

The Vienna Risk-Taking Test – Traffic

A New Measure of Road Traffic Risk-Taking

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Abstract. The study reports results regarding the dimensionality and construct validity of a newly developed, objective, video-based personality test that assesses the willingness to take risks in traffic situations. On the basis of the theory of risk homeostasis developed by Wilde, different traffic situations with varying degrees of objective danger were filmed. During the test the respondents are asked to indicate at which point the action that is contingent on the described situation will become too dangerous to carry out. Latencies at the item level were recorded as a measure for the subjectively accepted degree of a person's willingness to take risks in the sense of the risk homeostasis theory by Wilde. In a study on 274 people with different educational levels and gender, the unidimensionality of the test as corresponding to the latency model by Scheiblechner was investigated. The results indicate that the Vienna Risk-Taking Test – Traffic assesses a unidimensional, latent personality trait that can be interpreted as subjectively accepted degree of risk (target risk value).

Keywords: risk-taking, traffic, personality test, dimensionality, construct validity

Introduction

Driving a car is dangerous, especially if a driver is willing to take risks in road traffic. The determining factors of risky behavior have been the focus of attention in traffic psychological research for a long time, while recently researchers have been increasingly shifting their focus toward personality traits (Iversen & Rundmo, 2002).

Different studies have examined traits such as locus of control, sensation-seeking, normlessness, and willingness to take risks (Burns & Wilde, 1995; Deffenbacher, Oetting, & Lynch, 1994; Montag & Comrey, 1987) more closely. These studies have in common their use of conventional personality questionnaires to assess personality traits, which feature not only the disadvantage that they can be faked, but also (Ones, Viswesvaran, & Reiss, 1996) a reduction of ecological validity as well as the necessity of a self-assessment of personal behavioral tendencies.

The study conducted by Horswill and McKenna (1999) is an exception to this methodological communality. Its aim was to measure, in an ecologically valid manner, (Neisser, 1978) respondents' willingness to take risks on the basis of how they selected their speed when driving in different traffic situations by using video clips as item material. The authors interpreted the selection of driving speed as an indicator for the respondent's willingness to take risks and were able to show that their test explained a large amount of the variance of the number of accidents, which could not be explained before by paper-and-pencil questionnaires on

speed selection. One weak point of this operationalization, however, is the test's lack of theoretical reference to current models of risky driving behavior despite its empirically established criterion validity. This makes interpretations of the test scores more difficult and also reduces the test's usefulness in planning theory-guided intervention programs for respondents referred to retraining because of traffic violations or road accidents.

One of the most common theoretical models of risky driving behavior is the risk homeostasis theory developed by Wilde (1978, 1994). This theory is characterized by the assumption of subjective and objective components of risk perception. Wilde (1978, 1994) assumes that risk-taking behavior in a road traffic situation is formed homeostatically by a correlation between a subjectively accepted degree of risk (target risk value) and an objective traffic situation on the basis of a cost-benefit ratio. Thus, the model assumes that people accept a certain amount of risk in daily life in exchange for an expected gain, which the intended actions seem to promise.

According to Wilde (1978, 1994), people compare the actual risk of a situation with the degree of risk that they are willing to accept. The degree of risk that respondents are willing to accept is called target risk value. If a respondent's objective degree of risk in a situation increases during a driving maneuver, he or she will adapt their driving behavior accordingly so that the target value of the perceived degree of risk remains constant. Wilde (1978, 1994) calls this the homeostasis principle.

Furthermore, the model also assumes that people differ

with respect to the degree of risk they are willing to take when confronted with given objective risks in daily life. In a specific traffic situation, the time elapsed until a person acts in order to bring the actual and the target risk value into accord may be an indicator of the willingness to take risks, that is, the subjectively accepted degree of risk (target risk value). Depending on the characteristics of a traffic situation (e.g., speed of vehicles, various driving maneuvers, etc.) and given a driver's target risk value, action to adjust driving behavior may take place sooner or later. If the amount of perceived danger falls below the subjectively accepted degree of risk, people tend to carry out risky actions or make risky decisions. If the perceived danger exceeds the subjectively accepted degree of risk, however, measures to reduce the danger will be taken. Thus, as a latent personality trait, the subjectively accepted degree of risk corresponds at a manifest level to the reaction time that elapses before a person either acts or decides not to carry out a specific driving maneuver in order to achieve risk homeostasis in the sense of Wilde (1978, 1994). According to Wilde the subjectively accepted degree of risk (target risk value) can be considered as a unidimensional latent personality trait that effects the respondent's behavioral decisions in various daily life situations such as gambling or driving.

Based on the theory of Wilde (1978, 1994), a pilot version of an objective, video-based personality test was constructed (Hergovich, Arendasy, Sommer, Bogner, & Olbrich, 2004). Originally the test was only one subtest of the Vienna Risk-Taking test (Hergovich & Schuster, 2003). This subtest, behavior in traffic, comprised 15 different traffic situations (including one warm-up item) featuring decisions at intersections and passing maneuvers using the construction rationale described by Schuster (2000).

