E-Z Reader 7

Reichle, Rayner & Pollatsek (2011)

E-Z Reader v. 8

Pollatsek, Reichle & Rayner, (2006). Tests of the E-Z Reader model: Exploring the interface between cognition and eye-movement control. Cognitive Psychology, 52, 1-56.

E-Z Reader v. 10

Reichle (2011). Serial-attention models of reading. In Liversedge, Gilchrist & Everling (Eds.), Oxford Handbook of Eye Movements. Oxford University Press (pp. 767-786).

A Small Provocation for your consideration ...

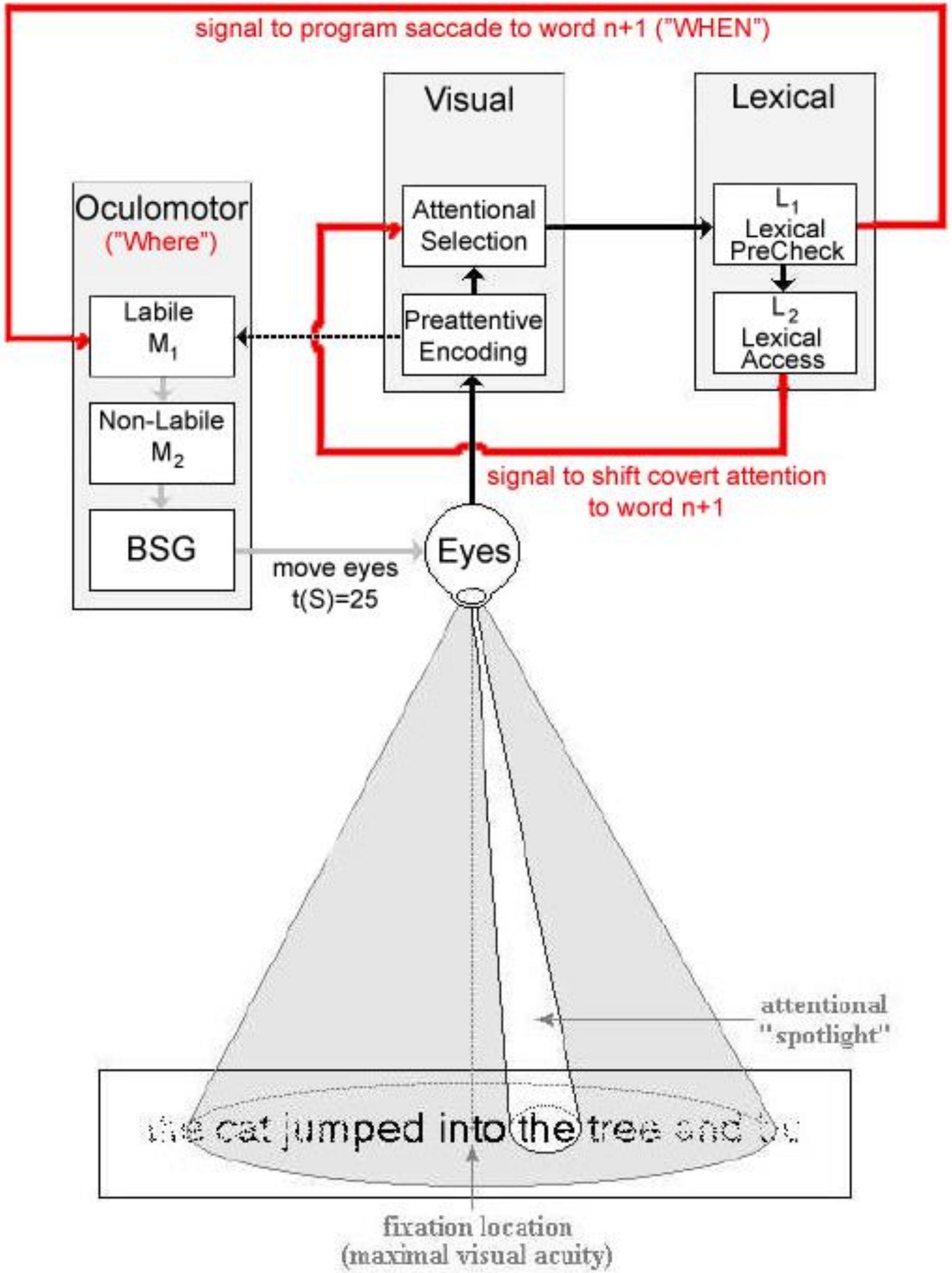
USD Internet Psychology Laboratory

Aoccdrnig to a rscheearch at Cmabrigde Ui nervtisy, it deosn't mttaer in waht oredr the ltteers in a wrod are, the olny iprmoetnt tihng is taht the frist and lsat ltteer be at the rghit pclae.

The rset can be a total mses and you can sitll raed it wouthit porbelm.

Tihs is bcuseae the huamn mnid de os not raed ervey lteter by istlef, but the wrod as a wlohe.

