FROM THEORIES OF ATTITUDE REPRESENTATION TO QUESTIONNAIRE DESIGN

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In this paper, the general implications of three different approaches to attitude representation for questionnaire design in attitude measurement are examined. Especially the theories by Tourangeau and Pratkanis were taken into account for the construction of a questionnaire for the assessment of attitudes toward the computer. We assume that memory representations of computer-related attitudes are structured by means of topicality and that they are structured in a bipolar rather than a unipolar manner. In two studies, the attitude questionnaire constructed on the basis of these assumptions was administered to a German-speaking sample (*N*=232) and an English-speaking sample (*N*=251). Psychometric aspects of a topical and bipolar structure of computer-related attitudes were tested using confirmatory factor analysis. For both samples, measurement models without topical differentiations or bipolarity assumptions were associated with a significant decrease of model fit. The results are discussed with respect to the design of questionnaires for the assessment of cognition-based attitudes.

Key words: attitude measurement, attitudes toward the computer, bipolar structure, cognition-based attitudes, confirmatory factor analysis, topical structure

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1 OVERVIEW

In the following two sections of this paper, we will give a brief sketch of some models of attitude representation and discuss how these models may serve as theoretical grounds for the design of attitude scales. Afterwards, we will relate these considerations to the case of attitudes toward the computer and describe the construction of an instrument for the content-specific assessment of attitudes toward the computer. The design of this questionnaire is based on assumptions following the topical approach to attitude representation (Tourangeau, 1987, 1992) and the notion of a bipolar structure of attitude representation (Pratkanis, 1989). The third section reports the results of two studies that provide empirical evidence for the diagnostic usefulness of these assumptions. In the final section, some implications for the design of instruments for the assessment of cognition-based attitudes are discussed.

2 THEORIES OF ATTITUDE REPRESENTATION

This section deals with theories of attitude representation and their implications for the design of attitude scales. Generally, there is a vast amount of literature on the attitude construct that will not be reviewed here (for an overview, see Eagly & Chaiken, 1998). Instead, we will argue for attempts to clarify the representation of attitudes in memory, explain the distinction between two important types of attitudes, give a brief sketch of diverging views on attitude representation, and sketch their implications for questionnaire design.

On a high level of abstraction, there are two ways of understanding the theoretical role of the attitude concept. First, attitudes can be regarded as continuously varying traits, that is, predispositions to display certain behaviors with respect to the attitude object. In this – essentially neo-behavioristic – view, there is certainly no need to clarify the representation of attitudes in memory: Attitudes are regarded as theoretical constructs that relate (overt) stimuli to (overt) behavior and thus make the prediction of behavior more parsimonious, just like any other personality traits (McGuire, 1985). From the perspective of cognitive psychology however, a different view on attitudes seems to be more appropriate. If an attitude is a person's evaluation of an attitude object and if it is assumed to be stable over time, it must be stored in memory in some way. Most of the theories within the social cognition approach, which aim at a detailed understanding of how attitudes are stored in memory, take into account recent work of the structure of semantic memory, such as Anderson's ACT-Theory (cf. Anderson, 1993). These theories make more or less use of the notion that attitudes could be represented by means of semantic networks. The detailed structure of this representation however may differ considerably between different kinds of attitudes.

One important distinction here is the difference between *cognition-based* and *affect-based* attitudes (cf. Wilson, Dunn, Kraft and Lisle, 1989). Affect-based attitudes are associated with a strong affective reaction to the attitude object; they are easily accessible and automatically activated through mere exposure to the attitude object or its name. They can hardly be changed or established by arguments (Edwards, 1990; Edwards & von Hippel, 1995) because affect-based attitudes are not based on cognitive reasons. Prototypical examples are attitudes established through classical conditioning (cf. Staats & Staats, 1954) or subliminal priming with pleasant or unpleasant stimuli (Edwards, 1990). In contrast to this, cognition-based attitudes are a result of controlled cognitive processes rather than automatic processes. They consist of a set of evaluative beliefs concerning an attitude object rather than an affective reaction. Many political issues provide good examples for cognition-based attitudes: An average person's attitude toward social welfare, for instance, might be associated with knowledge of numerous pro- and con-arguments relating to different aspects of the issue. It should be noted that the distinction between cognition- and affect-based attitudes is not to be seen as a strictly dichotomous one. Attitudes toward abortion, for example, might consist of a spontaneous disapproval of the issue as well as reasons for and/or against legalization. In terms of the common tripartite-model of attitude structure (assuming affective, cognitive, and conative components, e. g. Secord & Backman, 1964), cognitive components are central for cognition-based attitudes, whereas affect-based attitudes have strong affective components while their cognitive components can be neglected. The models of attitude representation sketched in the next paragraph apply to cognition-based and affect-based attitudes to different degrees.

2.1 Fazio: Evaluative Nodes in Semantic Memory

Certainly one of the most widely noted models of attitude representation is the model developed by Fazio (1986, 1989). The core assumption of this model is that the nodes representing attitude objects in semantic memory are connected to a node representing an evaluation ('good' vs. 'bad'); this connection is termed "attitude". Since the association between an attitude object and its evaluation is considered to vary in strength, the model transforms Converse's (1970) distinction between 'attitudes' and 'nonattitudes' into a continuum: The stronger the association between attitude object and evaluation in long term memory, the more can be spoken of an attitude that influences behavior and can be measured. Attitude activation is conceptualized as an automatic process: In the case of strong attitudes, mere exposure to the attitude object (or its name) is sufficient to activate the attitude. Consequently, the early experiments designed to test the theory were primarily concerned with automatic activation of attitudes, i. e. through the so-called evaluative decision task (e. g. Fazio, Sanbonmatsu, Powell & Kardes, 1986). In this task, subjects are asked to determine the connotation of adjectives ('target adjectives') which are presented immediately after the quick presentation of the name or the image of an attitude object ('attitude primes'). The main result of these studies is that target adjectives are judged faster if they are congruent in valence to the attitude prime, but this happens only for strong attitudes and for short time intervals between presentation of prime and target. Meanwhile, the effect of valence congruency is replicated in a number of studies, which corroborate the basic findings while raising questions about a number of details (e. g. Bargh, Chaiken, Govender & Pratto, 1992; Hermans, DeHouwer & Eeelen, 1994; Klauer, Roßnagel & Musch, 1997; for an overview see Klauer, 1998).

The supposed automaticity of the valence congruency-effect, the kind of attitude objects typically studied, and its representational parsimony (object-evaluation associations and nothing else) make Fazio's model especially suitable for representing affect based attitudes (although the theory's claim is to be capable of dealing with attitudes in general).

