.0
α
0.0
0.2
0.4
0.6
0.8
1.0
β
−1.0
−0.5
0.0
0.5
1.0
γ

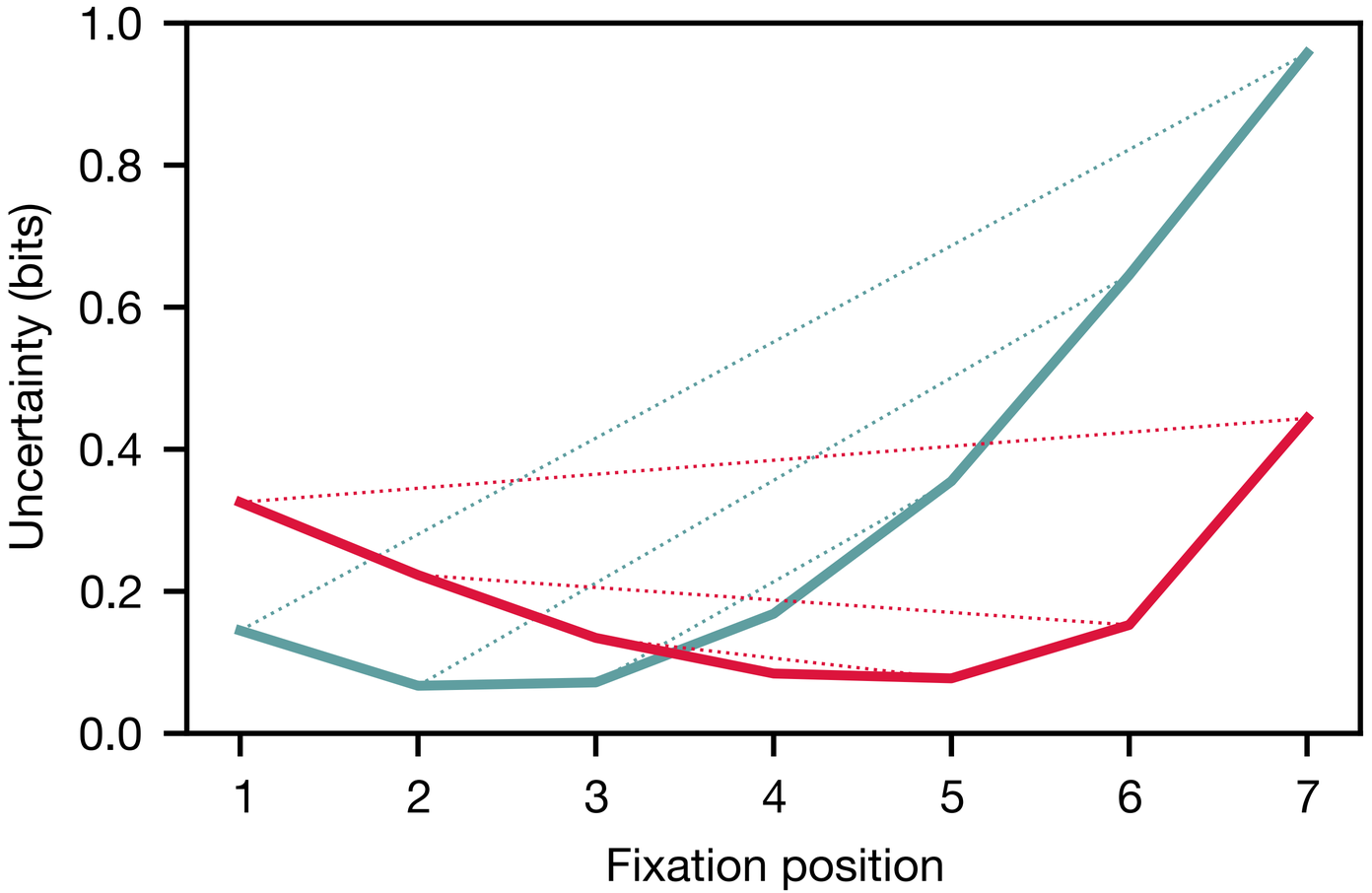

1.0
0.8
0.6
0.4
0.2
0.0
Uncertainty (bits)
1
2
3
4
5
6
7
Fixation position

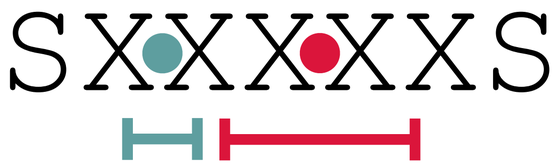

1.0
0.8
0.6
0.4
0.2
0.0
Uncertainty (bits)
1
2
3
4
5
6
7
Fixation position

SXXXXXXS


1.0
0.8
0.6
0.4
0.2
0.0