Amzanig huh?



signal to program saccade to word n+1 ("WHEN")
Visual
Lexical
Oculomotor
("Where")
Attentional Selection
L1 Lexical PreCheck
Labile M1
Preattentive Encoding
L2 Lexical Access
Non-Labile M2
BSG
signal to shift covert attention to word n+1
move eyes t(S)=25
Eyes
attentional "spotlight"
the cat jumped into the tree and
fixation location (maximal visual acuity)

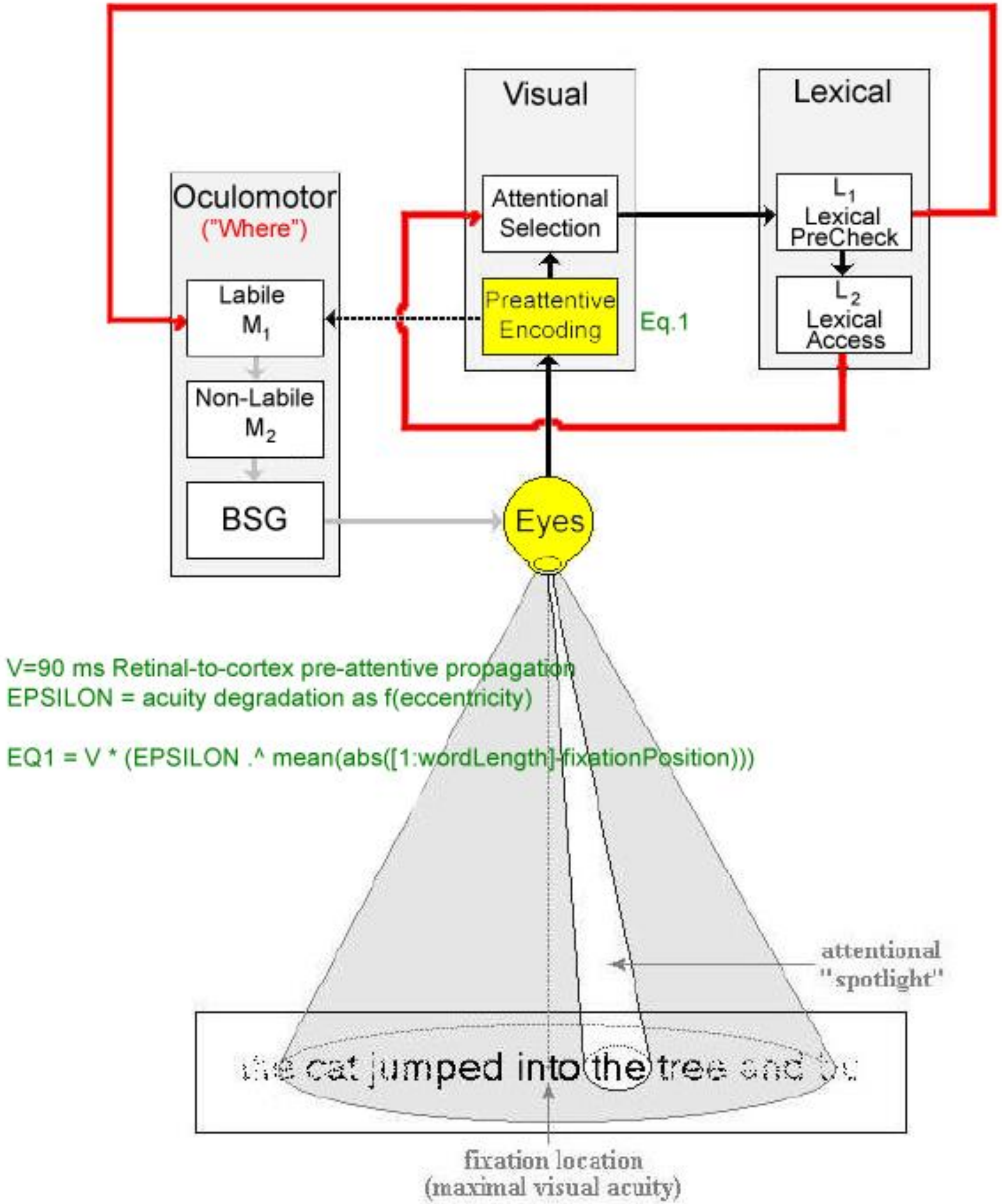
Model Inputs

freq	#chars	predictability	word
1	6	0.00	Margie
181	5	0.00	moved
1789	4	0.20	into
3036	3	0.25	her
1635	3	0.65	new
81	9	0.75	apartment
5372	2	0.00	at
69974	3	0.60	the
409	3	0.10	end
36414	2	0.95	of
69974	3	1.00	the
134	7	0.10	summer.@
69974	3	0.00	The
92	9	0.00	principal
52	10	0.00	introduced
69974	3	0.80	the
1635	3	0.35	new
382	9	0.00	president
36414	2	0.55	of
69974	3	1.00	the
75	6	0.00	junior
207	6	0.70	class.@

