DETAILS OF TRANSITION FROM EQUATION 12 TO EQUATION 13

Starting with equation 12 (equation 8 in the previous manuscript):

$$M = Max_{(t \in t_r, t_r+\varepsilon))}[(a_{EC}^{(c)})^T a_{CA1}(t) - (a_{EC}^{(n)})^T a_{CA1}(t)] \quad (12)$$

Move comparison vectors together:

$$M = Max_{(t \in t_r, t_r+\varepsilon))}[(a_{EC}^{(c)})^T - (a_{EC}^{(n)})^T] a_{CA1}(t)$$

Insert equation 11:

$$M = Max_{(t \in r, r+\varepsilon)}[(a_{EC}^{(c)})^T - (a_{EC}^{(n)})^T]$$
$$[\theta_{EC}(t) a_{EC}^{(r)} + \theta_{CA3}(t)(W_{CA3}(t_c)) a_{CA3}^{(r)}]$$

Insert equations 8, 9 and 10:

$$M = Max_{(t \in r, r+\varepsilon)}[(a_{EC}^{(c)})^T - (a_{EC}^{(n)})^T][\theta_{EC}(t) a_{EC}^{(r)} + \theta_{CA3}(t)\{K a_{EC}^{(n)} a_{CA3}^{(n)\,T} +$$
$$\sum_{k=n+1}^{n+e} \int_{t_k}^{t_{k+1}} \theta_{LTP}(t)[\theta_{CA3}(t) W_{CA3}(t_k) a_{CA3}^{(e)}] a_{CA3}^{(e)\,T} dt + \sum_{k=n+e+1}^{n+e+c} \int_{t_k}^{t_{k+1}} \theta_{LTP}(t)[\theta_{EC}(t) a_{EC}^{(c)} + \theta_{CA3}(t) W_{CA3}(t_k) a_{CA3}^{(c)}] a_{CA3}^{(c)\,T} dt\} a_{CA3}^{(r)}]$$

To simplify things further, we will consider retrieval after a single error trial and a single correct trial. This allows removal of the summation signs, and use of the time points at the end of the error trial te and at the end of the correct trial tc described above. In addition, this allows us to drop the spread of activity across previously modified synapses during the correct trials because $W_{CA3}(t_n) a_{CA3}^{(c)} = k a_{EC}^{(n)} a_{CA3}^{(n)\,T} a_{CA3}^{(c)} = 0$. We now distribute the multiplier for presynaptic activity on the retrieval trial $a_{CA3}^{(r)}$ and move the constant portions out of the integrals:

$$M = Max_{(t\in t_r, t_r+\varepsilon))}[(a_{EC}^{(c)})^T - (a_{EC}^{(n)})^T][\theta_{EC}(t) a_{EC}^{(r)} + \theta_{CA3}(t)\{K a_{EC}^{(n)} a_{CA3}^{(n)\,T} a_{CA3}^{(r)} +$$

$$\int_{t_n}^{t_{n+e}} \theta_{LTP}(t)[\theta_{CA3}(t)]dt(W_{CA3}(t_n) a_{CA3}^{(e)} a_{CA3}^{(e)\,T} a_{CA3}^{(r)}) + \int_{t_{n+e}}^{t_{n+e+c}} \theta_{LTP}(t)[\theta_{EC}(t)]dt(a_{EC}^{(c)} a_{CA3}^{(c)\,T} a_{CA3}^{(r)})\}]$$

Distribute the comparison entorhinal input for left and right food reward, and replace the matrix $W_{CA3}(t_n) = K a_{EC}^{(n)} a_{CA3}^{(n)\,T}$:

$$M = Max_{(t\in t_r, t_r+\varepsilon))}[\theta_{EC}(t)(a_{EC}^{(c)})^T a_{EC}^{(r)} + \theta_{CA3}(t)\{K(a_{EC}^{(c)})^T a_{EC}^{(n)} a_{CA3}^{(n)\,T} a_{CA3}^{(r)} +$$

$$\int_{t_n}^{t_{n+e}} \theta_{LTP}(t)[\theta_{CA3}(t)]dt(a_{EC}^{(c)})^T (K a_{EC}^{(n)} a_{CA3}^{(n)\,T}) a_{CA3}^{(e)} a_{CA3}^{(e)\,T} a_{CA3}^{(r)}) + \int_{t_{n+ee}}^{t_{n+e+c}} \theta_{LTP}(t)[\theta_{EC}(t)]dt((a_{EC}^{(c)})^T a_{EC}^{(c)} a_{CA3}^{(c)\,T} a_{CA3}^{(r)})\}] -$$

$$[\theta_{EC}(t)(a_{EC}^{(n)})^T a_{EC}^{(r)} + \theta_{CA3}(t)\{K(a_{EC}^{(n)})^T a_{EC}^{(n)} a_{CA3}^{(n)\,T} a_{CA3}^{(r)} +$$

$$\int_{t_n}^{t_{n+e}} \theta_{LTP}(t)[\theta_{CA3}(t)]dt((a_{EC}^{(n)})^T (K a_{EC}^{(n)} a_{CA3}^{(n)\,T}) a_{CA3}^{(e)} a_{CA3}^{(e)\,T} a_{CA3}^{(r)}) + \int_{t_{n+e}}^{t_{n+e+c}} \theta_{LTP}(t)[\theta_{EC}(t)]dt((a_{EC}^{(n)})^T a_{EC}^{(c)} a_{CA3}^{(c)\,T} a_{CA3}^{(r)})\}]$$

Apply assumptions from the paragraph after equation 12:

$$M = Max_{(t\in r, r+\varepsilon)}[\theta_{EC}(t)(0) + \theta_{CA3}(t)\{K(0)(1) +$$

$$\int_{t_n}^{t_e} \theta_{LTP}(t)[\theta_{CA3}(t)]dt K(0)(1)(1) + \int_{t_e}^{t_c} \theta_{LTP}(t)[\theta_{EC}(t)]dt((1)(1))\}] -$$

$$[\theta_{EC}(t)(0) + \theta_{CA3}(t)\{K(1)(1) +$$

$$\int_{t_n}^{t_e} \theta_{LTP}(t)[\theta_{CA3}(t)]dt((1)(1)(1)) + \int_{t_e}^{t_c} \theta_{LTP}(t)[\theta_{EC}(t)]dt((0)(1))\}]$$

Remove the zeros:

$$M = Max_{(t\in r, r+\varepsilon)}[\theta_{CA3}(t)\{\int_{t_e}^{t_c} \theta_{LTP}(t)[\theta_{EC}(t)]dt\}]$$

$$-[\theta_{CA3}(t)\{K + \int_{t_n}^{t_e} \theta_{LTP}(t)[\theta_{CA3}(t)]dt\}]$$

These assumptions allow the performance measure to be reduced to an interaction of the oscillatory terms.

$$M = Max_{(t \in t_r, t_r + \varepsilon))}[\theta_{CA3}(t)\{\int_{t_{n+e}}^{t_{n+e+c}} \theta_{LTP}(t)\theta_{EC}(t)dt - K - \int_{t_n}^{t_{n+e}} \theta_{LTP}(t)\theta_{CA3}(t)dt\}] \quad (13)$$