RESULTS

Artificial Neural Network with RBM and CSD

The ANN, which was trained with the examples, preprocessed using the RBM and CSD methods to identify activations, performed well when trained with both staged and non-staged training. The staged training, however, produced better results than the non-staged training when tested with the identical set of 200 unseen test examples.

When trained with staged training, the ANN generated a SE of less than 0.25 for all of the test examples. The SEs for the test examples, which were generated from the ANN using RBM and CSD data and trained with staged training, are shown graphically in Figure 11a. When the ANN was trained using non-staged training, the error rate was slightly higher. Figure 11b. displays the SEs for the test examples when the ANN was trained with non-staged training.

Since the SE for each test example was less than 0.25 when staged training was used, the 200 unseen test examples were all considered to have been classified correctly as activations or not activations. With non-staged training, the examples that were not activations were again accurately identified, but only 97 of the 100 activation examples were correctly classified. Table 3. shows the classification results for the ANN with RBM and CSD data for both staged and non-staged training.

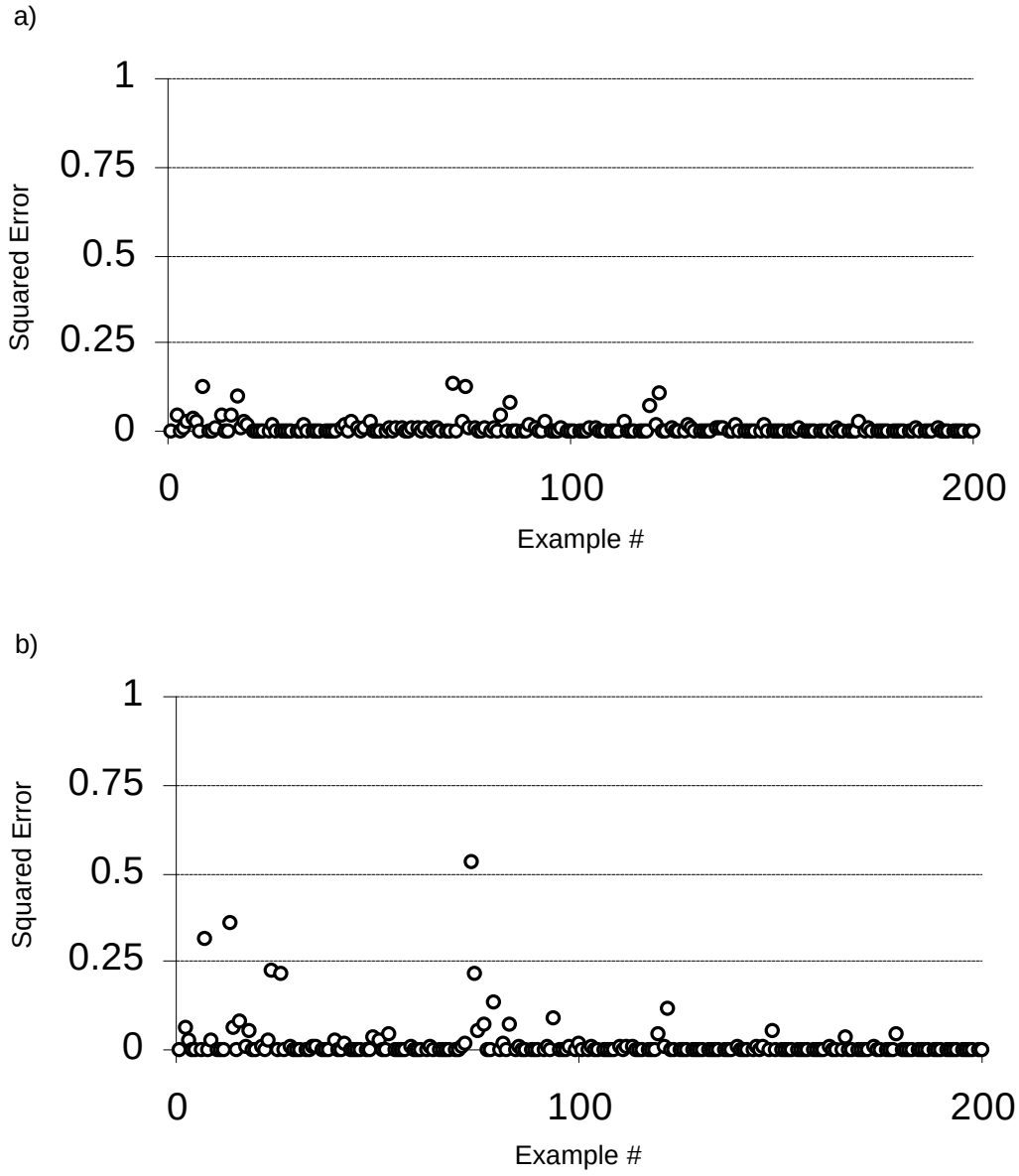

Figure 11. Squared error on unseen test examples after training the artificial neural network that incorporated RBM and CSD data only. The examples numbered 1 to 100 are activations. Examples from 101 to 200 are not activations. a) Squared error on test examples after staged training. b) Squared error on test examples after non-staged training.

Table 3. Classification results for the artificial neural network using RBM and CSD data. The number and percentages of the 200 unseen test examples that were correctly classified for examples that were activations and examples that were not activations.

		Staged Training	Non-staged Training