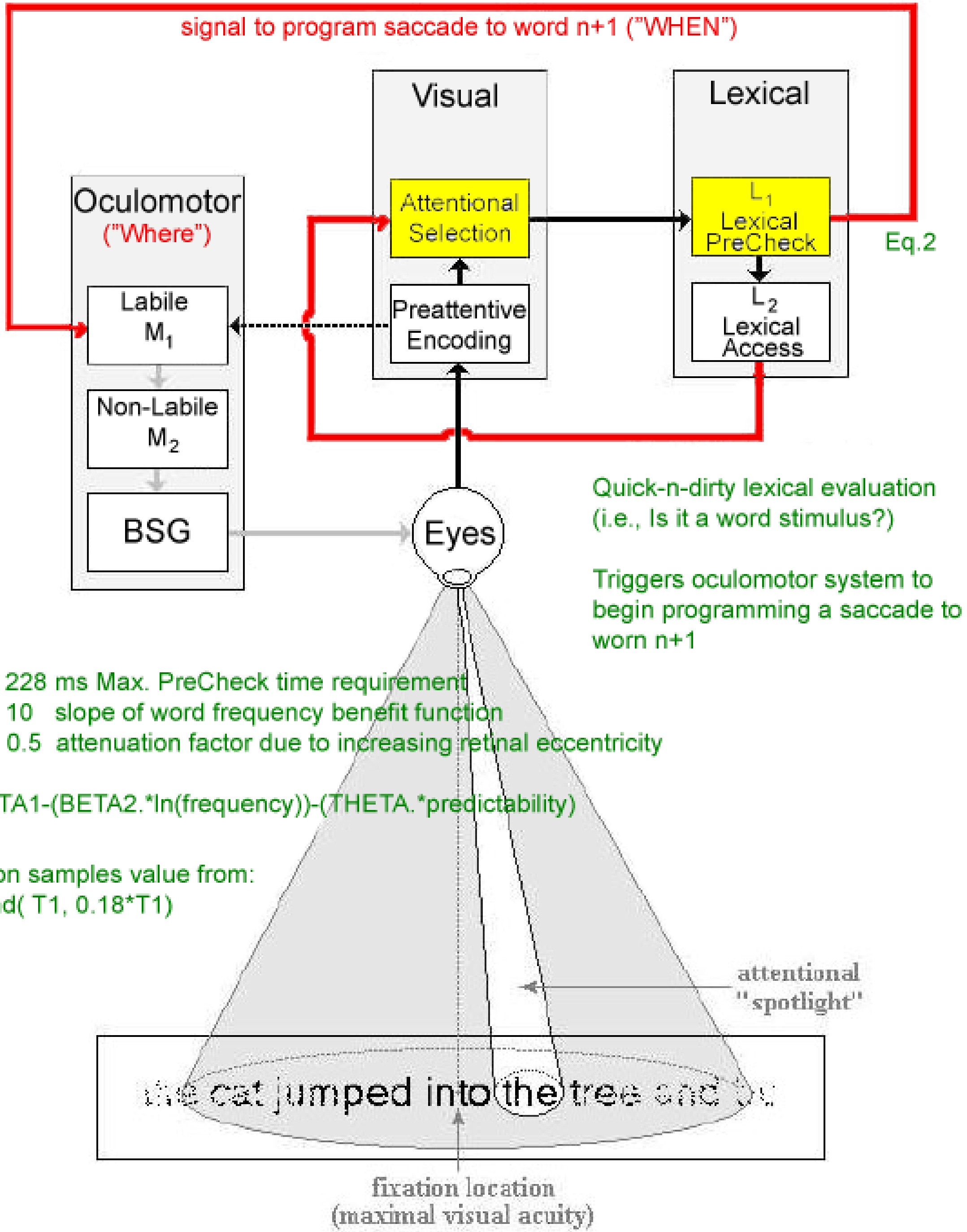
Cloze Predictability

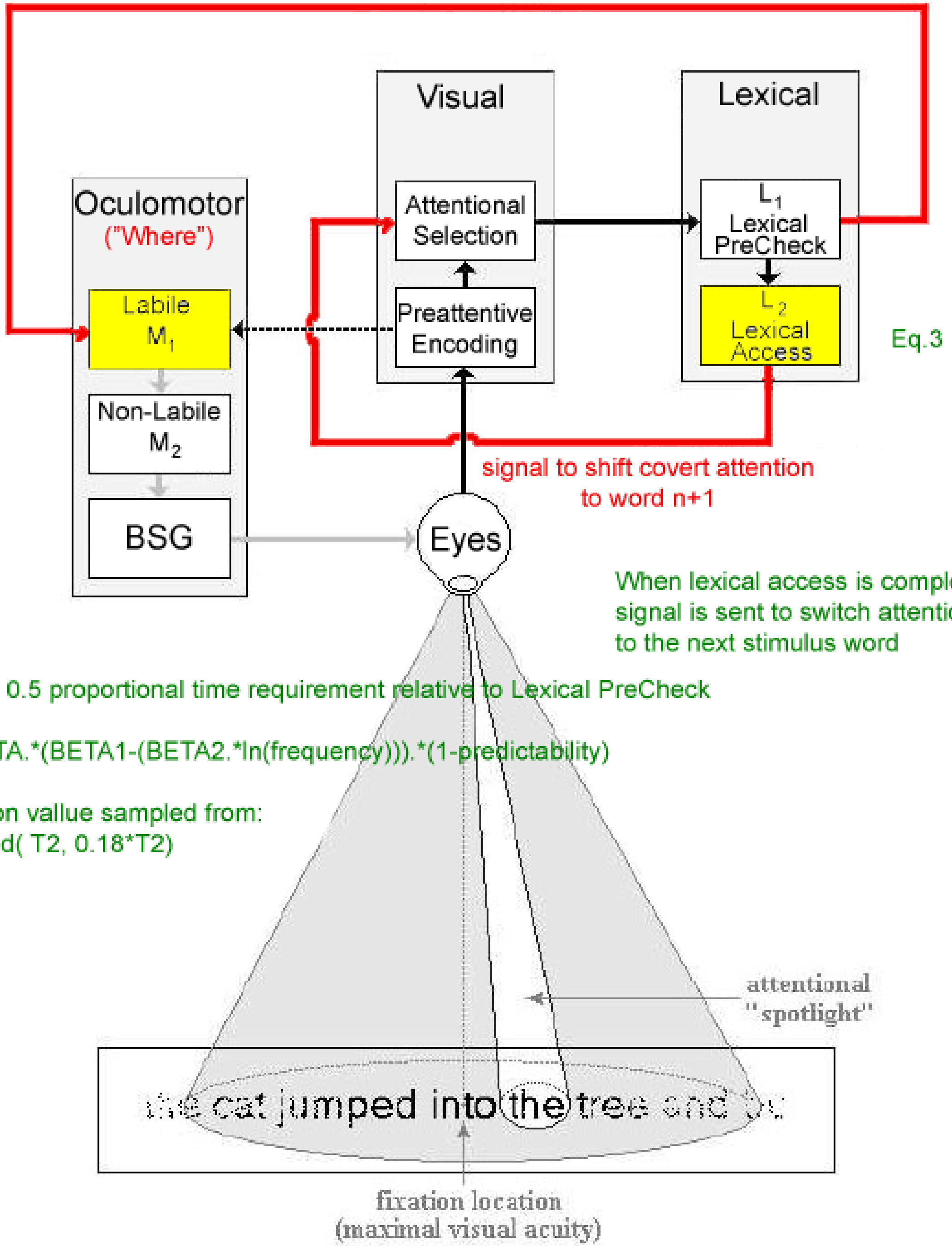
__________ moved into her _______ apartment at the end of the summer.

The ________ introduced the new president of _______ junior class.



Visual
Lexical
Oculomotor
("Where")
Attentional Selection
L1 Lexical PreCheck
Labile M1
Preattentive Encoding
Eq.1
L2 Lexical Access
Non-Labile M2
BSG
Eyes
V=90 ms Retinal-to-cortex pre-attentive propagation
EPSILON = acuity degradation as f(eccentricity)
EQ1 = V * (EPSILON .^ mean(abs([1:wordLength]-fixationPosition)))
attentional "spotlight"
cat jumped into the tree
fixation location
(maximal visual acuity)


signal to program saccade to word n+1 ("WHEN")
Visual
Lexical
Oculomotor
("Where")
Attentional Selection
L1
Lexical PreCheck
Eq.2
Labile M1
Preattentive Encoding
L2
Lexical Access
Non-Labile M2
BSG
Eyes
Quick-n-dirty lexical evaluation
(i.e., Is it a word stimulus?)
Triggers oculomotor system to begin programming a saccade to worn n+1
BETA1 = 228 ms Max. PreCheck time requirement
BETA2 = 10 slope of word frequency benefit function
THETA = 0.5 attenuation factor due to increasing retinal eccentricity
T1=BETA1-(BETA2.*ln(frequency))-(THETA.*predictability)
Simulation samples value from:
gamrnd(T1, 0.18*T1)
attentional "spotlight"
the cat jumped into the tree and the
fixation location
(maximal visual acuity)