2.2 Tourangeau: Attitudes as Memory Structures Organized by Means of Topicality

In contrast to Fazio's model, Tourangeau's (1987, 1992) topical approach does not focus on the overall evaluation of attitude objects. Instead, attitudes are regarded as complex memory structures which comprise of beliefs, feelings, personal experiences stored in memory, and images related to the attitude issue. The central representational assumption of this approach is that the attitude representation is organized according to topical aspects, i. e. memory contents belonging to an attitude issue are more strongly associated with each other if they fall into the same or at least into a related topical cluster, than if they belong to an unrelated cluster. The representation of the attitude toward social welfare, for instance, might be structured by topics such as "self-help as alternative", "poor management" (as examples for anti-welfare clusters), "responsibility to the poor" or "benefits of welfare" (as examples for pro-welfare clusters) (cp. Tourangeau, Rasinski & D'Andrade, 1991). Besides evidence from a priming study (Tourangeau et al., 1991), there are results from a field experiment in which the influence of preceding attitude items on answers to subsequent attitude items could be demonstrated to vary according to the strength of the argument relation between the items (Tourangeau, Rasinski & Bradburn, 1989). Additional but indirect evidence for the topical approach stems from numerous studies which examined context effects in attitude surveys (for an overview, see Tourangeau, 1992). Together with a model of cognitive processes in survey responding (see Tourangeau & Rasinski, 1988), the structural assumptions of the topical approach provide an adequate framework for explaining context effects.

Although not explicitly stated by the authors, Tourangeau's model seems to apply to cognition-based attitudes exclusively. People are assumed to rely on cognitive components of attitudes when responding to questionnaires; the response process consists of interpreting the item, retrieving relevant knowledge from memory, forming a judgement and formatting it with respect to the answer categories given (Tourangeau & Rasinksi, 1988); thus, attitude judgements are regarded as knowledge-based and dependent on controlled judgement processes.

2.3 Pratkanis: Bipolar vs. Unipolar Attitude Structure

Similar to Tourangeau's model, Pratkanis' (1989) theory is primarily concerned with the question how evaluative beliefs related to an attitude issue are organized in memory (see also the socio-cognitive model by Pratkanis & Greenwald, 1989). The basic representational assumption of Pratkanis' model is that it is useful to distinguish *unipolar* from *bipolar* structures of attitude representations. The defining feature of unipolar attitude structures is that a person holds either negative or positive beliefs concerning the issue, but rarely both of them. Another feature is that interindividual variability in the evaluation of the attitude object normally occurs only between neutrality and either the positive or the negative extreme of the attitude continuum. The attitude toward sports would be an example for an attitude structured in a unipolar manner: Some people are quite enthusiastic about sports and can possibly state reasons why they like it, whereas others simply do not care. But only few people oppose sports and can give arguments why you should not like it. (Consequently, there are numerous lobby groups and organizations acting in favor of sports, but people uniting to fight sports are a rather rare phenomenon.) On the contrary, for bipolar attitude structures, knowledge about both sides of the issue is characteristic. Despite the fact that people vary with respect to their overall evaluation of an attitude object and the valence of this evaluation (e. g. 'pro' and 'con'), they nevertheless can produce arguments supporting their own position as well as opposing arguments, and are able to recognize and judge both kinds of arguments with the same ease (Pratkanis, 1984). Apparently, a bipolar attitude can play the role of a schema that facilitates processing of attitude-congruent and attitude-incongruent information (Judd & Kulik, 1980). According to Pratkanis (1989), many political issues, especially those that are controversially discussed in public – e. g. abortion, nuclear power, and social welfare – are represented in a bipolar manner.

With respect to the cognition-based – affect-based distinction, unipolar attitudes may be cognition-based attitudes as well as affect-based attitudes, whereas attitudes structured in a bipolar manner are mainly cognition-based.

3 ATTITUDE REPRESENTATION AND QUESTIONNAIRE DESIGN

3.1 Implications of Theories of Attitude Representation - Which Theory for Which Attitude?

Instead of treating the three models of attitude representation described above as competing theories (for such a view see e. g., Tesser & Shaffer, 1990, p. 483), we would like to propose that each of the models cited above applies to different types of attitudes. Accordingly, the implications the various theories have for the measurement of attitudes, are restricted to the type of attitude in question.

Implications of Fazio's model. As we stated earlier, Fazio's model is suitable especially for the representation of affect-based attitudes. Consequently, unobtrusive measurement procedures were derived from the model. Fazio, Jackson, Dunton and Williams (1995), for instance, used a modified evaluative decision task (a so-called bona-fide-pipeline) to measure implicit racism; in their study, photographs of blacks and whites were used as primes. The measurement of supposedly affect-based attitudes by attitude questionnaires, however, is problematic in principle because responding to items such as evaluative statements or adjectives invariably requires a huge amount of cognitive processing, which makes use of cognitive components of the attitude and is at least partly non-automatic. Nonetheless, the notion of attitude as association of attitude object and evaluation of continuously varying strength can be regarded as an implicit theoretical precondition for the measurement of attitudes with unidimensional scales: The sum score derived from the application of unidimensional scales does in no way reflect *what* people think about an issue, but only mirrors the *intensity* of the respondents' inclination or disinclination towards the attitude object. From a cognitive-psychological point of view, the empirical relative of such measures would be associations of objects and evaluations in memory.

Implications of Tourangeau's model. If an attitude can be regarded as cognition-based and as organized according to the topical structure of attitude-relevant knowledge, it seems reasonable to take these topical clusters into account by constructing different attitude scales for distinct clusters. There are a number of reasons for this claim. First, and most important, suppose an attitude conceptually consists of a number of beliefs belonging to different topical clusters. Clearly, the content validity of a scale that mixes up these topical clusters would be questionable: If an attitude is not the mere feeling that something is 'good' or 'bad', but consists of a number of clustered beliefs concerning the issue, a measure of the attitude is adequate only if it separates the different evaluative aspects that possibly underlie a person's judgements. Otherwise the attitude scores have no clear interpretation (which is a variant of the ambivalence-indifference problem, see e. g. Cacioppo & Berntson, 1994). Second, in most cases one does not know if all the proposed aspects of an issue are also represented in the individual respondent's belief system. Grouping the items used for attitude measurements according to aspects of topicality, the researcher can provide the respondents with the option to leave out certain subscales instead of judging statements they basically know nothing about – thus avoiding the 'measurement' of nonattitudes (Converse, 1970).