Class	**# in Class**	**# Correctly Classified**	**# Correctly Classified**
Activation	100	100	97
Not Activation	100	100	100
Total	200	200	197

To further evaluate the performance of the ANN using RBM and CSD data, the Sensitivity and +P for both classes of examples, activations and not activations, were determined. The Sensitivity and +P for both classes of examples was 100.0 % when staged training was used. When the ANN was trained using non-staged training, the Sensitivity dropped to 97.0 % for examples that were activations. The examples that were not activations had a Sensitivity of 100.0 %. The +P of the activation class was 100.0 % and the +P for examples that were not activations was 97.1 %.

Table 4. Sensitivity and Positive Predictiveness (+P) for the artificial neural network using RBM and CSD data.

	Staged Training		Non-Staged Training	
Class	**Sensitivity**	**+P**	**Sensitivity**	**+P**
Activation	100.0 %	100.0 %	97.0 %	100.0 %
Not Activation	100.0 %	100.0 %	100.0 %	97.1%

Artificial Neural Network with RBM, CSD, and TCM

The ANN that incorporated RBM, CSD, and TCM data in the input examples was also able to distinguish examples that were activations from examples that were not activations. This ANN with the additional 23 inputs for TCM data also generated superior results when staged training was used.

After the ANN was trained using staged training, 96 of the 100 unseen test examples that represented activations had a SE less than 0.25. All of the examples that were not activations generated errors below 0.25. When the ANN was trained with non-staged training, 95 of the activation examples had SE smaller than 0.25 and the examples that did not represent activations showed very low errors. The results of testing the ANN that incorporated RBM, CSD, and TCM data for both staged and non-staged training are shown in Figure 12. A summary of the SE results shown graphically in Figure 11 for the ANN with RBM and CSD data and Figure 12 for the ANN using RBM, CSD, and TCM data is provided in Table 5.