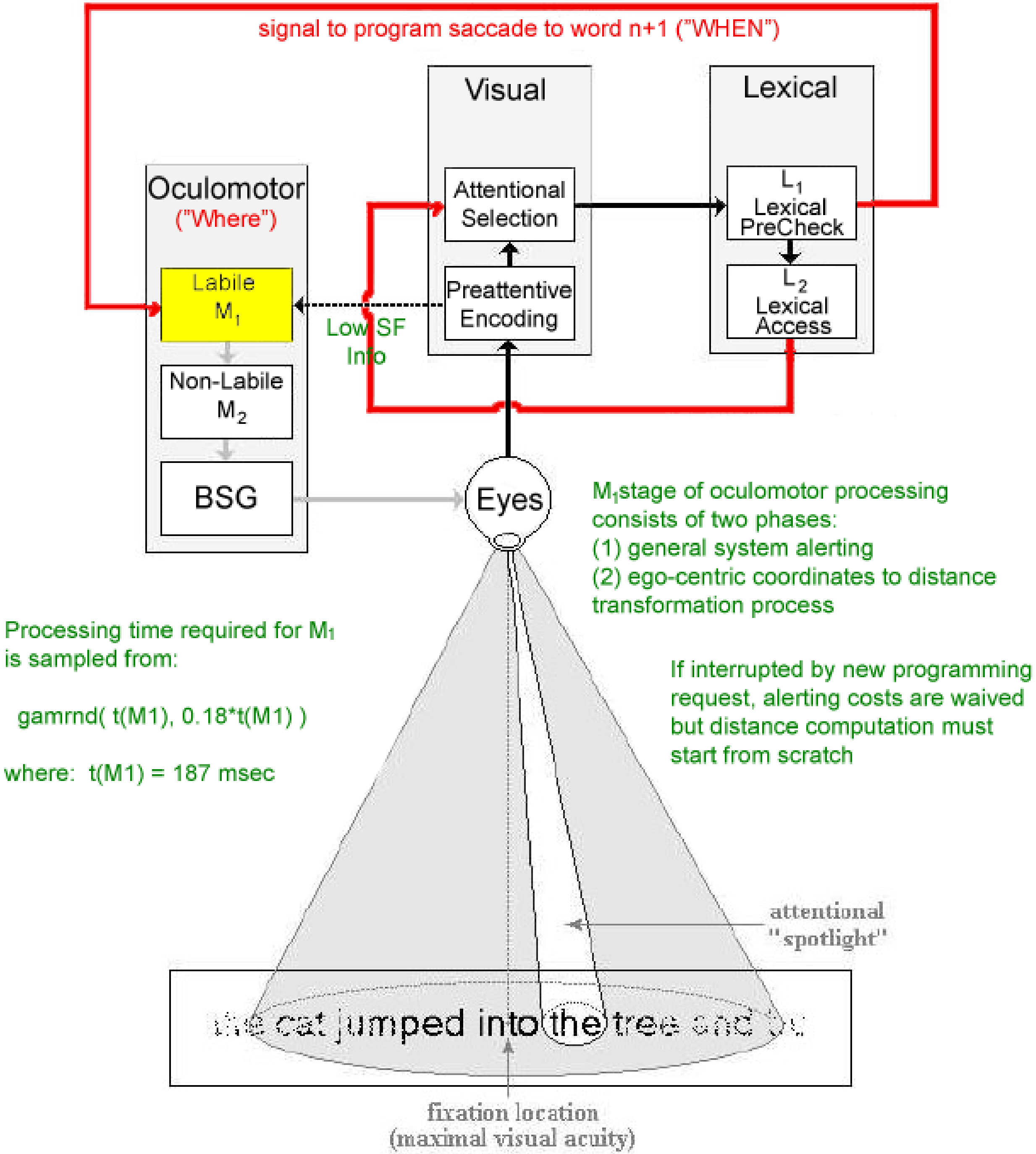
Eq.3

When lexical access is completed signal is sent to switch attention to the next stimulus word

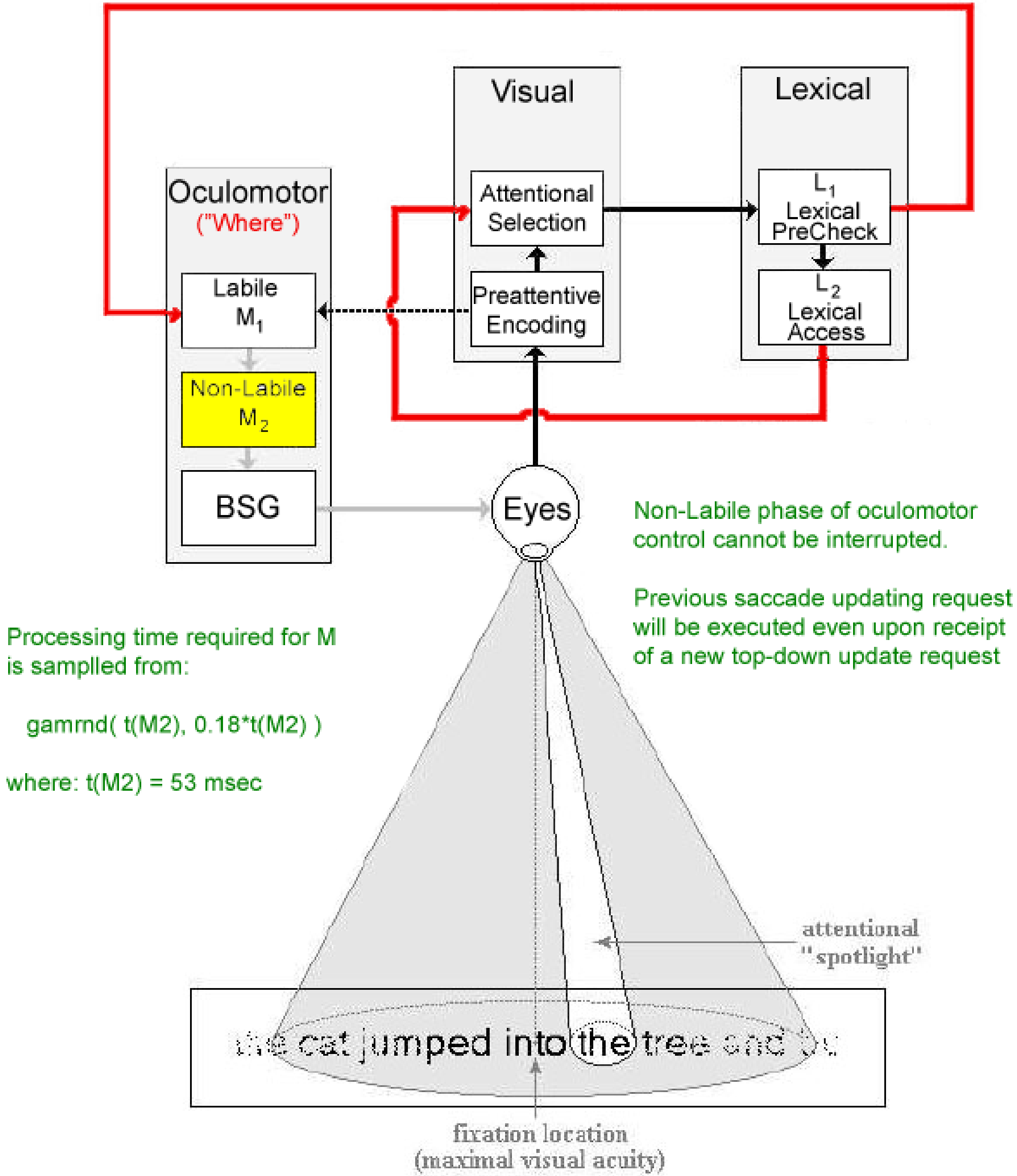
DELTA = 0.5 proportional time requirement relative to Lexical PreCheck

