

Psychometric Equivalence of an English and a German Online-Version of the Questionnaire for the Content-Specific Measurement of Attitudes toward the Computer (QCAAC)¹

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Introduction: Content-specific measurement of attitudes toward the computer

Content in existing computer attitude scales

The study of attitudes related to the computer is well-established in psychology and in social sciences such as sociology and education. Consequently, a number of instruments have been developed for the measurement of attitudes toward the computer. Though, a closer look at a sample of existing scales shows that they differ significantly in what exactly is addressed: Some scale developments focus on people's experiences of using the computer (e.g. Popovich, Hyde, Zakrajsek and Blumer, 1987). Other instruments address the consequences which respondents believe the computer technology has for society (e.g. Bannon, Marshall & Fluegal, 1985). Some scales, especially those designed in the context of industrial psychology, deal with working with the computer (e.g. Rafaeli, 1986), while others are concerned with computer-aided learning (e.g. Bear, Richard & Lancaster, 1987). Most scales, however, mix up different purposes of computer use, or the items are worded in general terms without reference to specific domains of computer use. As Kay (1989) notes, most scales do not take into account affective, conative and cognitive attitude components, and thus do not make clear which attitude component is actually addressed.

The scale conception of the QCAAC

The *Questionnaire for the content-specific assessment of attitudes toward the computer (QCAAC)* explicitly focuses on the cognitive component of attitudes: Attitudes toward the computer are treated as beliefs. As assumed by the topical approach to attitude representation (cf. Tourangeau, 1992; Tourangeau, Rasinski & D'Andrade, 1991) these beliefs are organised according to topical aspects. The QCAAC assumes that the distinction between the *computer as an object of personal experience* vs. the *consequences of computer technology for society* is an important distinction in this sense. Secondly, computer use is taken into account: the *computer as an instrument for working and learning* is distinguished from the *computer as an instrument for entertainment and communication*. Additionally, research on unipolar vs. bipolar structured attitudes (cf. Pratkanis, 1989) suggests that attitudes towards the computer were bipolarly structured that is, a person

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might hold negative and positive beliefs about the issue at the same time. The research on computer related attitudes mirrors this: Positively and negatively worded items of computer attitude scales often form separate dimensions (e.g. Rainer & Miller, 1996; Brock and Sulsky, 1994). Brock and Sulsky (1994) refer to the 'positive' component as *beneficial tool*-dimension and to the 'negative' component as *autonomous entity*-dimension of computer use. We adopt this terminology. Figure 1 gives an overview of the scale conception of the QCAAC.

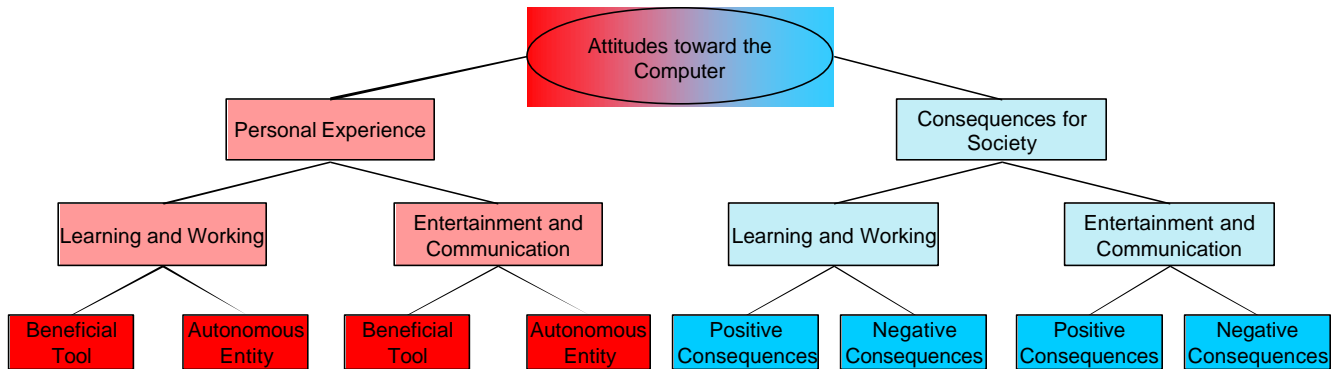


Figure 1: Scale conception of the QCAAC

Previous research with the QCAAC and aim of the present study

Previous studies have proven the scales of the QCAAC to be reliable (Richter, Naumann & Groeben, in press) and valid (Naumann & Richter, in press). Furthermore, the online-version and the paper-pencil-version of the German form are psychometrically equivalent (Richter, Naumann & Noller, 1999). Since the QCAAC was proven reliable and valid in its German version, it seems to be of interest whether psychometric equivalence of the German and English version of the instrument can be assumed. To be more specific, this research aims at answering the following questions:

- Do the German and the English online-version of the QCAAC differ in scale means?
- Do the German and the English online-version of the QCAAC differ in reliability?
- Do the German and the English online-version of the QCAAC differ in factorial structure?

