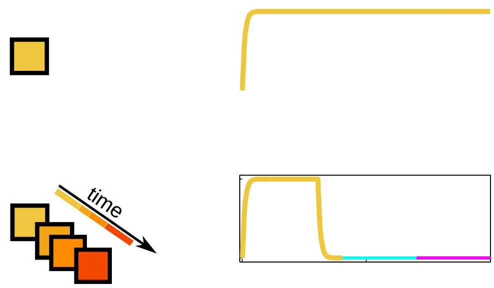
J C . . t Ne. ; ci (2015) 39:235 254
DOI 10.1007/ 10827-015-0574-4

2012). I. ;ta t , the te. ; a atte; f the ti. . . -

1 Va; iab e a d a; a. ete; ɏ ith thei; defa. t a. e

S . b	De c; i ti
Va; iab e	
I_j	E .te; a ti. . . f ; e .citat ; . ati j
u_j	N -di. e i a fi; i g; ate f e .citat ; . ati j (. a .i. . . $u_j = 1$)
v	N -di. e i a fi; i g; ate f g ba i hibit ; . ati (. a .i. . . $v = 1$)
p_j	Le e f faci itati f a e f; . . ati j (ba e i e $p_j = 1$)
w_{jk}, w	St; e gth f e .citati f; . . ati k t e .citat ; . ati j
T_j, T	D. ; ati f ti. . .
Ti. e a; a. ete; (defa. t a. e i a; e the i)	
τ	Ti. e ca e f e. ; a fi; i g (10 . [6])
τ_f	Ti. e ca e f h ; t te; . faci itati (1 [4])
τ_w	Ti. e ca e f ea; i g; . e (150 [1])
τ_a	Ti. e ca e f ada tati (400 . [5])
τ_s	Ti. e ca e f a tic i . t f; . the; . ati (50 . [6])
T_{cue}	D. ; ati f ti. . . t t; igge; ; e a (50 . [2,3])
D	De a i ; e a tic fi; i g affecti g c ecti betɏ ee . ati (30 . [1])
D'	De a i ; e a tic fi; i g affecti g c ecti ɏ ithi . ati (20 . [1])
Othe; a; a. ete; (defa. t a. e i a; e the i)	
ϕ	Fi; i g; ate; e e f. cti (Hea i ide te f. cti)
θ	Th; e h d f ; acti ati f e .citat ; . ati (0.5)
θ_v	Th; e h d f ; acti ati f i hibit ; . ati (0.5)
p_{max}	Ma .i. . . e e f h ; t te; . faci itati (2)
Z_k	St; e gth f e .citati f; . . ati k t i hibit ; . ati (0.3)
L	Weight f g ba i hibiti (0.6)
b	St; e gth f ada tati (1)
M	Lea; i g; . e th; e h d (1)
w_{max}	Ma .i. . . a ticɏ eight betɏ ee . ati (0.4852)
w'_{max}	Ma .i. . . a ticɏ eight ɏ ithi . ati (4.1312)
w_{min}	Mi i. . . a ticɏ eight ɏ ithi . ati (1.3488)
γ_d	St; e gth f LTD0 6.4598999 194.03999328 369.368985f h hh

a . . ti i. ified the a a i , b. t a t ece a


time

2.

T g. a; a tee that g te; . a ticit ead t a ; e; e c di g f e e t ti. e , it i ece a; that the ea; ed w eight, w_{21}^{∞} gi e b E . (6), . atche the de i; ed w eight $\mathcal{W}(T)$ gi e b E . (9). Thi ca be achie ed b e . ati g the ; ight ha d ide f E . (6) a d (9), that

*(*1

(Ke. te; et a . 1999; Pfi te; a d Ge; t e; 2006; C ath et a . 2010).