Implications of Pratkanis' model. The distinction between bipolar and unipolar attitude structures has similar implications concerning the measurement of attitudes.[2] When attitudes structured in a unipolar manner are concerned, these are measurable as far as the items of the questionnaire relate to respondent's beliefs about the attitude object. The case of bipolar attitudes is more complicated. A good deal of attitude questionnaires designed for the assessment of attitudes probably represented in a bipolar manner, group positive and negative ('inverted') items into one unidimensional scale. Apparently, this procedure can be problematic if positive and negative beliefs about the attitude object form separate clusters of beliefs, and thus, 'liking' and 'disliking' components of attitude are confounded in a unidimensional measure (this is another variant of the ambivalence-indifference problem). Our suggestion is to construct separate scales for pro-arguments and contra-arguments in the first place if attitudes are to be assessed for which a bidimensional attitude structure must be assumed.

3.2 The Case of Attitudes Toward the Computer

Since computer technology is nowadays indispensable in nearly all areas of society (work, communication, education) as well as in a growing number of people's private lives, there is a growing body of research on computer related attitudes, and a number of instruments have been developed for their measurement (for an overview, see LaLomia & Sidowski, 1991; Brock & Sulsky, 1994). Unfortunately, usually little attention is paid to the content validity of these instruments. As Kay (1989) notes, most of the scales are not clear with respect to the attitude component (cognitive, affective, conative) that should be addressed. In addition, most scales mix up different potential uses of the computer (e. g. purposes of education with purposes of entertainment). Furthermore, frequently items addressing the computer as a matter of personal experience are mixed up with items referring to the presumed consequences of computer technology for society (e.g. Nickell & Pinto, 1986). Finally, according to Brock and Sulsky (1984), most of the available instruments are unidimensional scales consisting of items relating to both positive and negative aspects of the computer issue.

In the face of the models of attitude representation described above, it seems reasonable to conceptualize attitudes toward the computer as cognition-based attitudes, which are structured by means of topicality as well as in a bipolar way. In present (post-)industrial societies, the computer issue is certainly a topic most intensively discussed in public. Besides, an increasing number of students and employees can no longer avoid relying on the computer in their daily life. It is plausible that these phenomena correspond to a differentiation in individual representations of computer-related attitudes. Following this consideration, an instrument for the assessment of computer related attitudes should be constructed according to the implications of the assumptions of a topical and bipolar structure of attitude representations. We tried to do so in the construction of the *Questionnaire for the Content*

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[2] Note that this distinction refers to the structure of the attitude representation and that, consequently, it is not

Differentiated Assessment of Attitudes toward the Computer (QCAAC) (Richter, Naumann & Groeben, in press a, in press b). This instrument was originally developed in German, but meanwhile there is an English version, too, with the English version being psychometrically equivalent to the German version (Naumann, Richter & Noller, 2000).

The QCAAC is based on three dichotomous distinctions, which result in a total of $2 \times 2 \times 2 = 8$ different scales (for a more detailed explanation of the scale distinctions see Richter, Naumann & Groeben, in press a). First, we take into account the presumed topical structure of attitudes toward the computer by distinguishing between *personal experience* with the computer from *consequences of computer technology for society.* Next, a second topical distinction is made by discriminating different computer uses; that is, the computer as an instrument for *learning and working* on the one hand, and the computer as an instrument for *entertainment and communication* on the other hand. Finally, we take into account the presumed bidimensional structure by differentiating between the *computer as a beneficial tool* and the *computer as an autonomous entity* (cp. Brock & Sulsky, 1994) as far as the computer as a matter of personal experience is concerned. With respect to the consequences of computer technology for society we distinguish between *positive consequences* and *negative consequences* of computer technology for society (i. e. *useful* vs. *uncontrollable technology*).

4 EMPIRICAL EVIDENCE FOR BIPOLARITY AND TOPICALITY IN THE REPRESENTATION OF ATTITUDES TOWARD THE COMPUTER

The empirical evidence we report here for the assumptions of a topical and bipolar structure of attitudes toward the computer stems from two different studies conducted with the QCAAC. Both assumptions were tested using confirmatory factor analyses. Additionally, internal consistencies of the scales as well as their correlations with measures of computer use will be reported.

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synonymous with the common distinction of bipolar and unipolar rating scales.

4.1 Method

Mode of Data Collection

Attitudes toward the computer were assessed using the QCAAC. In Study I we used both a paper-and-pencil and an online version of the instrument, which have proven to be psychometrically equivalent (Richter, Naumann & Noller, 1999). The items were presented in German. In Study II only the online version and the English translation of the QCAAC was used. The online version of the questionnaires paralleled the paper and pencil form as far as possible. Each scale was placed on one page; for the longer scales, the subjects had to scroll. In order to proceed to the next scale subjects had to click on a button labeled "next page". In addition to responses to the attitude questionnaires, subjects were asked for their sex, age and profession as well as for information concerning actual computer use: the number of years they had used a computer, the number of hours per week they were using the computer, and the number of hours per week they were using the internet.

Samples

Study I. The sample of Study I (*N* = 232) consisted mainly of university students at the University of Cologne. Of the subjects of study I, 76 filled in the German online version of the instrument, 146 completed the German paper-and-pencil form. 136 participants were female, 85 male; (missing data for 11 subjects). The mean age was 27.8 years (*SD* = 7.5). 103 subjects were recruited through the internet or at university computer pools and had a presumably high degree of computer experience; 51 subjects of this subsample completed the online version and 52 filled in the paper-and-pencil version. The remaining 129 subjects were undergraduates from Psychology and other social sciences and had a presumably low level of computer experience; 25 of these subjects completed the online version and 104 filled in the paper-and-pencil version. For the total sample, the mean number of years of experience in using the computer amounted to 6.3 (*SD* = 5.1). On average, the computer was used for 12 hours (*SD* = 13.6) a week, and the internet for 4.3 hours (*SD* = 5.5) a week. Subjects were rewarded by the possibility to take part in a lottery, in which an amount of DM 100.- could be won; the Psychology undergraduates participated fulfilling a requirement for their *Vordiplom* exams.

Study II. In contrast to Study I, the sample of Study II (*N* = 251) consisted of internet users only. The subjects were recruited through postings on mailing lists or web sites such as *Online Social Psychology Studies* [http://socialpsychology.org/expts.htm]. So, the respondents in this study had a presumably high degree of computer experience. 129 respondents were male, 118 female (missing data for four subjects). The mean age was 34.2 years (*SD* = 14.3). The mean number of years of experience in using the computer was 12.2 years (*SD* = 6.6). On average, participants spent 30.2 (*SD* = 18.1) hours a week using the computer and 13.5 (*SD* = 12.3) hours using the internet. Subjects were rewarded by the possibility to take part in a lottery, in which a voucher for a well-known online bookshop could be won.

