Careless responses in questionnaire data: A knowledge structure perspective on the detection performance

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Indices

The following indices have been considered:

- Consistency indices
  - **Even odd consistency**: Pearson correlation between the even and odd items
- Response pattern indices
  - **Longstring index**: sequence of consecutive responses in the same response category of maximal length
  - **Individual response variabaility**: standard deviation of consecutive responses
- Outlier indices
  - **Mahalanobis distance**: distance between the response vector and the mean
- KST-based indices
  - **Minimal distance**: minimal symmetric set difference between the response pattern and the knowledge structure
  - **Low probability index**: the probability distribution on the response patterns is determined by the BLIM functions

Methods

Item Tree Analysis was applied to the data of the 1999 normative sample of the **Freiburg Personality Inventory** (Fahrenberg, 2010) for 20 Items of the subscales irritability (Erregbarkeit) and aggressiveness (Aggressivität). **Three different quasi ordinal knowledge spaces** ($|\mathcal{K}_1| = 40960, |\mathcal{K}_2| = 18720, |\mathcal{K}_3| = 3510$) were derived.

Knowledge states and response patterns were simulated for attentive and inattentive participants in different conditions:

- attentive responses: response error probabilities $\beta_q, \eta_q \in [0.05, 0.15]$
- random careless responses: response error probabilities $\beta_q, \eta_q \in [0.35, 0.45]$
- non-random careless responses: responses were replaced by zeros or ones

The number of careless responders and the extent of their carelessness were varied for sample sizes of 3000 and 10000 participants. The following table shows the percentage of careless responses:

		participants		
		5%	**20%**	**50%**
items	**25%**	1.25%	5%	12.5%
	50%	2.5%	10%	25%
	100%	5%	20%	50%

Signal detection theory was used to evaluate the performance of the indices. Receiver operating characteristic (ROC) curves were determined and the **Youden's index** (maximal sum of sensitivity and specificity) was used as a cut off value for classifying the response patterns as attentive and inattentive, respectively.

References

Fahrenberg, J. (2010). Freiburger Persönlichkeitsinventar FPI-R. Primärdaten der Normierungsstichprobe 1999. Trier: Psychologisches Datenarchiv PsychData des Leibniz-Zentrums für Psychologische Information und Dokumentation ZPID.

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Robin, X., Turck, N., Hainard, A., Tiberti, N., Lisacek, F., Sanchez, J.-C., and Müller, M. (2011). proc: an open-source package for r and s+ to analyze and compare roc curves. *BMC Bioinformatics*, 12:77.

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Results

The total number of participants and the specific knowledge space did not influence the results systematically. Therefore in the following part the results are presented for the quasi ordinal knowledge structure $\mathcal{K}_3$ with a sample of 10000 simulated participants:

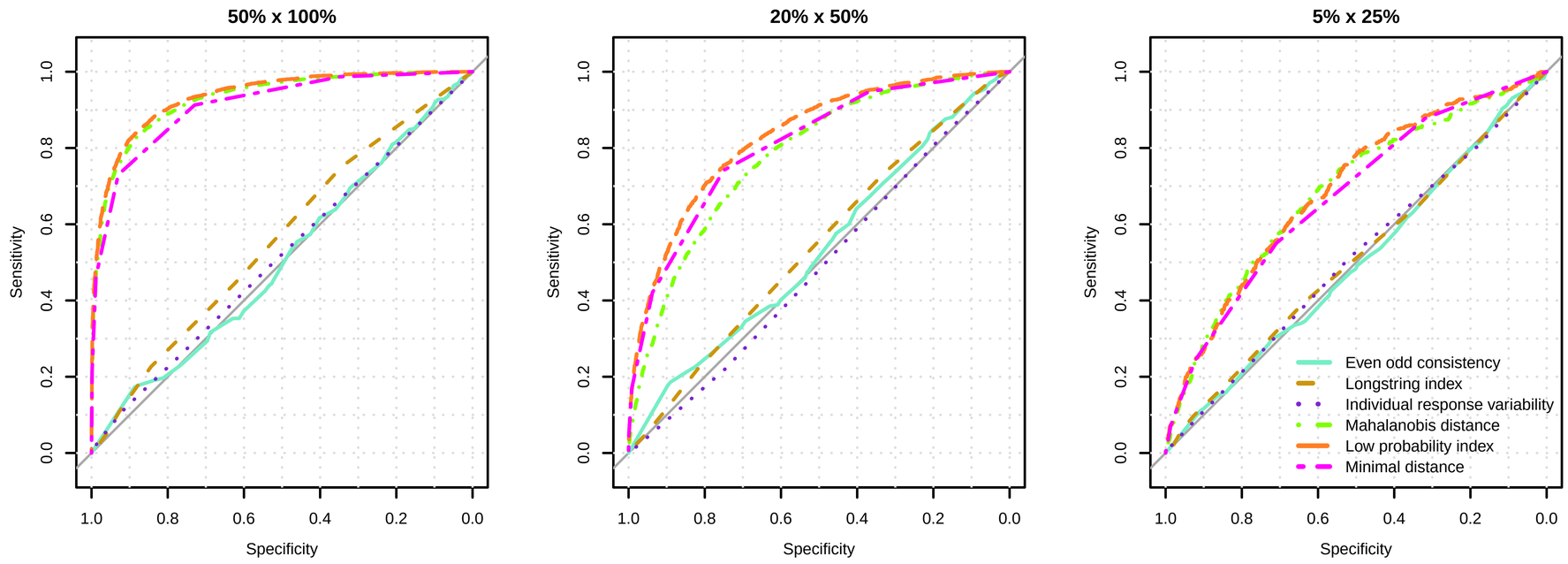

Figure 1: ROC curves of all indices for the conditions $50\% \times 100\%$, $20\% \times 50\%$ and $5\% \times 25\%$ (left to right) and **random** careless responses.

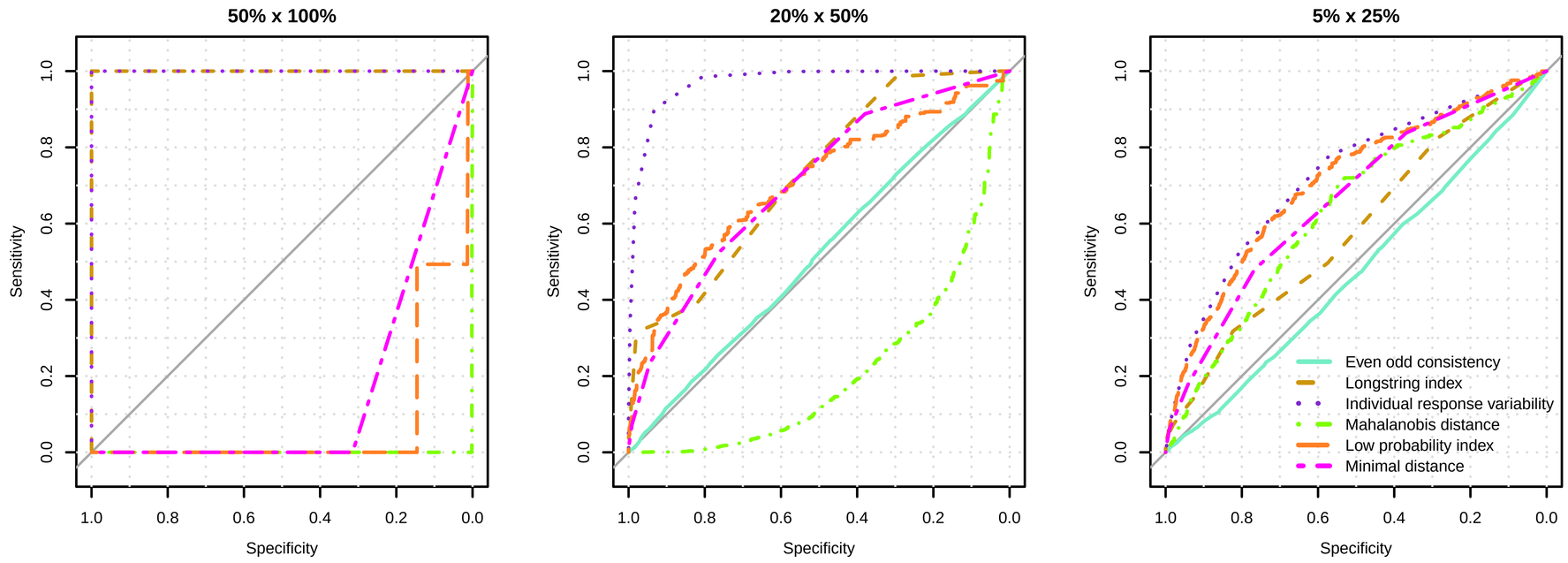

Figure 2: ROC curves of all indices for the conditions $50\% \times 100\%$, $20\% \times 50\%$ and $5\% \times 25\%$ (left to right) and **non-random** careless responses.