T2=DELTA.*(BETA1-(BETA2.*ln(frequency))).*(1-predictability)

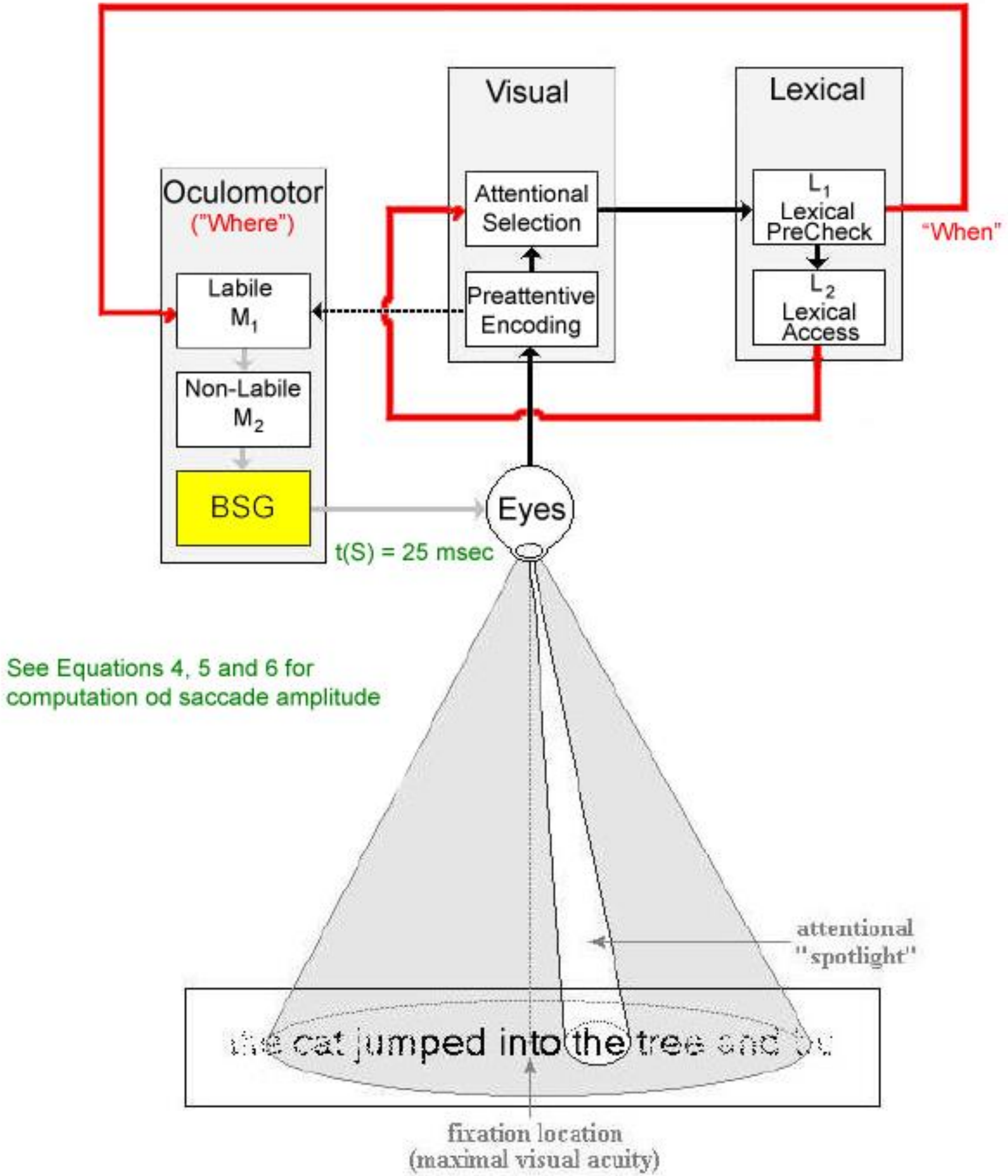
Simulation vallue sampled from:
gamrnd(T2, 0.18*T2)



signal to program saccade to word n+1 ("WHEN")
Visual
Lexical
Oculomotor
("Where")
Attentional Selection
L1 Lexical PreCheck
Labile M1
Preattentive Encoding
L2 Lexical Access
Low SF Info
Non-Labile M2
BSG
Eyes
M1 stage of oculomotor processing consists of two phases:
(1) general system alerting
(2) ego-centric coordinates to distance transformation process
Processing time required for M1 is sampled from:
gamrnd(t(M1), 0.18*t(M1))
where: t(M1) = 187 msec
If interrupted by new programming request, alerting costs are waived but distance computation must start from scratch
attentional "spotlight"
cat jumped into the tree
fixation location
(maximal visual acuity)