Method

Sample

English language sample. The English language sample ($n = 151$) was recruited through postings on mailing lists and posting links to the questionnaire on websites such as *Online Social Psychology Studies* [<http://socialpsychology.org/expts.htm>]. The sample consists of 75 males and 73 females (missing data for 3 subjects) with a mean age of 40 years ($SD = 14.23$). 20 (13.25%)

participants were students, all others were employees, usually academics. Participants could take part in a lottery, in which vouchers for a well-known internet bookshop could be won.

German language sample. Of the German language sample ($n = 76$) 54 subjects were recruited through postings on mailing lists and related web-sites. Subjects could take part in a lottery were they could win DM 100.-. The remaining 22 subjects participated on-screen and received course credit or money (DM 20.-). The mean age was 29 years ($SD = 6.28$), 38 subjects were male, 32 female (missing data for 6 subjects). 57 (90%) participants were students. All the others were employees and had a degree equivalent to a M.A. or a higher-ranking academic degree.

Testing equivalence of factorial structure: Hierarchically nested models

The factorial structure of the QCAAC and its equivalence in the English and German sample was investigated using confirmatory factor analyses and multi-sample analyses (cf. Jöreskog, 1971). The hypothetical measurement-models for the scales related to *personal experience* and *consequences for society* each consisted of four factors. To ensure model identification, each scale was split into two item parcels. Hierarchically nested models were used to test if (1) patterns of factor loadings, (2) size of factor loadings, (3) indicator errors, and (4) factor intercorrelations can be assumed to be identical in both samples. Figure 2 gives an illustration. Parameters were estimated using the ML-procedure of LISREL 8 (Jöreskog & Sörbom, 1996). The overall fit of the models was tested using χ^2 and the χ^2 -df ratio. The latter should not exceed 2 (Bollen, 1989). Besides χ^2 -measures, the Normed Fit Index (NFI), which is expected to reach values $\geq .95$, and the Root Mean Square Error of Approximation (RMSEA), which should not exceed .05 (Hu & Bentler, 1995), were taken into account. χ^2 -difference tests were employed in order to test whether, if parameters for the German and English sample were restricted to be identical, this would cause a decrement of model fit.

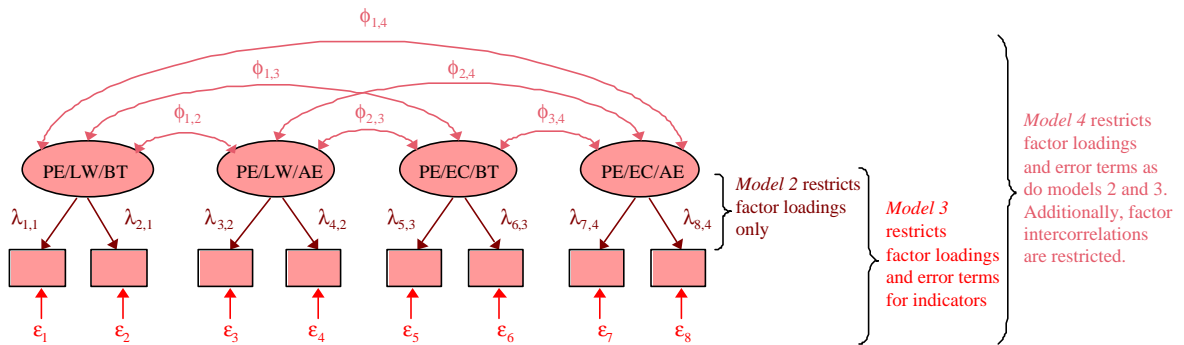


Figure 2a: Measurement models of the *personal experience*-scales. CS: Consequences for society, LW: Learning and working, EC: Entertainment and communication, BT: Beneficial tool, AE: Autonomous entity