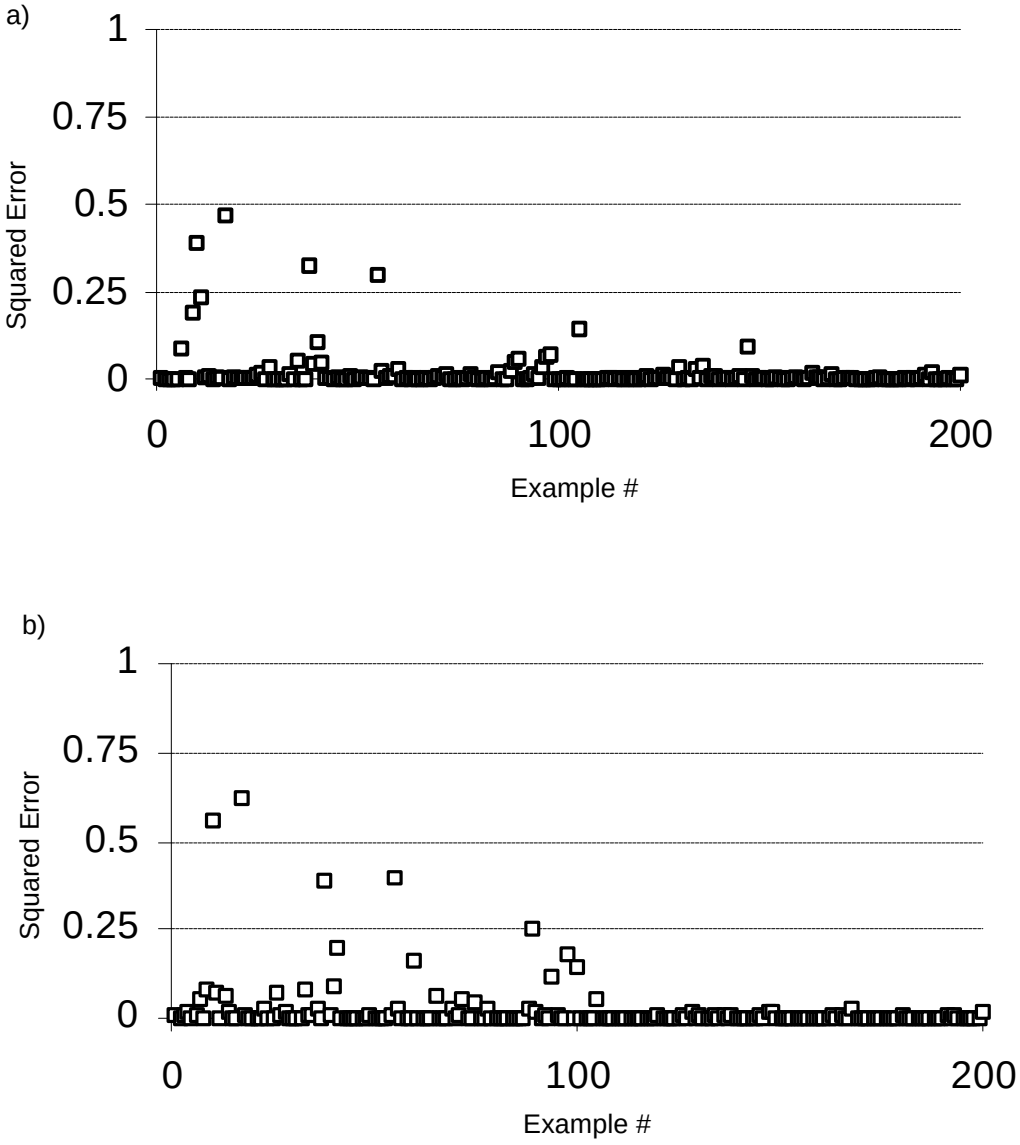

Figure 12. Squared error on unseen test examples after training the artificial neural network that included RBM, CSD, and TCM data. The examples numbered 1 to 100 represent activations, and the examples 101 to 200 are not activations.
a) Squared error on test examples after staged training. b) Squared error on test examples after non-staged training.

Table 5. Squared error results from testing the artificial neural networks with 200 unseen test examples.

Artificial Neural Network	Staged Training # of examples SE < 0.1	Staged Training # of examples SE < 0.25	Non-staged Training # of examples SE < 0.1	Non-staged Training # of examples SE < 0.25
ANN using RBM and CSD	195	200	191	197
ANN using RBM, CSD, and TCM	192	196	190	195

The classification results for the ANN using RBM, CSD, and TCM data are shown in Table 6. Only the unseen test examples that generated a SE greater than 0.25 were considered to have been misclassified. Test examples for which the ANN produced a SE less than 0.25 were classified correctly as activations or not activations.

Table 6. Classification results for the artificial neural network using RBM, CSD, and TCM data. The number and percentages of the 200 unseen test examples that were correctly classified for examples that were activations and examples that were not activations.

		Staged Training	Non-staged Training
Class	**# in Class**	**# Correctly Classified**	**# Correctly Classified**
Activation	100	96	95
Not Activation	100	100	100
Total	200	196	195

The Sensitivity and +P were also calculated for the ANN using RBM, CSD, and TCM data. The Sensitivity for examples that were activations was 96.0 % when staged training was utilized and decreased to 95.0 % with non-staged training. The Sensitivity for examples that did not represent activations was 100.0 % for both staged and non-staged training. The +P for the activation class was also 100.0 % when the ANN was trained with either staged or non-staged training. Finally, the +P for examples that were not activations was 96.2 % with staged training and 95.2 % with non-staged training. Table 7. summarizes the Sensitivity and +P results for the ANN using RBM, CSD, and TCM data.

Table 7. Sensitivity and Positive Predictiveness (+P) for the artificial neural network using RBM, CSD, and TCM data.

	Staged Training		**Non-Staged Training**	
Class	**Sensitivity**	**+P**	**Sensitivity**	**+P**
Activation	96.0 %	100.0 %	95.0 %	100.0 %
Not Activation	100.0 %	96.2 %	100.0 %	95.2 %