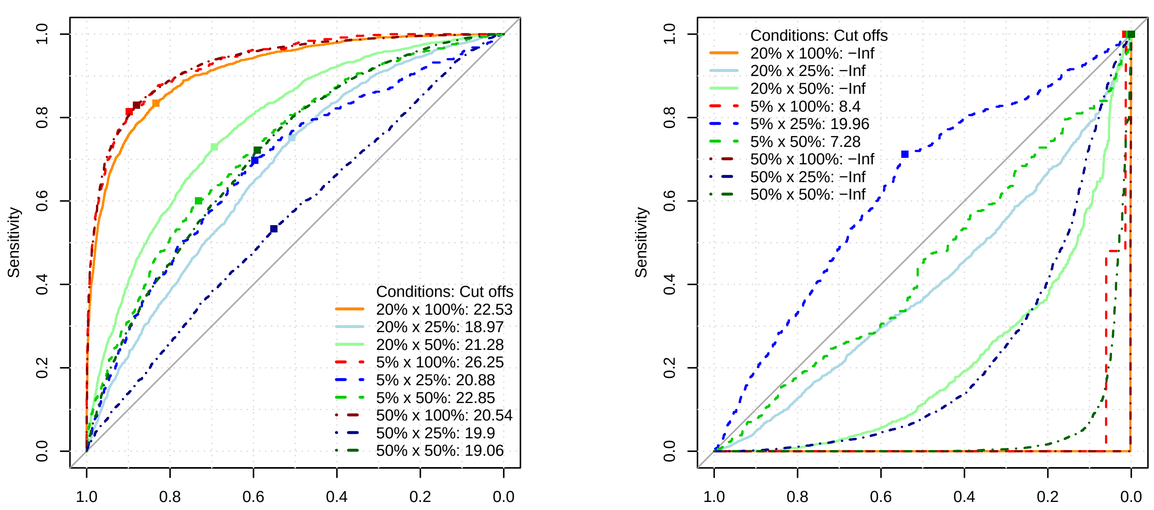

Figure 3: ROC curves of Mahalanobis distance for all 9 conditions showing results for **random (left)** and **non-random careless responses (right)**.

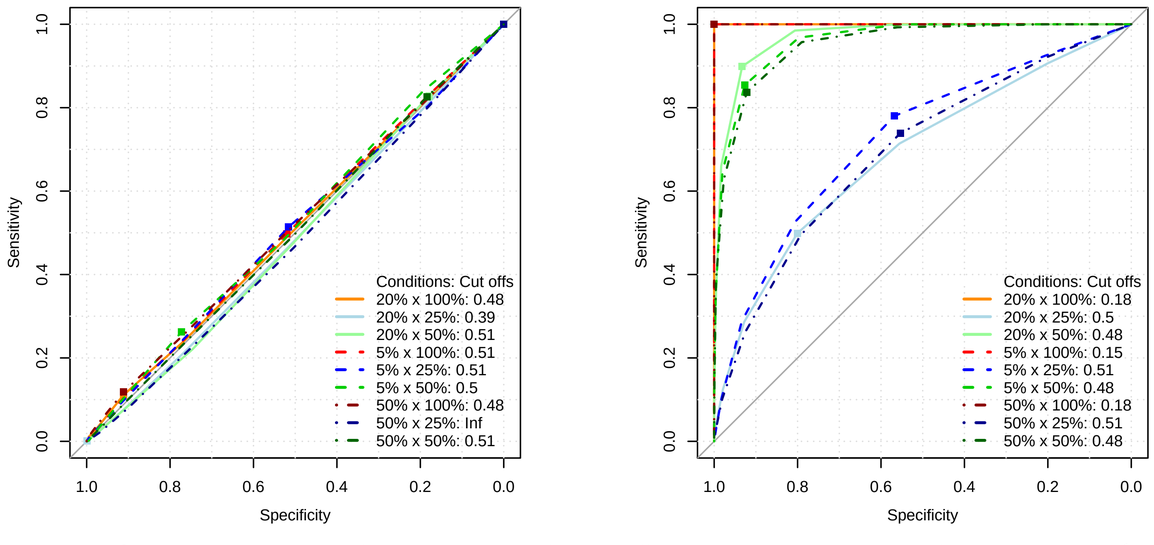

Figure 4: ROC curves of individual response variability for all 9 conditions showing results for **random (left)** and **non-random careless responses (right)**.

Future research

Because of the marked differences in the detection performance of the indices, and since in real data both forms of careless responses will co-occur, a pilot simulation study on mixed careless responses was conducted.

Data generation:

- 8000 attentive responders
- 1000 random and 1000 nonrandom careless responders each answering to 50% of the items inattentively

Classification by a **stepwise detection mechanism**:

1. Exclude (random) careless responders based on Youden's index for the Mahalanobis distance.
2. Exclude (nonrandom) careless responders in the remaining data set based on Youden's index for individual response variability.

Overall detection performance:

	careless responses	
	yes	no
detected	1644	2955
not detected	356	5045

As 33.1% of all decisions were wrong, this leaves room for improvement and provides a starting point for future research.