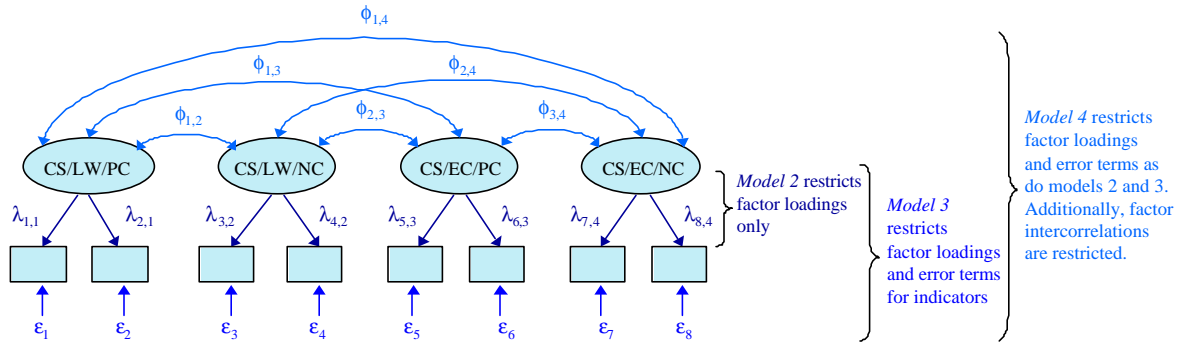


Figure 2b: Measurement models of the *consequences for society*-scales. CS: Consequences for Society, LW: Learning and working, EC: Entertainment and communication, PC: Positive consequences, NC: Negative consequences

Results

Scale distributions, means and reliabilities. As can be seen from Figure 3 and Tables 1 and 2, mean differences between the German and English sample are rather small and insignificant for most of the scales (six out of eight). The same holds true for the reliabilities of the scales, which differ significantly for only one out of eight scales between the German and the English sample.

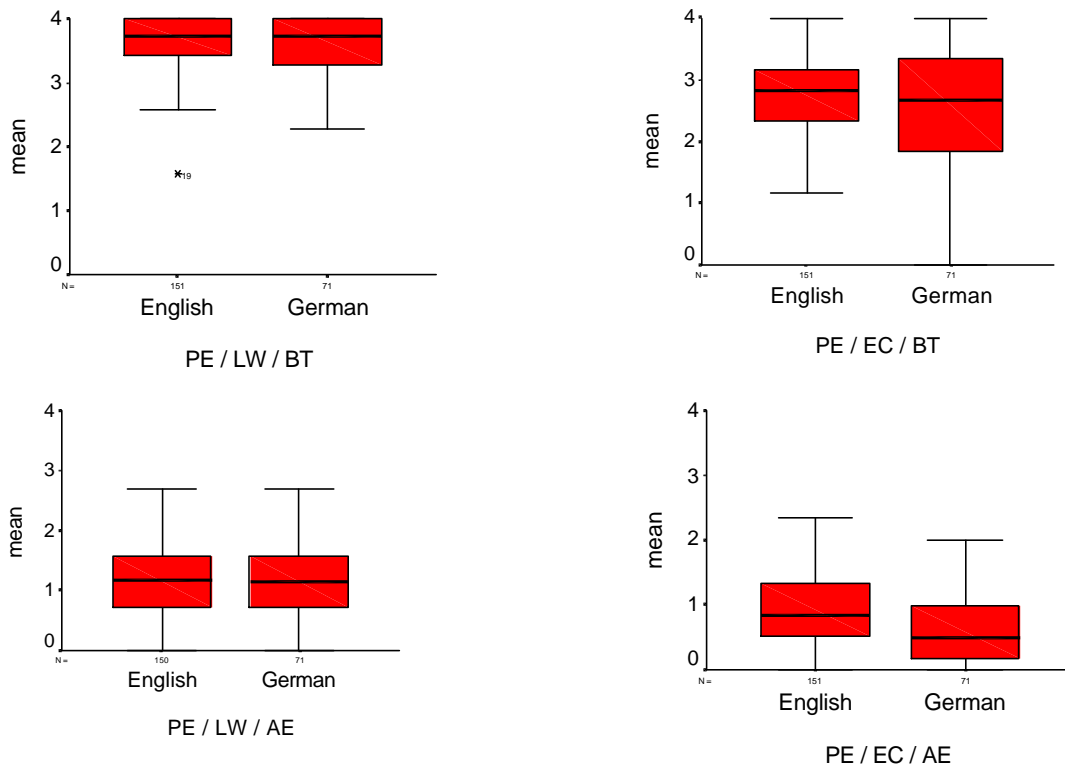


Figure 3a: Boxplots of QCAAC score-distributions for the *personal experiences*-scales in the English and the German sample. See Fig. 2 for abbreviations.