Uncertainty (bits)
1
2
3
4
5
6
7
Fixation position

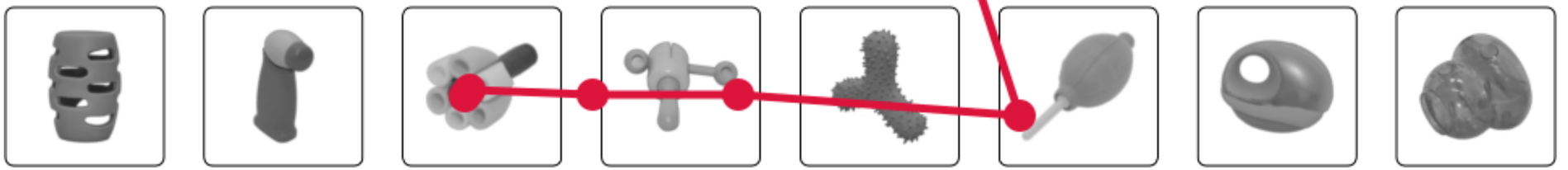
SXXXXXXS

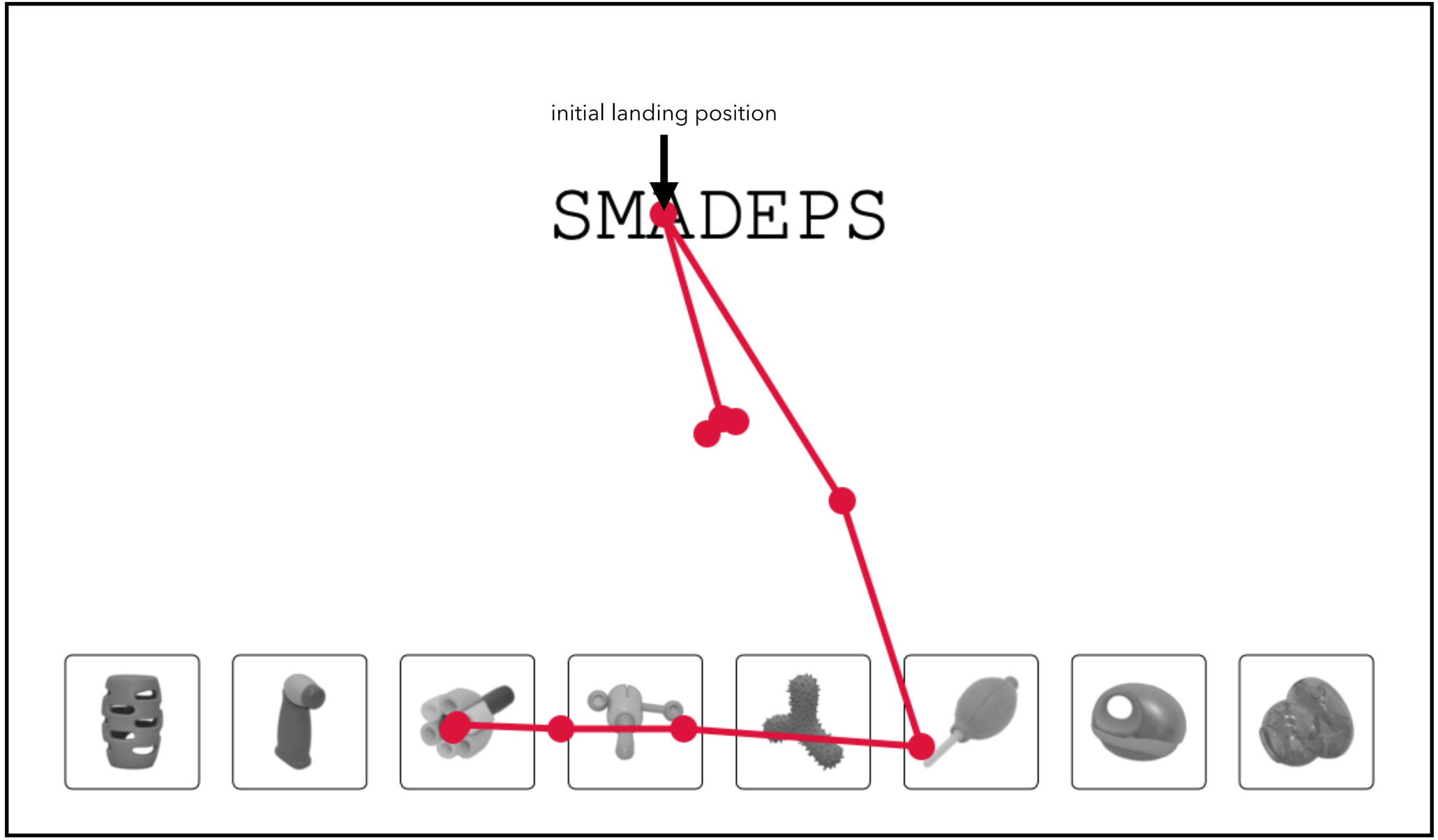

1.0
0.8
0.6
0.4
0.2
0.0
Uncertainty (bits)
1
2
3
4
5
6
7
Fixation position

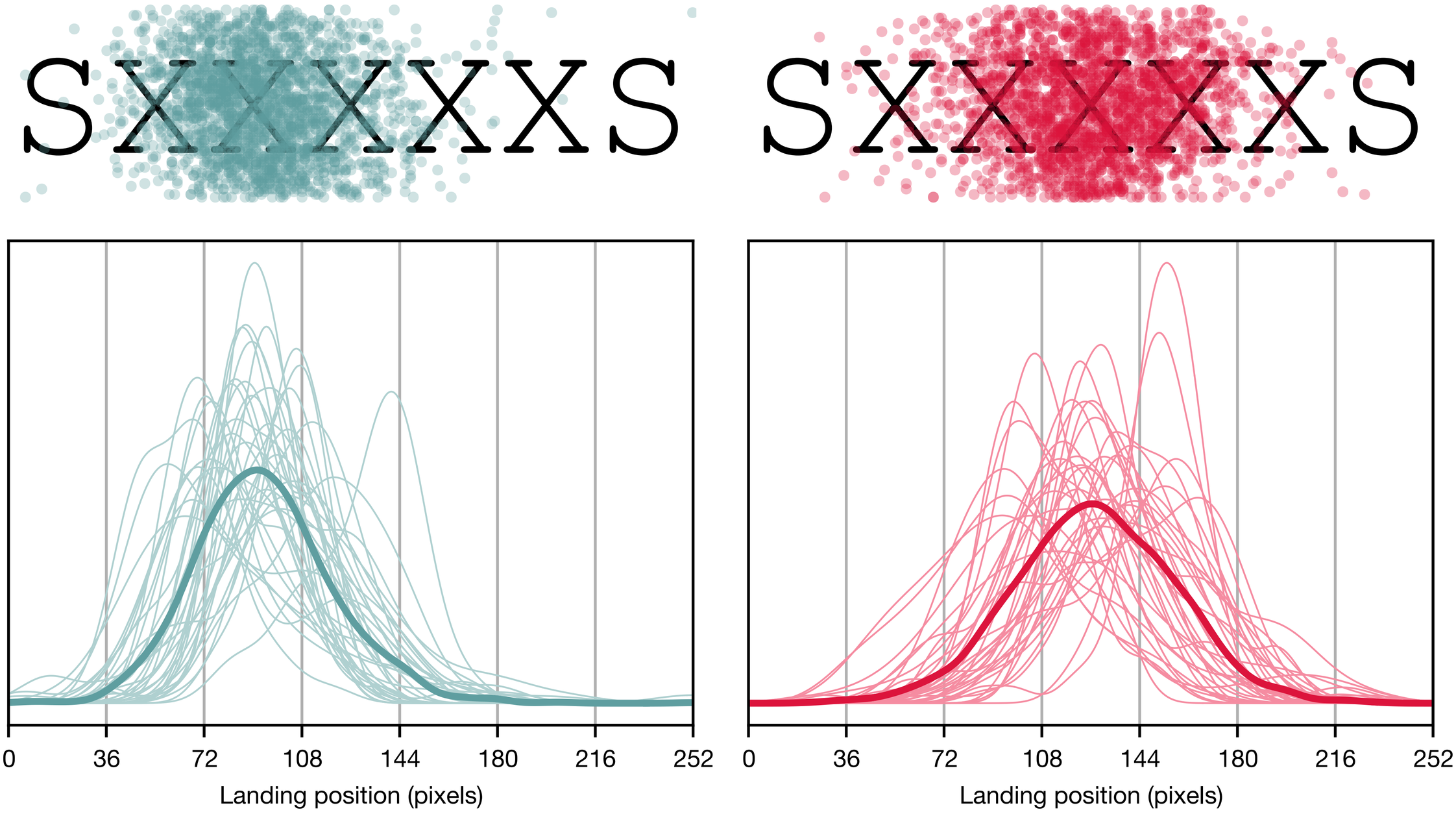

SXXXXXXS

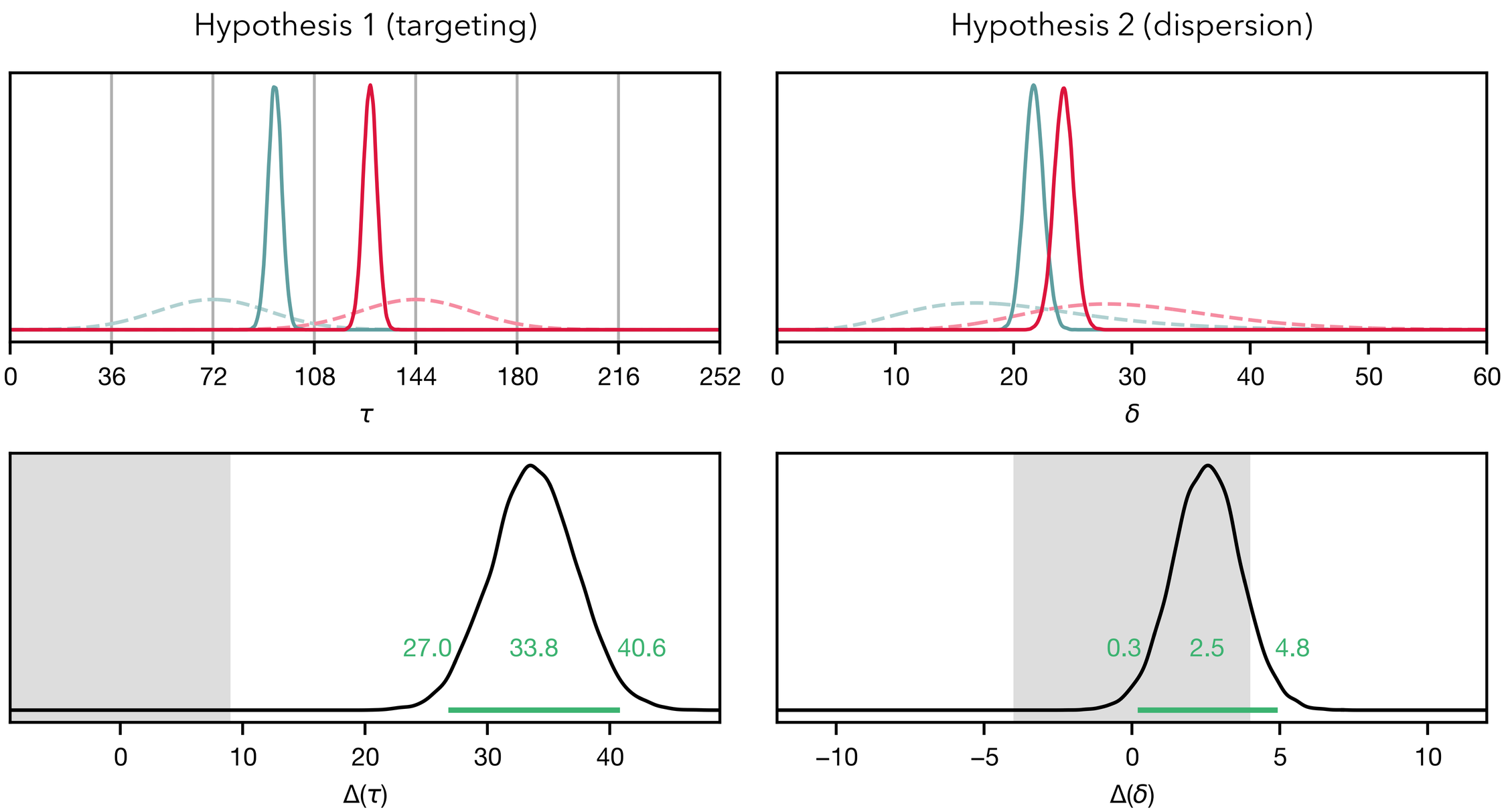
Experiment 2