Measurement models for testing the assumptions of topical and bipolar structure

The fruitfulness of the assumptions underlying the scale conception of the QCAAC was tested using confirmatory factor analyses. First, we constructed a measurement model for the QCAAC-scales that mirrors the assumptions of topical and bipolar structure of attitude representation, on which the scale conception of the QCAAC is based ('hypothesis' or 'target model'). Then we contrasted this model with six alternative models negating either the assumption of topical structure (alternative models A to E) or the assumption of a bipolar structure (alternative models F and G) for various subsets of scales. The following paragraphs describe the target model as well as the six alternative models in detail.

Target Model. The Target Model is based on the supposition that the three distinctions regarding different classes of evaluative beliefs about the computer (*personal experience* vs. *consequences for society*, *learning and working* vs. *entertainment and communication*, *beneficial tool*/*useful technology* vs. *autonomous entity*/*uncontrollable technology*) are diagnostically relevant for the assessment of attitudes toward the computer. That is, the target model consists of a total of eight latent factors, each representing one of the QCAAC-scales. Since none of these eight factors can be regarded as orthogonal, factor intercorrelations were not fixed. To ensure model identification, each scale was split into two item parcels with randomly assigning the scale items to one of the two item-parcels (cp. Bollen, 1989). Figure 1 gives an illustration of the Target Model.

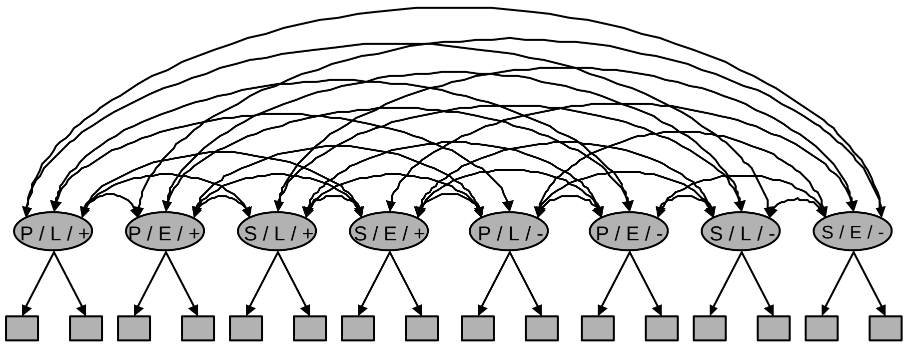

Figure 1. **Target Measurement Model for the QCAAC-Scales. P: personal experience, S: consequences for society, L: learning and working, E: entertainment and communication, + : positive (beneficial tool/useful technology), - : negative (autonomous entity/uncontrollable technology).**

In order to test the diagnostic relevance of the assumed topical structure of attitudes toward the computer, factor intercorrelations between factors representing different topical clusters were fixed on unity. The resulting Alternative Models A to E are each equivalent to measurement models assuming only one factor instead of the factors for which intercorrelations are fixed at unity. The alternative models are nested models with respect to the target model (Bollen, 1989).

Alternative model A. Alternative model A represents the most restrictive model. First, intercorrelations between factors belonging to 'positive' scales (*beneficial tool* or *useful technology*, respectively) are fixed on unity. In addition, all intercorrelations of factors belonging to 'negative' scales (*autonomous entity* or *uncontrollable technology*, respectively) are fixed on unity. That is, since positive and negative attitude components are separated, but no topical distinctions are made, Alternative model A is comparable to a pure bidimensional model as proposed by Brock and Sulsky (1994).

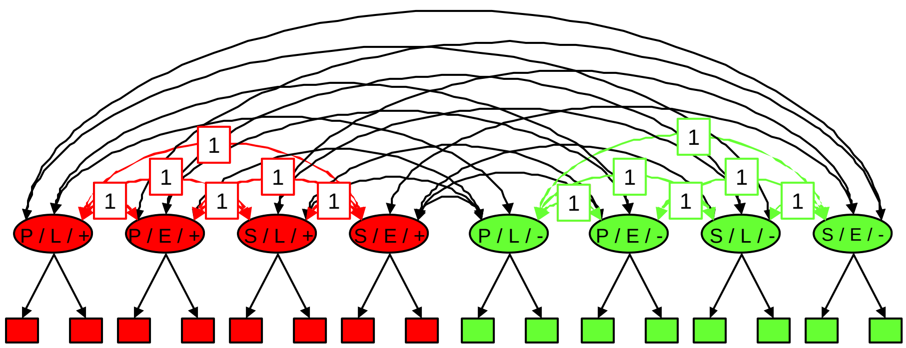

Figure 2. **Alternative Model A**

Alternative Model B. Alternative Model B fixes intercorrelations between *learning and working*- and *entertainment and communication*-scales on unity, but only for the *personal experience*-scales. Through contrasting Alternative Model B with the Target Model, the assumption can be tested that the distinction between personal experiences with the computer as an instrument for learning and working and personal experiences with the computer as an instrument of entertainment and communication is diagnostically useful. Figure 3 gives an illustration of Alternative Model B.

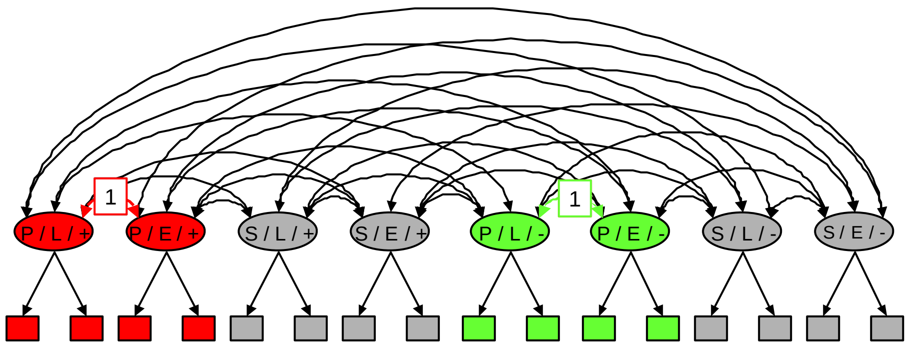

Figure 3. **Alternative Model B**

Alternative Model C. In Alternative Model C, the intercorrelations between *learning and working*- and *entertainment and communication*-scales are fixed on unity, but only for the scales related to *consequences for society*. Through contrasting Alternative Model C with the Target Model, the assumption can be tested that the distinction between the computer as an instrument for learning and working and the computer as an instrument of entertainment and communication is diagnostically useful as far as the consequences of computer technology for society are concerned. gives an illustration of Alternative Model C.

