



# Estimating Cognitive Performance in One Minute

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## Objektive

To develop a shorter, more sensitive, and more specific dementia screening tool, which allows to predict the Mini-Mental Status Examination score (MMSE) with just three questions. This is achieved by multiplying each question outcome with a weighting factor, which was calculated with artificial neural networks (ANN).

$$\text{MMSE prediction} = 11.28 + \text{weekday} * 3.509 + \text{year} * 3.64 + \text{spell} * 1.907$$

## Methodology

Artificial Neural network model: We tried to find a mathematical model to predict the MMSE-score with only few questions. In order to identify and test a subset of variables which can predict the MMSE-score with high accuracy, an approach with artificial neural networks was used. As it is pointed out by Bishop et al, 2000, it is crucial not only to find a statistical model which performs well with given data, but to find a reliable model which performs well in new previously unseen data (generalization of the model to new data). For doing so Bishop et al, (Bishop, 2000) recommends a split of data into a learning, verification and test sample with ratio 2:1:1 which is based on random numbers generated by a computer. In the learning sample, linear networks, radial based neuronal networks and three-layer perceptron networks with different network architectures were constructed (Bishop, 2000). Finally, the performance of the network is analyzed by using data of the independent test sample solely. All statistical analyses were done by using STATISTICA 10.0 (Hill, 2007) and MATHEMATICA 7.0 (Wolfram Research, 2008). The neural networks were designed and tested by using STATISTICA Neural Networks. The prediction with only three items works quite precise (Fig 1.), taking into account the very short and reduced screening.

Tab. 1

Classification	MMSE<25/30		MMSE<24/30		MMSE+CERAD	
	Sensitivity	Specificity	Sensitivity	Specificity	Sensitivity	Specificity
SDTP<25	.94	.68	.97	.62	.96	.7
SDTP<24	.82	.9	.87	.86	.83	.91
8-item	.97	.41	.98	.37	.97	.4
Chandler	.75	.7	.75	.64	.77	.73

Tab 1. Comparison of different screenings and cut-offs. Only the SDTP reaches a high specificity and an acceptable specificity.

## Results

A linear based neural network was finally selected with three independent predictor variables. The prediction error was less than or equal to three units in 83% and less than or equal to four in 91%. The Salzburg Dementia Test Prediction (SDTP) had a sensitivity of 94% (95% CI: 87%-97%) for classifying dementia correctly (Tab 1.) if only the MMSE was used for classification and 96% if the whole test battery (Consortium to Establish a Registry for Alzheimer's Disease (CERAD), MMSE) was used for classification. The specificity was 68% (95% CI: 57%-77%) if the MMSE was used and 70% if the whole test battery (MMSE + CERAD) was used for dementia classification.

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## Conclusion

The Salzburg Dementia Test Prediction is a one minute dementia screening, convenient for cognitive assessment on bedside or in the office setting. The biggest advantage of the SDTP compared to other short screenings is very high sensitivity and better specificity. The psychometrics are convincing, given the high sensitivity and specificity, thus allowing well directed planning of diagnostic and therapeutic strategies.

Fig. 1

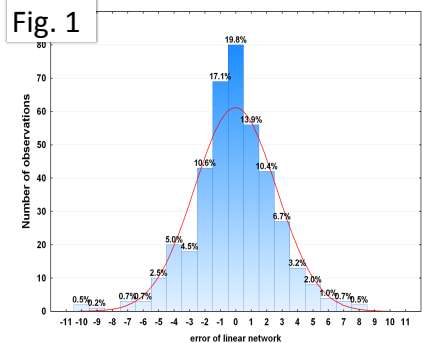


Figure 1. Prediction error of the SDTP. 50.8% are predicted with only one point deviation, 71.8% with maximal two point deviation.

Tab. 2

SALZBURG DEMENTIA TEST PREDICTION			
1) Weekday: exact without hints			
2) Year: exact including millennium (you were born in 19xx, and now we have?)			
3) Three attempts RADIO backwards (best trial counts, transpositions of letters count as one point (e.g.: ODAR = 4, ODAR = 4, IODAR = 4, ODIRA = 3, ORADIO = 1))			
1) weekday: one point	2) year: one point	3) radio: 5 points	predicted MMSE
weekday: right	year: right	spelling: 5/5	28
weekday: right	year: right	spelling: 4/5	26
weekday: right	year: right	spelling: 3/5	24
weekday: right	year: right	spelling: 2/5	22
weekday: right	year: right	spelling: 1/5	20
weekday: right	year: right	spelling: 0/5	18
weekday: wrong	year: right	spelling: 5/5	24
weekday: wrong	year: right	spelling: 4/5	23
weekday: wrong	year: right	spelling: 3/5	21
weekday: wrong	year: right	spelling: 2/5	19
weekday: wrong	year: right	spelling: 1/5	17
weekday: wrong	year: right	spelling: 0/5	15
weekday: right	year: wrong	spelling: 5/5	24
weekday: right	year: wrong	spelling: 4/5	22
weekday: right	year: wrong	spelling: 3/5	21
weekday: right	year: wrong	spelling: 2/5	19
weekday: right	year: wrong	spelling: 1/5	17
weekday: right	year: wrong	spelling: 0/5	15
weekday: wrong	year: wrong	spelling: 5/5	21
weekday: wrong	year: wrong	spelling: 4/5	19
weekday: wrong	year: wrong	spelling: 3/5	17
weekday: wrong	year: wrong	spelling: 2/5	15
weekday: wrong	year: wrong	spelling: 1/5	13
weekday: wrong	year: wrong	spelling: 0/5	11
> 25 no dementia			
18-24 possible mild dementia			
8-17 possible moderate dementia			