The subtest was developed to assess the subjectively accepted degree of risk through the use of response latencies. The 15 video-clips of traffic situations required a situation-contingent action from the tested person (such as an overtaking maneuver in a situation where one meets another car). Seven video clips deal with passing maneuvers or traffic situations that require speed choices (e.g., passing a slower car in front of one's own before a blind bend, deciding when to slow down when approaching another car in front on a highway . . .). The remaining seven traffic situations deal with decisions at intersections (e.g., turning to the right in a situation with crosswise traffic, crossing a road that has right of way . . .). If the test-taker views the situation as too risky to perform the situation-contingent reaction, a button is pressed. As time progresses in each video-clip, the apparent danger becomes greater and greater. The mean latency until the button was pressed was taken as a measure of the respondent's subjectively accepted degree of risk (target risk value; Wilde, 1978, 1994) in traffic situations. Initial results as to the dimensionality and construct validity of this pilot version (Arendasy, Hergovich, Sommer, & Bogner, 2005) showed unidimensionality of response latencies according to the latency model of

Scheiblechner (1978; 1985). Although the reliability of this pilot version was good (Cronbach's $\alpha = .87$), we decided to enlarge the item pool in order to enhance ecological validity, additionally including items that represent situations of bad driving conditions.

In the following, the item pool of 15 items was expanded to 24 items (Hergovich, Bogner, Arendasy, & Sommer, 2005; Voglsinger, 2005). The nine new traffic situations mostly represented situations of bad visibility caused by poor weather or sight conditions.

The main aim of the study was to test the assumption of unidimensionality of respondents' subjectively accepted degree of risk for the new Vienna-Risk-Taking Test – Traffic. This hypothesis is in line with Wilde (1978, 1994). Moreover, we wanted to analyse the construct validity (convergent and divergent validity) of the newly developed objective personality test. We hypothesized positive correlations between risk-taking in traffic on the one hand and sensation-seeking and adventurousness on the other. Emotional stability, self-control, and responsibility were assumed to correlate negatively to risk-taking in traffic.

Method

Scheiblechner's latency model was applied to the response latencies measured at the item level to assess the dimensionality and scaling fairness of the newly developed test for the assessment of willingness to take risks in road traffic.

Within the framework of examinations of the reading speed of children, Rasch (1960/1980) developed a model based on item-response theory (IRT) for speeded tests. This model may be applied in order to assess the unidimensionality of all kinds of assessments in which response latency is the variable of interest. In these tests, a sample of respondents is generally confronted with a set of items and the latency for each item is recorded. These latencies follow a distribution characterized by the intensity parameter λ . In general, Rasch (1960/1980, p. 39) specified the model using Formula 1.1.

$$P(t|1) = \lambda \exp - \lambda t [1.1]$$

The probability of correctly solving a specific item within a given time span t is modeled via the intensity parameter λ . According to Rasch (1960/1980), as well as Jansen (1997) and Jansen and Glas (2000), the latter may be broken down into the multiplicative combined parameters θ_v and ϵ_i . The parameter θ_v represents the speed of a person v , while parameter ϵ_i stands for the easiness of the item i . This means the higher θ_v and ϵ_i , the shorter the expected reaction times.

However, Fischer and Kisser (1983) proved that this multiplicative decomposition of the intensity parameter λ entails some disadvantages. For instance, no sufficient sta-

tistics can be derived for θ_v and ε_i , which can be estimated independently of each other. Under the assumption that the ability parameter θ_v is a gamma-distributed random variable, Jansen (1997) derived the corresponding Marginal Maximum Likelihood (MML) estimates. However, according to Molenaar (1995), Fischer (1995), and Pflanzagl (1994), MML estimates have the disadvantage that the distribution of the estimated latent traits has to be presumed in advance. The quality of the parameter estimations, therefore, depends on the correctness of this assumption that is solely necessary for the parameter estimation and is not examined on its own, or, according to Fischer (1995), cannot be known in advance in most cases. In contrast to this method, Conditional Maximum Likelihood (CML) estimation provides the possibility to estimate person and item parameters in separate terms independently of assumptions about the distribution of the estimated latent traits. This is called *separability of item and person parameters* and allows for specifically objective comparisons among various persons or items. To ensure the separability of item and person parameters, the intensity parameter λ must be decomposed in a nonmultiplicative manner. Scheiblechner (1978, 1985) suggests an additive decomposition of the intensity parameter λ . In his latency model, λ is replaced by the term " $\theta_v - \varepsilon_i$."