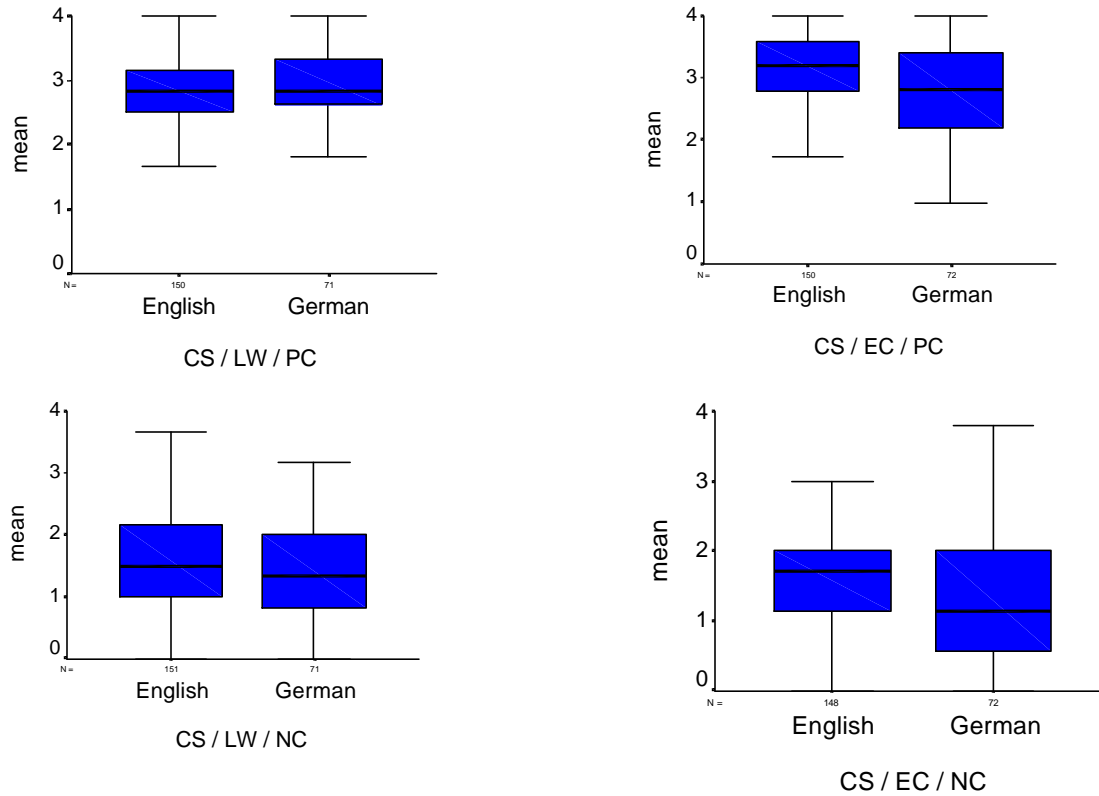


Figure 3b: Boxplots of QCAAC score-distributions for the *consequences for society*-scales in the English and the German sample. See Fig. 2 for abbreviations.

Table 1: Means and standard deviations of the QCAAC-scales in the English and the German sample

Scale ^b	<i>AM</i>		<i>SD</i>		<i>Effect of sample</i>		<i>Effect of covariate^a</i>	
	<i>Engl.</i>	<i>Ger.</i>	<i>Engl.</i>	<i>Ger.</i>	<i>f</i>	<i>F</i> _(1, 209)	<i>f</i>	<i>F</i> _(1, 215)
<i>Personal Experience</i>								
PE / LW / BT	3.63	3.54	0.45	0.51	.001	0.42 <i>n.s.</i>	.018	3.84 <i>n.s.</i>
PE / LW / AE	1.28	1.19	0.76	0.74	.009	1.85 <i>n.s.</i>	.024	5.24*
PE / EC / BT	2.77	2.53	0.68	1.06	.001	0.21 <i>n.s.</i>	.102	22.34***
PE / EC / AE	0.94	0.66	0.65	0.66	.071	16.61***	.061	14.31***
<i>Consequences for Society</i>								
CS / LW / PC	2.85	2.90	0.58	0.62	.009	1.87 <i>n.s.</i>	.031	6.58*
CS / LW / NC	1.62	1.46	0.76	0.87	.012	2.51 <i>n.s.</i>	.003	0.59 <i>n.s.</i>
CS / EC / PC	3.11	2.82	0.60	0.77	.015	3.52 <i>n.s.</i>	.051	11.77**
CS / EC / NC	1.65	1.30	0.72	0.93	.055	12.08**	.072	15.28***