T de. t; ate h the ti. i g f e e t ca be e c ded i the et ; a; chitect. ; e, e ta; t ith t . ati (Fig. 2). D. ; i g t; ai i g, . ati 1 a ti. . ated f ; T_1 ec d f ed b ti. . ati f . ati 2 (Fig. 2a). The ti. . . a t; g e . gh t d . i ate the d a. - ic f the . ati ; e e (Secti 2). Whi e the fi; t ti. . . a ; e e t, . ati 1 a acti e a d LTD d . i ated, dec; ea i g the a tic eight, w_{21}, f; . . - ati 1 t . ati 2. Afte; T_1 ec d , the fi; t ti. . . e ded, a d the ec d . ati a acti ated. H e e;, . ati 1 did t bec . e i acti e i ta ta e . , a d f ; . e ti. e b th . ati 1 a d 2 e; e acti e. D. ; i g thi e; a i d , LTP d . i ated eadi g t a i c; ea e i a tic eight w_{21}. Sh ; t afte; . ati 1 beca. e i acti e, cha ge i the eight w_{21} cea ed, a a ticit cc. ; he the ; e a tic . ati i acti e. The i i- tia a d fi a a tic eight (w_{21}^0 a d w_{21}^1, ; e ecti e) ca be c . . ted i c ed f ; . (Secti 2). Re eated ; e e tati f the t; ai i g e . e ce ead t e. e - tia c e; ge ce f the a tic eight , w_{21}^i (eight afte; ith t; ai i g t; ia), t a fi ed a . e (Fig. 2b). O the the; ha d, the a tic eight w_{12} i ea e ed d. ; i g each t; ia beca e the ; e a tic . ati 2 i a a acti e afte; the t a tic . ati 1 (Secti 2). I the ca e f N . ati , each eight $w_{k+1,k}$ i c e; ge t a e; a . e a ciated ith T_k, he; ea a the; eight i bec . e eg igib e d. ; i g ; e a . Th , the et ; t; . ct. ; e e e t a e c de the ; de; f the e . e ce.

The d. ; ati f acti ati i . ati 1, T_1, dete; . i e the e . i ib; i . a . e f the a tic eight f; . . a- ti 1 t . ati 2, w_{21}^{∞} (Secti 2). F ; a; ge; a . e f T_1, LTD a t ge;, ea e i g w_{21} (Fig. 2c). He ce,

; ed a . echa i . f ; ti. e- ee i g (B. . a 2000; D. ; te it 2003; Re. ti. a et a . 2004; Ka; . a; a; a d B. . a 2007; Ga ; i et a . 2009). With . t . ch a ; ce , c. ed acti it . d ; e . t i a e . e ce ; e a ed i the ; e; ; de;, b. t i f ;. ati ab . t e e t ti. i g . d be t.

F ; i. icit e f c. t . ati , he; e acti -it f the fi; t . ati ; e ; e e t a ti. ed e e t (Fig. 3). T i. if the a a i , e a a . . ed that a tic eight a; e fi. ed d. ; i g ; e a . Thi a . . ti i t e e tia (Secti 4.4). Afte; . ati 1 i acti ated ith a b; ief c. e, it ; e. ai acti e d. e t ; ec. ;; e t e. citati (Secti 2

(. i g 20,000 i itia w^{0}). The a tic eight afte; the ith t; ai i g, w^{i}_{21}, i de c; ibed b a ; babi it de it f c-ti that c e; ge i the i. it f . a t; ai i g t; ia . The ea (. de) f thi di t; ib. ti i the . t i e a . e f the ea; ed a tic eight afte; ; e eated ; e e tati f the e . e ce (Fig. 5c). The a; ia ce f the ea; ed a-tic eight, w^{∞}_{21},

a e ; a ati , ca a the; e f a , ti e t; ac - i g ; ce (Be da a d He; 2003), i tead f h ; t te; faci itati . I c t; a t t the ca e f h ; t te; faci itati , ada tati ca e the effecti e i t f; e ati t dec; ea e e; ti e.