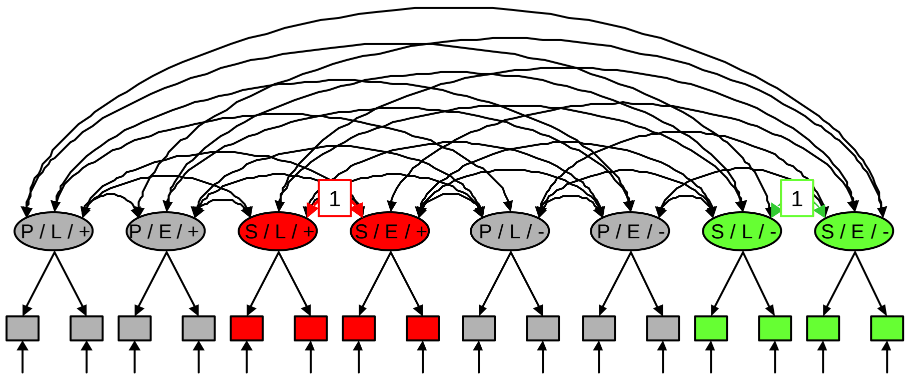

Figure 4. **Alternative Model C**

Whereas Alternative Models B and C concern the distinction between the computer as an instrument for *learning and working* vs. *entertainment and communication*, alternative models D and E put the *personal experience* vs. *consequences for society*-distinction to test.

Alternative Model D. In Alternative Model D, the intercorrelations between the *personal experience* and *consequences for society*-scales are fixed on unity, but only for the *learning and working*-scales. Through contrasting Alternative Model D with the Target Model, the assumption can be tested that it is diagnostically useful to distinguish between the computer as a matter of personal experience on the one hand and the consequences of computer technology for society on the other hand, as far as the computer as and instrument for learning and working is concerned. Figure 5 gives an illustration of Alternative Model D.

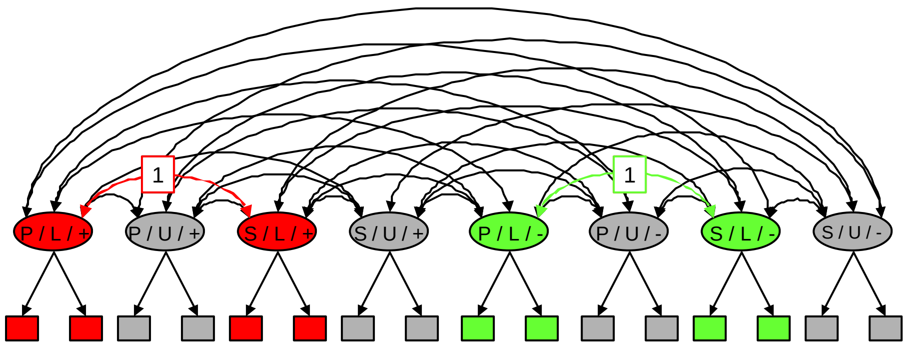

Figure 5. **Alternative Model D**

Alternative Model E. Complementarily to Alternative Model D, in Alternative Model E the intercorrelation between the *personal experience* and *consequences for society*-scales are fixed on unity, but only for the *entertainment and communication*-scales. Through contrasting Alternative Model E with the Target Model, the assumption can be tested that the distinction between the computer as a matter of personal experience and consequences of computer technology for society is diagnostically relevant, as far as the computer as and instrument for entertainment and communication is concerned. Figure 6 gives an illustration of Alternative Model E.

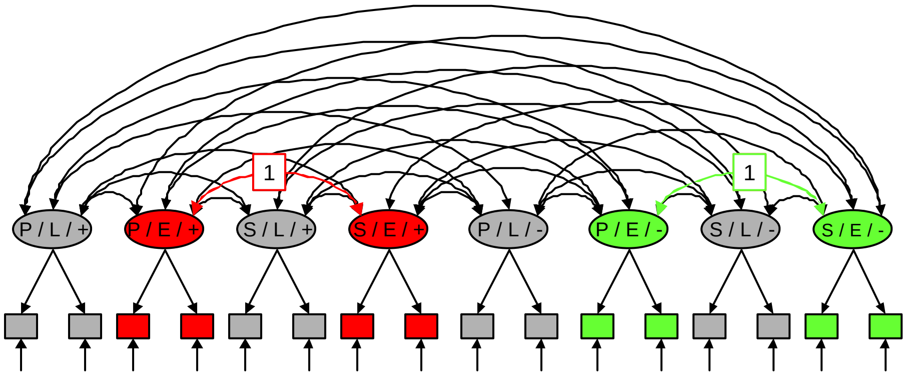

Figure 6 **Alternative Model E**

The diagnostic relevance of the assumption of bipolar (bidimensional) structure was tested in a manner analogous to the tests of the topicality assumptions. Nested models (with reference to the target model) were employed, which restrict intercorrelations between scales that are topically related, but differ in polarity.

Alternative Model F. Alternative Model F claims that attitudes toward the computer that are related to *personal experience* are unipolar rather than bipolar. That is, the intercorrelation between positive and negative scales relating to *personal experience* are fixed on –1. More precisely: Intercorrelations between *benefical tool*- and *autonomous entity*-scales relating to *learning and working* are fixed on –1, as well as *benefical tool*- and *autonomous entity*-scales relating to *entertainment and communication*. Figure 7 illustrates alternative model F.

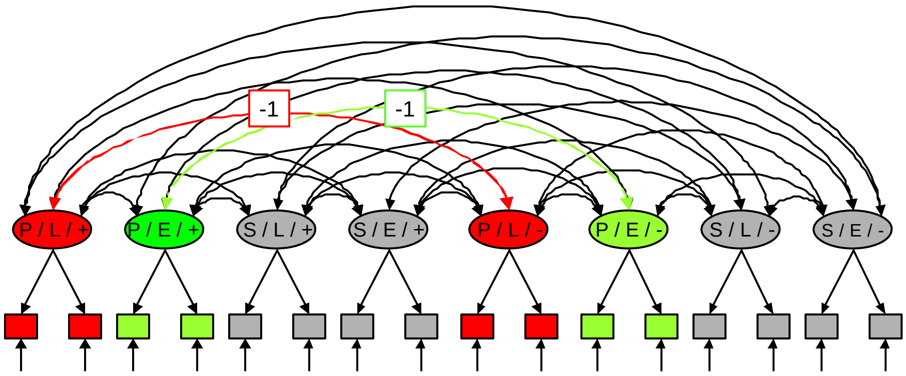

Figure 7. **Alternative Model F**

Alternative Model G. Complementarily to Alternative Model F, Alternative Model G tests the assumption of a bidimensional structure with respect to the *consequences for society*-scales: The intercorrelation between positive and negative scales relating to *consequences for* *society* are fixed on –1. More precisely: Intercorrelations between scales referring to *positive* and *negative consequences* of the computer as an instrument for *learning and working* are fixed on –1, as well as intercorrelations between scales referring to *positive* and *negative consequences* of the computer as an instrument for *entertainment and communication*. Figure 8 gives an illustration of Alternative Model G.