Visual
Lexical
Oculomotor
("Where")
Attentional Selection
L_1 Lexical PreCheck
Labile M_1
Preattentive Encoding
L_2 Lexical Access
Non-Labile M_2
BSG
Eyes
Non-Labile phase of oculomotor control cannot be interrupted.
Previous saccade updating request will be executed even upon receipt of a new top-down update request
Processing time required for M is samplled from:
gamrnd(t(M2), 0.18*t(M2))
where: t(M2) = 53 msec
attentional "spotlight"
the cat jumped into the tree and be
fixation location (maximal visual acuity)


Visual
Lexical
Oculomotor
("Where")
Attentional Selection
L_1 Lexical PreCheck
"When"
Labile M_1
Preattentive Encoding
L_2 Lexical Access
Non-Labile M_2
BSG
Eyes
t(S) = 25 msec
See Equations 4, 5 and 6 for computation od saccade amplitude
attentional "spotlight"
the cat jumped into the tree and
fixation location (maximal visual acuity)

Saccade Amplitude Computation

Equation 4: Amplitude = ISL + SE + RE (unit of measurement = characters)

where:

ISL = intended saccade length (model assumption: midpoint of next stimulus word)
SE = systematic error (or bias)
RE = random motor error

Equation 6: RE = normrnd(mu, sigma)

where:

mu = 0;
sigma = ETA_1 + (ETA_2 .* ISL)
ETA_2 controls increase in size of error as words become longer

ETA_1 = 1.2; ETA_2 = 0.15

Saccadic Amplitude (cont.)

Eq. 5 SE = (PSI-ISL).*[($OMEGA_1$-(ln(fixation_duration))) / $OMEGA_2$]

where:

PSI = 7 = most likely saccade amplitude while reading English text (baseline bias)

ISL's longer that **PSI** tend to undershoot (biased toward expected value) while those shorter then to overshoot (again, toward the expected value).

This form of systematic bias is mitigated somewhat when launch position fixations are of long duration (i.e., more processing of look-ahead buffer available)

$OMEGA_1$ = ceiling on size of systematic error effect (y-intercept) = 7.3
$OMEGA_2$ = scaling factor (gain) for overall SE effect = 4

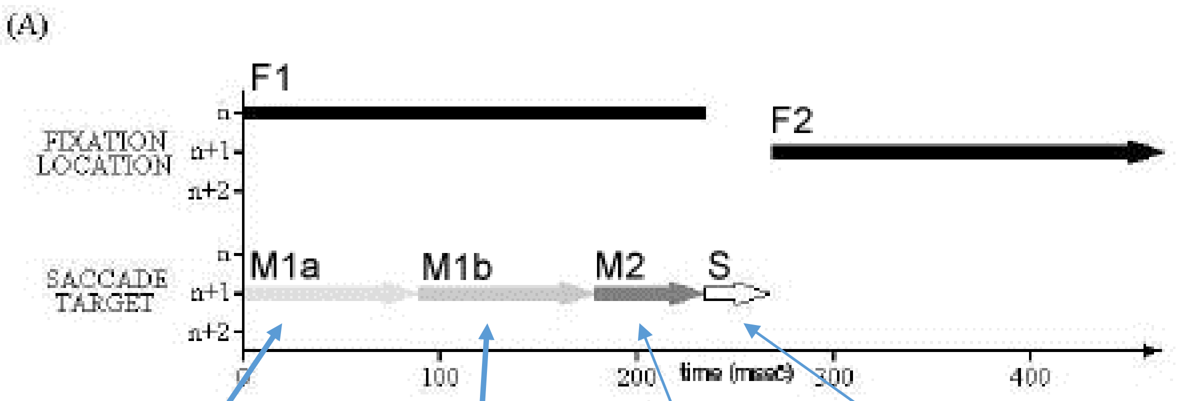
fixation_duration = $t(L_1) + t(L_2)$ {stochastic}

$$\text{ISL} + (\text{PSI-ISL}).*[(\text{OMEGA}_1-(\ln(\text{fixation\_duration}))) /\text{OMEGA}_2] + \text{normrnd}(0, \text{ETA}_1 + (\text{ETA}_2 .* \text{ISL}))$$

Saccade Movement Time

$t(S)$ = 25 msec (minimum saccade time)

