Supplementary Note on "A Spiking Neuron Model of Cortical Broadcast and Competition"

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February 2007

In Shanahan (2007), a computer model of cortical broadcast and competition based on spiking neurons is presented in order to reify the hypothesis of a global neuronal workspace underlying conscious information processing in the brain. Over a course of 36 trials, the model exhibited a series of broadcast states, each of which was sustained for a short period through reverberation before being succeeded by the next state. The model incorporated a competitive mechanism for determining successor states based on mutual inhibition between rival cortical populations.

The purpose of the present note is to present the results of a further set of 36 trials using a modified parameter set. The results are notably better than those presented in Shanahan (2007), but the trials were carried out too late for inclusion in the original article. The experimental setup is exactly as described in Section 4 of Shanahan (2007) except in the following respects. First, levels of both excitation and inhibition between workspace nodes have been increased (F_{WW}, F_{WI}, and F_{IW}). Second, the level of mutual inhibition between competing cortical populations has been increased (F_{CL} and F_{LC}). The modified scaling factors are shown in Table 1. Third, while in the first set of experiments the input current to a neuron was never allowed to become negative, in the new experiments negative input currents are allowed, although these are limited to –5mA.

Table 1: Modified Parameters of the Model

F_{WC}	40
F_{AW}	90
F_{WW}	90
F_{CC}	3
F_{CL}	30
F_{LC}	300

F_{WI}	4.5
F_{IW}	4.5
F_{AC}	90
F_{CA}	90
F_{LL}	90

Key to parameters

$F_{\alpha\beta}$ = scaling factor applied to connections from area type α to area type β

W = workspace area
I = workspace inhibitory pool
C = cortical column
L = lateral inhibitory pool
A = workspace access area

The general pattern of behaviour exhibited by the model is as described in the original paper. However, the new results differ significantly in their details, and a number of anomalies have disappeared. First, it is now clear that, with the original parameters, reverberation was quite limited, and that workspace states tended to fade even without the inhibitory effect caused by the arrival of a new pattern of activation. By contrast, in the new experiments the reverberatory effect is strong, with broadcast patterns being sustained over longer periods and only fading as a direct result of the arrival in the workspace of a new pattern.

Second, in each of the trials in the original experiments, whenever two patterns competed for access to the workspace, one pattern's victory over the other was only ever temporary, with the initially losing pattern invariably making a later appearance to take over the workspace. By contrast, the present set of trials includes several examples of one pattern shutting out its rival so completely that the latter never has any significant influence over the workspace, which shows the

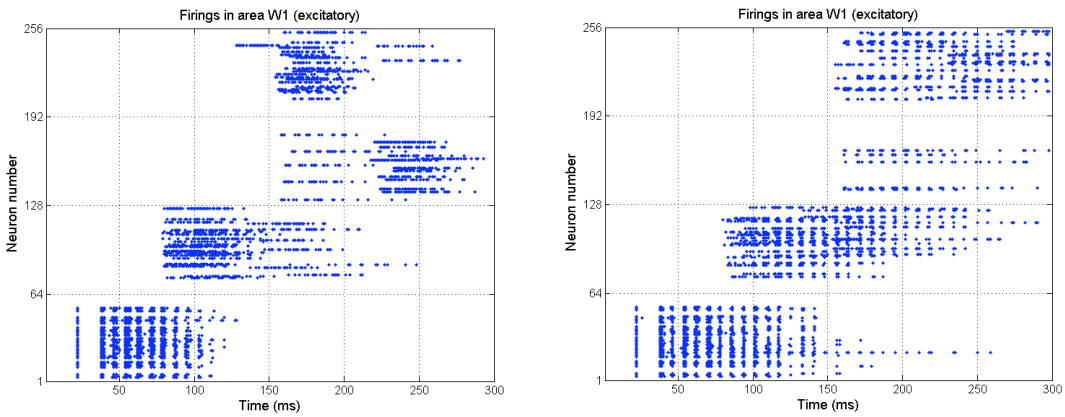

Fig. 1: A representative trial (no.1) using the original parameters (left), and a comparable trial (no.9) using the modified parameters (right). The right-hand plot exhibits stronger reverberation, does not show a resurgence of the initially losing pattern (in neurons 129–192), and has more bands of synchronous firing.

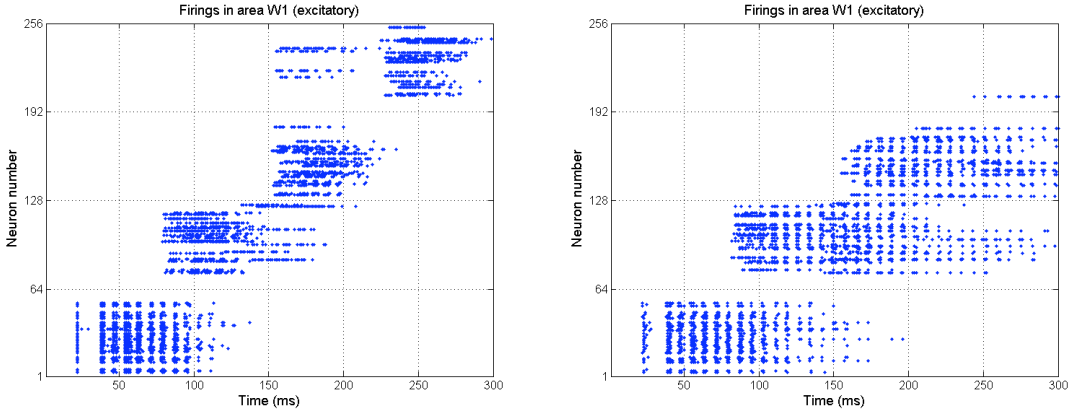

Fig. 2: Another representative trial (no.16) using the original parameters (left), and a comparable trial (no.6) using the modified parameters (right). In both cases the pattern in neurons 129–192 initially wins out over that in 193–256. But with the original parameters the second pattern makes a late reappearance, whereas with the new parameters it has negligible influence.

competitive mechanism working more effectively.

Figures 1 and 2 show the evolution of workspace area W1 during two trials from the original set of experiments set alongside two comparable trials with the modified parameter set. A third difference between the results is also visible in these plots. The pronounced vertical banding in the right-hand plots is characteristic of the later experiments, and shows a large degree of synchronous firing. It is conjectured that this is an artefact of the regular structure of the model's interconnections between workspace areas, something which promotes rhythmic activity in the context of strong reverberation.

Reference

Shanahan, M.P. (2007). A Spiking Neuron Model of Cortical Broadcast and Competition. *Consciousness and Cognition*. In press.