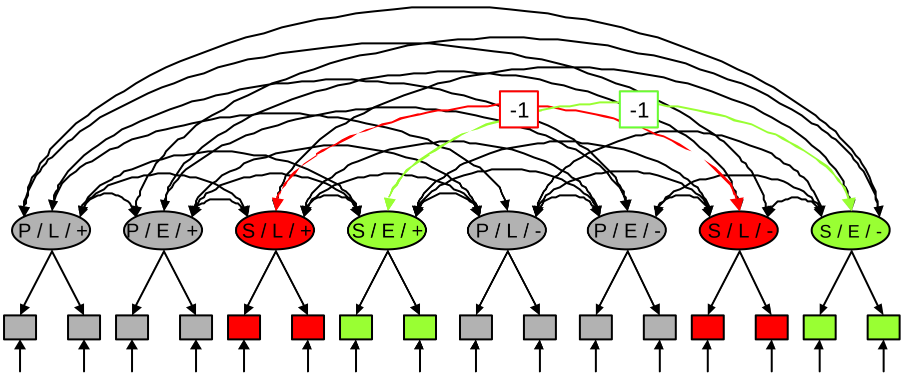

Figure 8. Alternative Model G

Model Evaluation

Parameters were estimated using the Maximum-Likelihood procedure of LISREL 8 (Jöreskog & Sörbom, 1996). The fit of the various models was examined using a number of different fit statistics to obtain a comprehensive evaluation of model fit (cp. Bollen & Long, 1993). First of all, χ^2 values were computed and tested for significance. Since χ^2 depends on sample size, the χ^2 / *df*-ratio, which should not exceed 2 (Bollen, 1989), was used as an additional criterion for overall model fit. In order to compare the six alternative models to the Target Model, χ^2-difference-statistics were computed. As differences of the χ^2-values of nested models form a χ^2-distribution themselves, this statistic can be used to test whether the parameter restrictions of the alternative models lead to a decrement in model fit with respect to the Target Model (Bollen, 1989). Besides χ^2–measures, the goodness of fit index (GFI) was taken into account. GFI can be regarded as a measure of the percent variance determined by the model. Since more parsimonious models usually explain less variance than do more complex models, the adjusted goodness of fit index (AGFI) was additionally inspected. AGFI adjusts GFI for the number of free parameters. Further on, the normed fit index (NFI) is looked at. The NFI can be regarded as an incremental fit index if nested models are inspected and thus provides additional information on the decrement in model fit that is caused by restrictions of the alternative models. GFI and NFI should reach values ≥ .95; since AGFI is adjusted for degrees of freedom, values ≥ .90 indicate an acceptable model fit (Hu & Bentler, 1995). Finally, the root mean square error of approximation (RMSEA) was taken into account. The RMSEA provides a 'test of close fit' of the model-implied covariance-matrix to the empirically obtained covariance-matrix; it should not exceed .05 (Browne & Cudeck, 1993).

In addition to these fit statistics, which provide information only on the question if there is *any* way to fit the model-implied covariance matrix to the empirical covariance matrix, we further examined the reliability and validity of the Target Model by inspecting indicator errors, factor loadings and factor intercorrelations. We followed a suggestion by Fornell and Larcker (1981) to evaluate the model by inspection of *variance extracted estimates* for each of the latent factors. Variance extracted estimates are defined for each latent construct as the ratio of the variance determined by the construct to the variance determined by the construct plus indicator errors:

$$\rho_{vc(\xi)} = \frac{\sum_{i=1}^{q} \lambda_{\xi i}^2}{\sum_{i=1}^{q} \lambda_{\xi i}^2 + \sum_{i=1}^{q} \mathrm{var}(\varepsilon_i)} \tag{1}$$

$\rho_{\mathrm{vc}(\xi)}$: variance determined by construct ξ. $\lambda_{\xi \mathrm{i}}$: loading of indicator i on construct ξ. ε_{i}: error of indicator i.

In the first place, this ratio should take on values ≥ .50 – otherwise more than 50% of indicator variance would not be determined by the construct but would be error variance. Second, all pairs k,l of latent variables should fulfill the following criterion:

$$\rho_{\mathrm{vc}(\xi k)} > \gamma^2_{\mathrm{kl}} \cap \rho_{\mathrm{vc}(\xi l)} > \gamma^2_{\mathrm{kl}} \tag{2}$$

$\rho_{\mathrm{vc}(\xi)}$: variance determined by construct ξ. γ^2_{kl}: squared estimated intercorrelation between factors k and l.

According to this criterion, for all pairs of latent variables the variance determined by the individual constructs should be greater than their squared intercorrelation. If the reverse were true, this would question the discriminant validity of the measurement model under inspection because in this case at least one latent construct would have more common variance with another latent construct that with its indicators.

4.2 Results

Scale Means and Standard Deviations

Scale means and standard deviations are reported in Table 1. As can be seen from Table 1, for all 'positive' scales (*beneficial tool* and *useful technology*), means in Study II were higher than in Study I descriptively, and significantly higher for 3 out of 4 scales. For all 'negative' scales (*autonomous entity* and *uncontrollable technology*), the means in Study I were descriptively higher than in Study II, but, however, significantly only for 2 out of 4 scales. For all scales, variances were significantly greater in Study I.

Table 1. Scale Means and Standard Deviations for Study I and II

	AM			*SD*		
Scale	Study I	Study II	*t*	Study I	Study II	*F* [a]
'Positive' scales						
PE / LW / BT	3.38	3.62	-4.49***	0.64	0.45	14.61***
PE / EC / BT	2.18	2.87	-7.37***	1.20	0.71	45.64***
CS / LW / PC	2.74	2.85	-1.84	0.69	0.59	4.37⁺
CS / EC / PC	2.58	3.12	-8.22***	0.82	0.60	22.03***
'Negative' scales						
PE / LW / AE	1.53	1.28	3.23**	0.91	0.75	14.98***
PE / EC / AE	1.00	0.87	1.86	0.85	0.64	16.05***
CS / LW / NC	1.93	1.56	4.86***	0.88	0.77	4.98⁺
CS / EC / NC	1.67	1.54	1.63	0.92	0.74	11.84*

Notes. PE: personal experience. CS: consequences for society. LW: learning and working. EC: entertainment and communication. BT: beneficial tool. PC: positive consequences (useful technology). AE: autonomous entity. NC: negative consequences (uncontrollable technology). Study I: *N* = 232. Study II: *N* = 251.
[a] Levene's Test for equality of variances.
[+] $p < .05$. *$p < .01$. **$p < .001$. ***$p < .0001$.