SMADEPS



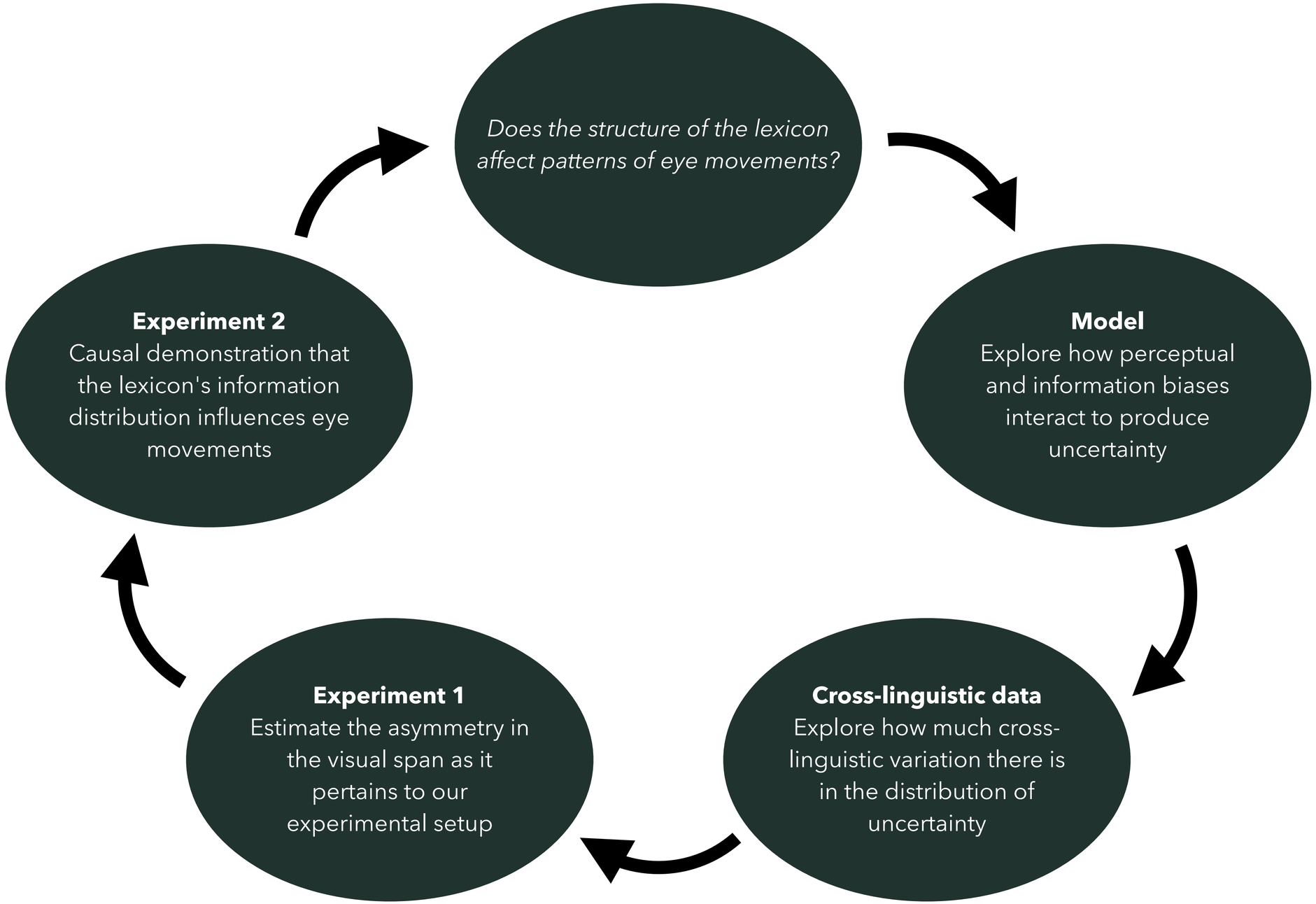

initial landing position
SMADEPS


SXXXXXXS
SXXXXXXS
0
36
72
108
144
180
216
252
Landing position (pixels)
0
36
72
108
144
180
216
252
Landing position (pixels)


Hypothesis 1 (targeting)
Hypothesis 2 (dispersion)
0
36
72
108
144
180
216
252
τ
0
10
20
30
40
50
60
δ
27.0
33.8
40.6
0
10
20
30
40
Δ(τ)
0.3
2.5
4.8
−10
−5
0
5
10
Δ(δ)

Does the structure of the lexicon affect patterns of eye movements?

Does the structure of the lexicon affect patterns of eye movements?


Does the structure of the lexicon affect patterns of eye movements?
Model
Explore how perceptual and information biases interact to produce uncertainty
Cross-linguistic data
Explore how much cross-linguistic variation there is in the distribution of uncertainty
Experiment 1
Estimate the asymmetry in the visual span as it pertains to our experimental setup
Experiment 2
Causal demonstration that the lexicon's information distribution influences eye movements