Scenario A: Uneventful saccade update event

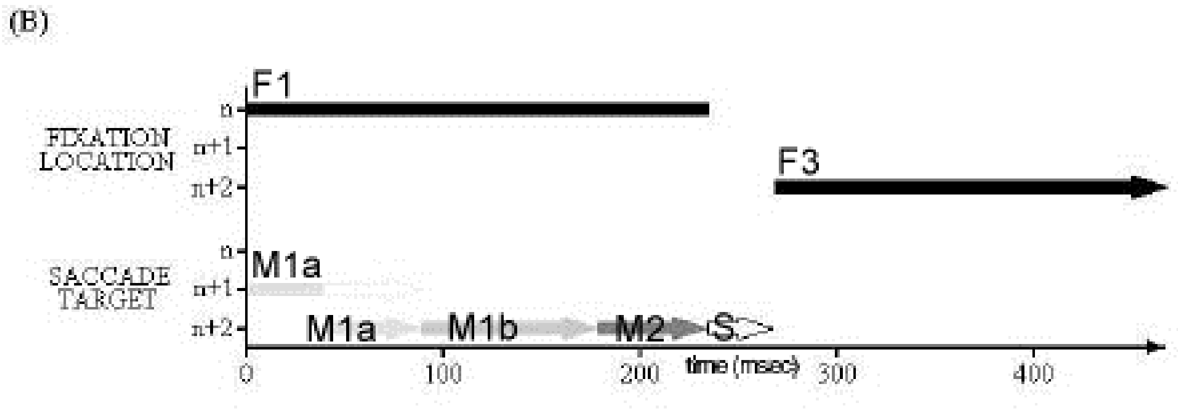


Oculomotor Alerting

Location coordinates to distance transform

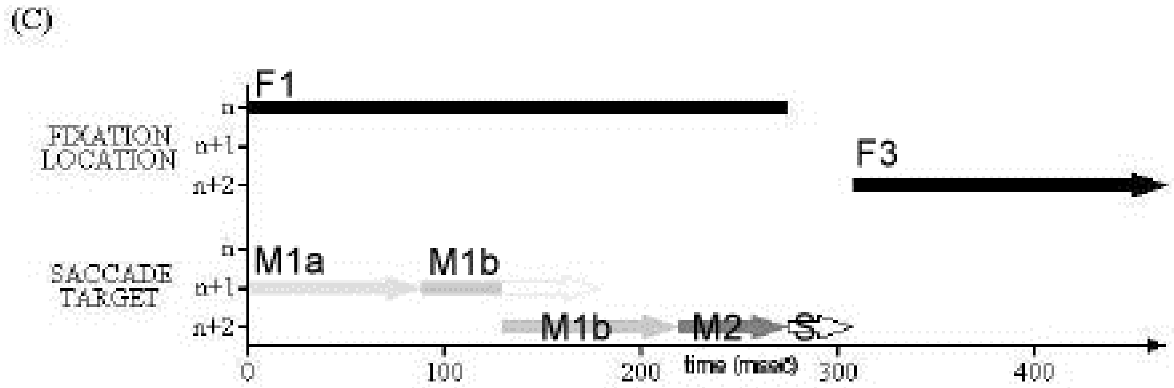
Non-Labile stage…Cannot be interrupted

saccade

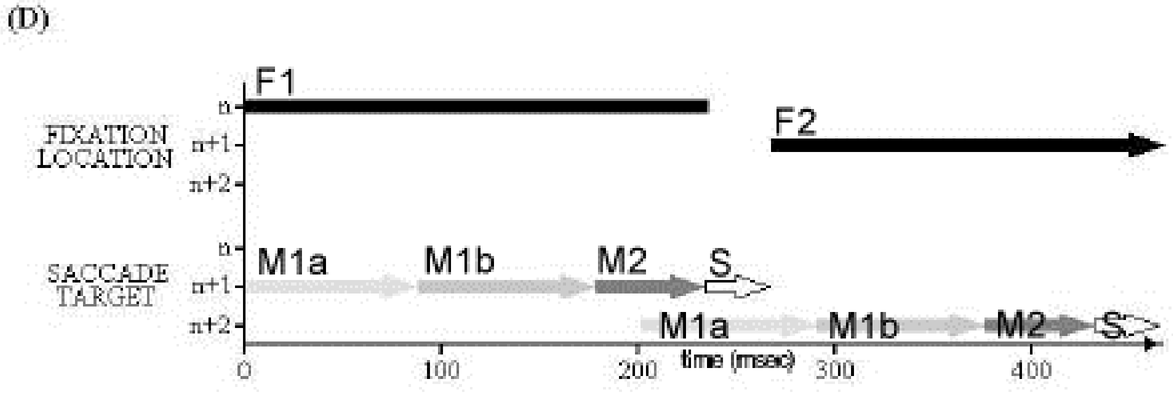


Word (n) is fixated.
Program to word (N+1) is initiated (by L1 trigger).
Shortly thereafter program to word (n+2) requested (parafoveal preview)
Program to word (n+1) is cancelled and programming to word (n+1) starts w/o benefit.
Saccade to word (n+2) is executed and word (n+1) is skipped.

Model predicts that word skipping is more likely when word (n+1) is high frequency, predictable and/or short.



Same as scenario B except that saccade (n+2) programming request comes during M1B phase. Hence, M1a oculomotor alerting benefit "inherited" by programming of saccade to word (n+2)….Freeing up addition processing resources.



No skipping of word (n+1) since request to program saccade to word (n+2) received during non-labile phase of saccade preparation for word (n+1). (The horse has already left the barn)…