* $p < .05$, ** $p < .01$, *** $p < .001$

^a Hours per week spent using the internet (subjects' self-reports)

^b See Fig. 2 for abbreviations.

Table 2: Reliabilities of the QCAAC-scales in the English and the German sample

Scale ^a	α_{English}	α_{German}	z	k_{items}
<i>Personal Experience</i>				
PE / LW / BT	.81	.78	0.56 <i>n.s.</i>	7
PE / LW / AE	.84	.79	1.02 <i>n.s.</i>	7
PE / EC / BT	.74	.85	-2.20*	6
PE / EC / AE	.76	.78	-0.34 <i>n.s.</i>	6
<i>Consequences for Society</i>				
CS / LW / PC	.77	.79	-0.39 <i>n.s.</i>	6
CS / LW / NC	.82	.81	0.02 <i>n.s.</i>	6
CS / EC / PC	.78	.83	-0.40 <i>n.s.</i>	5
CS / EC / NC	.83	.88	-1.24 <i>n.s.</i>	7

* $p < .05$ ^a See Fig. 2 for abbreviations.

Factorial structure. For the total sample the measurement models fit the data very well. For both *personal experience*-scales and *consequences for society*-scales the χ^2 value is insignificant and smaller than df , NFI equals .99 and RMSEA is below .02 (see Table 3).

Table 3: Goodness of fit of the measurement models for the total sample

Measurement model	χ^2 (14, $N = 222$)	p	NFI	AGFI	RMSEA
<i>Personal Experience</i> -scales	12.71	.55	.99	.96	.01
<i>Consequences for Society</i> -scales	12.00	.62	.99	.97	.02

Multi-sample analyses reveal that models 1 through 3 are acceptable, while the most restrictive model (model 4) must be rejected due to significant χ^2 and unacceptable NFI- and RMSEA-values. That is, not only are the patterns of factor loadings the same in the English and German sample, but also the size of the factor loadings and the errors of the indicators. Factor intercorrelations differ between the German and the English sample. Table 4 gives the goodness of fit of the various nested models; parameter estimates are reported in Figure 4.

Table 4: Goodness of fit of the various nested models

Measurement model of the scales relating to personal experiences						
Model	Restricted parameters ^a	χ^2	df	NFI	RMSEA	$\chi^2_{diff} (df)$
1	Same pattern	29.60	28	.97	.02	
2	+ L_x	42.53	32	.95	.04	2 vs. 1: 12.93 (4)*
3	+ L_x , Q_δ	53.31	40	.94	.04	3 vs. 2: 10.78 (8)
4	+ L_x , Q_δ , F	81.44**	50	.90	.13	4 vs. 2: 28.91 (18)*

Measurement model of the scales relating to consequences for society						
Model	Restricted parameters ^a	χ^2	df	NFI	RMSEA	$\chi^2_{diff} (df)$
1	Same pattern	41.16	28	.96	.04	
2	+ L_x	42.95	32	.96	.04	2 vs. 1: 1.79 (4)
3	+ L_x , Q_δ	53.38	40	.94	.05	3 vs. 2: 10.43 (8)
4	+ L_x , Q_δ , F	84.91**	50	.91	.14	4 vs. 2: 41.96 (18)**

Notes. $\chi^2_{diff} (df)$: Chi-square-difference (degrees of freedom). * $p < .05$, ** $p < .01$.

^a 'Restricted' parameters are assumed to be identical for the English and German sample. L_x designates the matrix of factor loadings, Q_δ designates the matrix of indicator errors and F designates the matrix of factor intercorrelations.