Internal Consistencies

The internal consistencies (Cronbach's α) of the eight scales were satisfactory in both studies (Table 2), with the only exception of the *personal experience/learning and working/beneficial tool*-scale, which reached an at most acceptable reliability of .70 in Study II. Generally, internal consistencies were higher in Study I, probably due to the greater heterogeneity of the sample in Study I and thus the greater variance of the scales (see Table 1).

Table 2. Internal Consistencies of the QCAAC-scales in Study I and II

	Cronbach's α	
Scale	Study I	Study II
'Positive' scales		
PE / LW / BT	.82	.70
PE / EC / BT	.88	.77
CS / LW / PC	.78	.76
CS / EC / PC	.83	.77
'Negative' scales		
PE / LW / AE	.86	.83
PE / EC / AE	.84	.76
CS / LW / NC	.83	.83
CS / EC / NC	.87	.82

Notes. PE: personal experience. CS: consequences for society. LW: learning and working. EC: entertainment and communication. BT: beneficial tool. PC: positive consequences (useful technology). AE: autonomous entity. NC: negative consequences (uncontrollable technology).

Correlations with Computer Use

The correlations of the eight attitude scales with self-reported computer use were substantial and significant in most of the cases. In Study I, all correlations were significant; most of the correlations amounted to about .40, with the exception of the correlations between the 'positive' scales and number of years of experience in using the computer, which ranged from .20 to .25. In Study II, the correlations with hours per week spent using the computer and hours per week spent using the internet were significant and substantial and ranged from .2 to .3. For the number of years the respondents were using the computer, the correlations were insignificant and numerically low in Study II (see Table 3). Again, this might be due to the relative homogeneity of the sample in Study II.

Table 3. Correlations between QCAAC-scales and Self-reported Computer Use

Scale	hours per week spent using the computer		hours per week spent using the internet		years of experience in using the computer	
	Study I	Study II	Study I	Study II	Study I	Study II
'Positive' scales						
PE / LW / BT	.43***	.27***	.36***	.23**	.41***	.26***
PE / EC / BT	.42***	.25***	.43***	.40***	.24**	-.05
CS / LW / PC	.25***	.15*	.23***	.21**	.22**	$.11^{+}$
CS / EC / PC	.41***	.24***	.37***	.30***	.24***	$.11^{+}$
'Negative' scales						
PE / LW / AE	-.43***	-.25***	-.34***	-.16*	-.46***	-.07
PE / EC / AE	-.45***	-.29***	-.39***	-.32***	-.49***	-.04
CS / LW / NC	-.45***	-.24***	-.42***	-.25***	-.42***	-.08
CS / EC / NC	-.45***	-.19*	-.40***	-.26***	-.36***	-.05

Notes. PE: personal experience. CS: consequences for society. LW: learning and working. EC: entertainment and communication. BT: beneficial tool. PC: positive consequences (useful technology). AE: autonomous entity. NC: negative consequences (uncontrollable technology). Study I: $N = 232$. Study II: $N = 251$.
$^{+}p < .05$. $^{*}p < .01$. $^{**}p < .001$. $^{***}p < .0001$.

Confirmatory Factor Analyses I: Evaluation of the Target Model

Overall model evaluation. The target model exhibited a good fit to the data in both studies. χ^2-values were significant at the .05-level in both studies, with χ^2 (76, N = 232) = 102.35 (p < .05) for Study I and χ^2 (76, N = 240) = 113.99 (p < .01) for Study II; but the χ^2 / df-ratios were smaller that 2. GFI, AGFI, NFI and RMSEA showed satisfactory values as well. GFI and NFI equaled .95 in both studies, AGFI amounted to .91 for Study I and .90 for Study II, RMSEA was .039 and .046 respectively.

Inspection of parameter estimates. According to the variance extracted estimates of the latent variables, the model can explain the data well. For both samples the variance extracted was > .50 for each latent variable. The discriminant validity criterion is also fulfilled: For each pair of latent variables their squared estimated intercorrelation was smaller than the indicator variance determined by each of the latent factors. Table 4 gives the estimates for **F** and the variance extracted estimates for the eight latent variables.

Table 4. Estimated Factor Intercorrelations (with Associated Standard Errors) and Variance Extracted Estimates

Study I	VEE	PE/LW/ BT	PE/EC/ BT	CS/LW/ PC	CS/EC/ PC	PE/LW/ AE	PE/EC/ AE	CS/LW/ NC	CS/EC/ NC
	.85	1.00							
PE/EC/BT	.57	0.48 (.06)	1.00						
CS/LW/PC	.52	0.51 (.07)	0.42 (.08)	1.00					
CS/EC/PC	.56	0.53 (.06)	0.70 (.06)	0.56 (.08)	1.00				
PE/LW/AE	.79	-0.53 (.05)	-0.44 (.06)	-0.36 (.07)	-0.43 (.06)	1.00			
PE/EC/AE	.57	-0.63 (.05)	-0.69 (.05)	-0.40 (.07)	-0.67 (.06)	0.74 (.04)	1.00		
CS/LW/NC	.70	-0.53 (.06)	-0.63 (.06)	-0.46 (.08)	-0.70 (.05)	0.55 (.06)	0.66 (.05)	1.00	
CS/EC/NC	.78	-0.44 (.06)	-0.69 (.05)	-0.39 (.08)	-0.68 (.06)	0.49 (.06)	0.72 (.04)	0.83 (.04)	1.00

Study II	VEE	PE/LW/ BT	PE/EC/ BT	CS/LW/ PC	CS/EC/ PC	PE/LW/ AE	PE/EC/ AE	CS/LW/ NC	CS/EC/ NC
PE/LW/BT	.71	1.00							
PE/EC/BT	.80	0.49 (.06)	1.00						
CS/LW/PC	.66	0.55 (.06)	0.51 (.06)	1.00					
CS/EC/PC	.66	0.62 (.06)	0.64 (.05)	0.71 (.05)	1.00				
PE/LW/AE	.73	-0.55 (.06)	-0.37 (.07)	-0.36 (.07)	-0.43 (.07)	1.00			
PE/EC/AE	.67	-0.68 (.05)	-0.70 (.05)	-0.40 (.07)	-0.71 (.05)	0.78 (.04)	1.00		
CS/LW/NC	.72	-0.53 (.06)	-0.55 (.06)	-0.68 (.05)	-0.70 (.05)	0.49 (.06)	0.67 (.05)	1.00	
CS/EC/NC	.75	-0.47 (.06)	-0.57 (.05)	-0.48 (.06)	-0.68 (.05)	0.45 (.06)	0.73 (.05)	0.77 (.04)	1.00

Notes. VEE: Variance extracted estimates.
PE:personal experience. CS: consequences for society. LW: learning and working. EC: entertainment and communication. BT: beneficial tool. PC: positive consequences (useful technology). AE: autonomous entity. NC: negative consequences (uncontrollable technology).