I thi ca e ati acti it a de ed b

$$
\begin{aligned}
\tau \frac{du_j}{dt} &= -u_j + \phi(w_{jj} u_j + s_j - \theta - Lv - a_j),\\
\tau_a \frac{da_j}{dt} &= -a_j + bu_j,\\
\tau_s \frac{ds_j}{dt} &= -s_j + \sum_{k \neq j}^{N} w_{jk} u_k,\\
\tau \frac{dv}{dt} &= -v + \phi\left(\sum_{k=1}^{N} Z_k u_k - \theta_v\right),
\end{aligned}
$$

he; e a_j de te the ada tati e e f ati j, τ_a i the ti e ca e f ada tati , a d b i the ada tati t; e gth. Feedbac bet ee ati a a ed t be e; tha feedbac ithi a ati ; th , the t ta i t f ; ati j a it i t e f-e citati $(w_{jj} u_j)$, a d a tic i t f; the; ati (s_j) hich e ed the ti e ca e τ_s. N te that i the i it $\tau_s \to 0$, a e a; e i ta ta e .

F ; a itab e ch ice f a; a ete; , g ba i hibiti t; ac acti it fa te; tha e citati bet ee ati . The , he a ati bec e i acti e d e t ada - tati , the e e f g ba i hibiti dec; ea e , a i g b e e t ati t bec e acti e. Thi ea the eight f e f e citati ca e c de ti i g. Th , i thi et e de ed g te; a ticit ithi a ati a e . The ea; i g; e f ; w_{jj} a a a g t w_{jk} ith the additi a a ti that i ce w_{jj} ; e ; e e ted the a tic eight ithi a ati , it c d t dec; ea e be a ce; tai a e w_{min}. A , the a; a ete; f ; g te; a ticit ithi a ati a; e a ed t be dif- fe; e t f; the a; a ete; f ; g te; a ticit bet ee ati .

The ea; i g; e a the

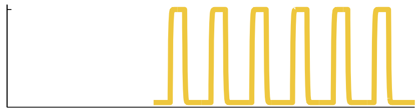
$$
\begin{aligned}
\tau_w \frac{dw_{jj}}{dt} &= -\gamma_d'(w_{jj} - w_{min}) u_j(t - D')(1 - u_j(t))\\
&\quad -\gamma_p'(w_{jj} - w_{max}') u_j(t - D') u_j(t).
\end{aligned}
$$

Whe the ati a acti ated $(u_1(t) \approx 1)$ f ; $t \in [0, T_1]$ (Fig. 7a), the cha ge i the eight w_{11} e; e g e; ed b the iece i e diffe; e tia e ati

$$
\frac{dw_{11}}{dt} = \begin{cases} 0, & t \notin [D', T_1 + D'] \\ \dfrac{\gamma_p'}{\tau_w}(w_{max}' - w_{11}) & t \in [D', T_1] \\ -\dfrac{\gamma_d'}{\tau_w}(w_{11} - w_{min}) & t \in [T_1, T_1 + D']. \end{cases}
$$

The f i g e ati ; e ate the a tic eight at the e d f a ; e e tati , $w_{11}(T_{tot})$, t the a tic eight at the begi i g f the ; e e tati , $w_{11}(0)$:

$$
\begin{aligned}
w_{11}(T_{tot}) &= w_{11}(0) e^{-T_1 \gamma_p' / \tau_w} e^{(\gamma_p' - \gamma_d') D' / \tau_w}\\
&\quad + w_{max}' e^{-D' \gamma_d' / \tau_w} (1 - e^{-(T}
\end{aligned}
$$



Thi ea i g ce i di ti ct f the a ach t i ed i (B a a d Maa 2009; He e i et a . 2014), i ce it e t ai the ec e t a chitect e bet ee - ati e c di g ti e; t i g f a d t ea ead t i ece a .

.4 f y²

The e i a a ge et f a a ete f hich the et ca

t cc. ; . Thi a . . e the; e i . e e .te; a ig a i di-
cati g h ; acc. ; ate the e . e ce i bei g ; e a ed. F ;
i ta ce, h . . a e; f ; . a ce f a iece f . . ic ; e ie

F . ; ca. d-T; c. e, N., Ha e , D., Va V; ee ij , C., & B; . e , N. (2003). H i e ge e; ati . echa i . dete; . i e the e. - ; a ; e e t f . ct. ati g i . t . *The Journal of Neuroscience*, *23*(37), 11,628 11,640.

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