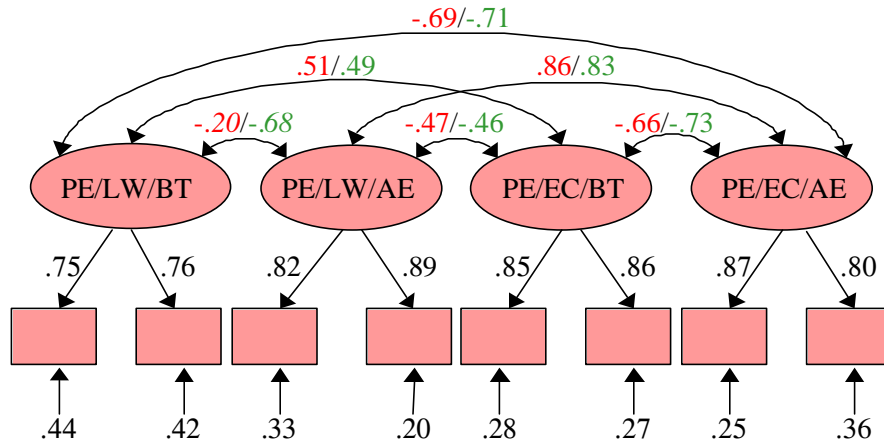


Figure 4a: Parameter estimations for the measurement model of the *personal experiences*-scales. The common metric completely standardized solution is reported for the elements of L_x and Q_δ . Since factor intercorrelations cannot be regarded as identical in the English and German sample, the respective within-group completely standardized solutions are reported for F , they are printed in green for the English sample and in red for the German sample.

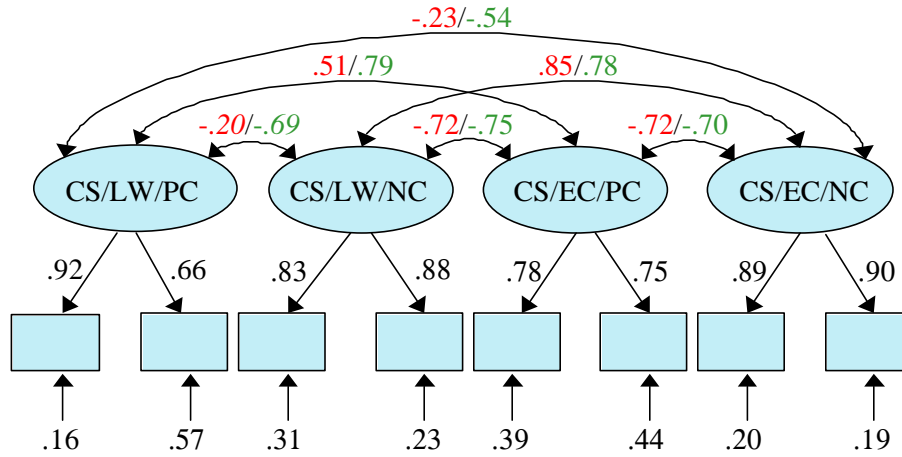


Figure 4b: Parameter estimations for the measurement model of the *consequences for society*-scales. The common metric completely standardized solution is reported for the elements of L_x and Q_{δ} . Since factor intercorrelations cannot be regarded as identical in the English and German sample, the respective within-group completely standardized solutions are reported for F' , they are printed in green for the English sample and in red for the German sample.

Conclusions

The results reported here prove assessments of attitudes toward the computer with the English and the German online-version of the QCAAC to be psychometrically equivalent in a number of important aspects. Furthermore, the results show that the English translations of the scales have - in absolute terms and despite of the homogeneity of the present sample - satisfactory internal consistencies. Thus, the QCAAC should be suitable for online-surveys in the English speaking world. With only a few exceptions, no significant differences in scale reliabilities can be found. As could be expected from a sample of 'onliners', for all 'negative' scales the means were below the theoretical scale mean of 2.0; for all 'positive' scales they were above that value. This holds true for both the English and the German sample. Whereas for the German version of the instrument, previous studies (e.g. Naumann & Richter, in press) have demonstrated significant differences in QCAAC scores between computer experts and novices, validations of this kind are still to be done for the English version. Reliable mean differences between the German and the English sample were found only for those scales which address negative aspects of the computer as an instrument for learning and working. The presumed factorial structure in general turns out to be true for both the English and German sample. Furthermore, identical factor loadings and indicator errors can be assumed. Factor intercorrelations differ, but a closer look at the parameter estimates reported in fig. 4 reveals, that to a large extent these differences must be attributed to the *learning and working*-scales only. For the German sample the correlations between 'positive' and 'negative' *learning and working*-scales are low (-.20), while they are substantial (about -.70)

for the English sample. A fundamental dilemma of collecting data through the WWW comes into play here: We do not know, if the (few) differences we found between the German and English sample are a result of different scale properties, or if they can be attributed to sample characteristics. On the other hand, given the large differences of the samples with respect to age and profession, the results are encouraging; at least to explore further the psychometric properties of the English version of the QCAAC.