Confirmatory Factor Analyses II: Comparison of the Alternative Models to the Target Model

Test of topicality assumptions. In contrast to the good fit of the Target Model and according to any of the criteria taken into account, none of the Alternative Models A to E, in which assumptions concerning the topical structure are restricted, fitted the data. Furthermore, all of the alternative models exhibited a significantly worse model fit than the target model ($p < .0001$), as indicated by χ^2-difference-tests. This holds true for both samples. Table 5 and 6 give the fit statistics for the nested alternative models.

Table 5. Model Fit for the Target Model and the (Nested) Alternative Models Concerning Topicality Assumptions (Study I)

Model	χ^2	*df*	GFI	AGFI	NFI	RMSEA	χ^2_{diff}	ΔNFI
1. Target model	102.35^{+}	76	.95	.91	.95	.039		
2. Alternative Model A	598.70***	88	.74	.59	.73	.159		
Model 2 vs. Model 1		12					496.35***	.12
3. Alternative Model B	250.47***	78	.89	.81	.89	.098		
Model 3 vs. Model 1		2					148.12***	.06
4. Alternative Model C	175.96***	78	.92	.86	.92	.074		
Model 4 vs. Model 1		2					73.61***	.03
5. Alternative Model D	284.26***	78	.88	.79	.87	.107		
Model 5 vs. Model 1		2					181.91***	.08
6. Alternative Model E	234.15***	78	.89	.81	.89	.093		
Model 6 vs. Model 1		2					132.16***	.06
7. Null model	1888.22*** (df = 120)							

$^{+}p < .05$. $***p < .0001$.

Table 6. **Model Fit for the Target Model and the (Nested) Alternative Models Concerning Topicality Assumptions (Study II)**

Model	χ^2	*df*	GFI	AGFI	NFI	RMSEA	χ^2_{diff}	ΔNFI
1. Target model	113.99*	76	.95	.90	.95	.046		
2. Alternative Model A	649.94***	88	.74	.60	.73	.163		
Model 2 vs. Model 1		12					535.59***	.12
3. Alternative Model B	283.21***	78	.89	.80	.88	.105		
Model 3 vs. Model 1		2					169.22***	.07
4. Alternative Model C	213.15***	78	.90	.82	.91	.085		
Model 4 vs. Model 1		2					99.16***	.04
5. Alternative Model D	336.39***	78	.86	.76	.86	.118		
Model 5 vs. Model 1		2					222.40***	.09
6. Alternative Model E	248.94***	78	.90	.82	.90	.096		
Model 6 vs. Model 1		2					134.95***	.05
7. Null model	2435.85*** (df = 120)							

*$p < .01$. ***$p < .0001$.

Test of bidimensionality assumptions. Alternative Models F and G, which allow tests of the assumptions of bidimensional structure, must be rejected as well. Again, these models fitted the data significantly worse ($p < .0001$) than the target model, as indicated by the χ^2-difference statistics. Inspection of indicators of overall fit reveals that both models are inacceptable with respect to all fit statistics taken into account. This result holds true for both studies. Table 7 and 8 give the fit statistics of the nested alternative models.

Table 7. Model Fit for the Target Model and the (Nested) Alternative Models Concerning Assumptions of Bidimensional Structure (Study I)

Model	χ^2	*df*	GFI	AGFI	NFI	RMSEA	χ^2_{diff}	ΔNFI
1. Target model	102.35^{+}	76	.95	.91	.95	.039		
2. Alternative model F	286.31***	78	.89	.80	.87	.108		
Model 2 vs. Model 1		2					183.96***	.08
3. Alternative model G	193.06***	78	.91	.85	.91	.080		
Model 3 vs. Model 1		2					90.71***	.04

Note. $^{+}p < .05$. $^{***}p < .0001$.

Table 8. Model Fit for the Target Model and the (Nested) Alternative Models Concerning Assumptions of Bidimensional Structure (Study II)

Model	χ^2	*df*	GFI	AGFI	NFI	RMSEA	χ^2_{diff}	ΔNFI
1. Target model	113.99*	76	.95	.90	.95	.046		
2. Alternative model F	292.53***	78	.88	.79	.88	.107		
Model 2 vs. Model 1		2					178.54***	.07
3. Alternative model G	238.21***	78	.90	.82	.90	.093		
Model 3 vs. Model 1		2					124.22***	.05

Note. $^{*}p < .01$. $^{***}p < .0001$.

5 DISCUSSION

The results reported here clearly corroborate the claim that topicality as well as bipolarity should be taken into account when instruments for the measurement of attitudes toward the computer are constructed. The results show that excluding assumptions of topical structure as well as assumptions of bipolar (bidimensional) structure, causes a substantial decrease in model fit, as compared to the Target Model which contains these assumptions. This result occurs not only, when all of the parameters relating to topical assumptions are fixed (as in a 'pure' bidimensional model), but also when parameters relating to just one of the presumed topical clusters are restricted (i. e., only two additional restrictions are employed). The same holds for the bidimensionality assumption. The Target Model itself fits the data quite well, and the results could be cross-validated using two different samples, which differed not only in language, but also with respect to the distribution of profession, sex, age, and – most important – computer experience. In addition, the internal consistencies of the single scales are satisfactory (despite of the fact that they are relatively short with a maximum of seven items).

So far, the results illustrate the potential gain in diagnostic information that can be obtained if an attitude instrument is constructed under consideration of assumptions taken from theories of attitude representation. This procedure may lead to relatively low parsimony of the resulting measurement models as well as to unusually large numbers of scales and items. But we think that in case of the QCAAC this loss in parsimony is by far compensated by a gain in diagnostic information and content validity of the scales. So, if in a certain study – for example, in the context of implementing computer-based learning environments – the attitude toward the computer is of interest, it is warranted to apply only selective scales according to the respective research purpose – for example, only the two scales relating to both *learning and working* and *personal experience*.

There is, of course, still work to do. First, the topical distinctions, for instance between the computer as an instrument for *learning and working* on the one hand and the computer as an instrument for *entertainment and communication* on the other hand, are not self-evident. Thus, we need more research to explore the validity of the assumed topical structure of computer-related attitudes, especially with respect to its construct and criterion validity. This will be done by examining the relationship between the different scales, fine-grained measures of computer use and different constructs (e. g. political attitudes). Furthermore, we are using the QCAAC for the assessment of covariates in experiments on learning with linear text vs. learning with hypertext (see Christmann, Groeben, Flender, Naumann & Richter, 1999). A second line of our research are laboratory experiments employing methods of cognitive psychology. We are currently carrying out an experiment similar to the Tourangeau et al. (1991) study, in which the topical and bidimensional structure of computer-related attitudes – as assumed by the QCAAC – is put to test through priming procedures.

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