References

- Bannon, S. H., Marshall, J. C. & Fluegal, S. (1985). Cognitive and affective computer attitude scales: A validity study. *Educational and Psychological Measurement*, 45, 679-681.
- Bollen, K.A. (1989). *Structural equations with latent variables*. New York: Wiley.
- Brock, D. B. & Sulsky, L. M. (1994). Attitudes toward computers: Construct validation and relations to computer use. *Journal of Organizational Behavior*, 15, 17-35.
- Hu, L.T. & Bentler, P. (1995). Evaluating model fit. In R. H. Hoyle (Ed.), *Structural equation modeling: Concepts, issues, and applications* (pp. 76-99). Thousand Oaks, CA: Sage.
- Jöreskog, K. G. (1971). Simultaneous factor analysis in several populations. *Psychometrika*, 35, 409-426.
- Jöreskog, K. G. & Sörbom, D. (1996). *LISREL 8: User's reference guide*. Chicago: Scientific Software.
- Kay, R. H. (1989). A practical and theoretical approach to assessing computer attitudes: The computer attitude measure. *Journal of Research on Computing in Education*, 23, 456-463.
- Naumann, J. & Richter, T. (2001). Diagnose von Computer Literacy: Computerwissen, Computereinstellungen und Selbsteinschätzungen im multivariaten Kontext [Assessment of computer literacy: Computer knowledge, computer-related attitudes and self-ratings in a multivariate context]. In W. Frindte, T. Köhler, P. Marquet & E. Nissen (Eds.), *Internet-based teaching and learning (IN-TELE) 99. Proceedings of IN-TELE 99 / IN-TELE 99 Konferenzbericht. Internet Communication Vol. 3* (pp. 295-302). Frankfurt/M.: Lang.
- Popovich, P. M., Hyde, K. R., Zakrajsek, T. & Blumer, C. (1987). The development of the attitudes toward computer usage scale. *Educational and Psychological Measurement*, 47, 261-269.
- Pratkanis, R. (1989). The cognitive representation of attitudes. In R. Pratkanis, S. Breckler & S. Greenwald (Eds.), *Attitude Structure and Function* (pp. 70-98). Hillsdale, NJ: Erlbaum.

- Rafaeli, A. (1986). Employee attitudes toward working with computers. *Journal of Occupational Behavior*, 7, 89-106.
- Rainer, R. K. & Miller, M. D. (1996). An assessment of the psychometric properties of the computer attitude scale. *Computers in Human Behavior*, 12, 93-105.
- Richter, T., Naumann, J. & Groeben, N. (2001). Das Inventar zur Computerbildung (INCOBI) – ein Instrument zur Erfassung von Computer Literacy und computerbezogenen Einstellungen bei Studierenden der Geistes- und Sozialwissenschaften [The Computer Literacy Inventory - An instrument for the assessment of computer literacy and attitudes toward the computer in students of the humanities and social sciences]. *Psychologie in Erziehung und Unterricht*, 48, 1-13.
- Richter, T., Naumann, J. & Noller, S. (1999). Computer Literacy und computerbezogene Einstellungen: Zur Vergleichbarkeit von Online- und Paper-Pencil-Erhebungen. In U.-D. Reips, B. Batonic, W. Bandilla, M. Bosnjak, L. Gräf, K. Moser & A. Werner (Eds.), *Current internet science - trends, techniques, results*. Zürich: Online Press [WWW document]. [Computer literacy and attitudes toward the computer: On the equivalence of online- and paper-pencil-assessments] Available URL: <http://dgof.de/tband99/>
- Tourangeau, R. (1992). Context effects on responses to attitude questions: Attitudes as memory structures. In N. Schwarz & S. Sudman (Eds.), *Context effects in social and psychological research* (pp. 35-48). Berlin: Springer.
- Tourangeau, R., Rasinski, K. A. & D'Andrade, R. (1991). Attitude structure and belief accessibility. *Journal of Experimental Social Psychology*, 27, 48-75.

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