For an examination of the fit of this model to empirical data sets, Scheiblechner (1979, 1985) suggests the application of a Likelihood Quotient Test (LRT) according to Andersen (1973) on the basis of a CML estimation of the item parameters. In this LRT, the likelihoods are related to each other in model estimations with varying degrees of restrictiveness, and this estimation results in a set of χ^2 statistics for the inferential statistical back-up. According to Rost (2004), the calculation of this fit statistic represents an examination of the assumption of person homogeneity, i.e., the statistical equivalence of item parameter estimations in different subgroups of people compared to the overall sample. Should the Andersen LRTs fail to reach the significance level, the assumption of person homogeneity made by the latency model may be retained and the item parameters can be generalized over the investigated subgroups. Analogous to this, the assumption of item homogeneity (Rost, 2004) of the latency model, i.e., the unidimensionality of a scale's hypothetically selected item subsets, can be examined via the LRT developed by Martin-Löf (1973). If the Martin-Löf statistic fails to reach the significance level, the null hypothesis – that the theoretically formed item subsets measure essentially the same unidimensional latent trait – can be retained. This essentially constitutes a check of the generalizeability over the investigated item or situation sets.

Procedure

The study was undertaken in 2005 at the University of Vienna and the laboratory of Schuhfried GmbHs.



Figure 1. Example of a picture taken from the video clip showing an overtaking situation taken from the Vienna Risk-Taking Test Traffic (WRBTV, Hergovich, Bognar, Arendasy, & Sommer, 2005). (Traffic situation 6 of 24: when would you no longer consider overtaking?)

left while a fire engine approaches from the left . . .) deal with decisions at intersections, while the remaining six situations deal with situations involving poor sight conditions. Thus, the new measure not only differs from previous measures of respondents' willingness to take risks in traffic situations (cf. Horswill & McKenna, 1999) because of its link to a theoretical model but also because of its coverage of a broader spectrum of potentially relevant traffic situations.

During testing, a decision was made to also administer the 20-item sensation-seeking scale to a part ($n = 200$) of the sample (each item was measured on a five-point Likert-scale) from Gniech, Oetting, and Brohl (1993), which is a short German version of the scale of Zuckermann (1979) and a newly developed questionnaire (inventory for traffic-relevant personality traits) regarding personality traits that are relevant to driving habits (Herle, Sommer, Wenzl, & Litzenberger, 2004). This inventory consists of four scales: emotional stability, responsibility, self-control, and adventurousness, which are measured on five-point Likert-scales. In a study by Sommer, Herle, and Wenzl (2004), it was demonstrated that drivers who had not been involved in accidents differed, in terms of their results, from drivers who had been assigned to a traffic-psychological investigation.

Results

The mean latencies of $k = 23$ items varied between 2.44 and 19.74 s ($M = 7.67$, $SD = 3.71$). Reliabilities (Cronbach's α coefficient) were calculated for all scales. α was .91 for the Vienna Risk-Taking Test – Traffic, .89 for the sensation-seeking scale, .72 for the emotional stability scale of the inventory for traffic-relevant personality traits,

.74 for the scale responsibility, .61 for the scale self-control, and .82 for the scale adventurousness.

The assumption of unidimensionality of the subtest behavior in traffic was examined on the basis of the classic partitioning criteria raw score, gender, age, and education level using the latency model of Scheiblechner (1978, 1979, 1985). For a part of the sample ($n = 185$) it was possible to calculate the latency model with respect to two further variables: maximum speed ever driven in a car on the highway and average speed driven on a highway. Because of the number of implemented model tests, the α -error level was set, a priori, to .01. The results of the likelihood ratio tests (LRTs) are depicted in Table 1.

As can be seen in Table 1, there was no need to reject the null hypothesis that the data fits the latency model. For all partitioning criteria the empirical χ^2 values were below the critical value at $\alpha = .01$. The results of the LRTs, thus, indicate that the parameter estimates can be generalized across the subsamples examined. Person homogeneity can be assumed. In addition, the assumption of item homogeneity was examined by dividing the items into two subgroups consisting of (1) traffic situations with passing maneuvers and traffic situations requiring speed choices and (2) traffic situations involving intersections or turns. The likelihoods of the two sets of test data were related to the likelihood of the entire data set. The resulting Martin-Löf statistics yielded a χ^2 value of 18.0 for $df = 129$. The critical χ^2 value for $\alpha = .01$ was 169.28, while the critical χ^2 value for $\alpha = .05$ was 156.51. The empirical χ^2 values stayed below the critical value in both cases. The latencies of the situations with passing maneuvers and the intersection and turn situations are, therefore, suited to measuring a unidimensional latent trait regardless of the type of traffic situation used (passing maneuvers vs. intersections or turns). A second analysis was undertaken with (1) traffic situations of good visibility for the driver and (2) traffic situations with bad visibility because of night or bad weather

Table 1. Sample size, means, standard deviations, and latency model goodness-of-fit tests (LRTs) for the 23 items of the Vienna Risk-Taking Test – Traffic (WRBTV, Hergovich, Bognar, Arendasy, & Sommer, 2005)

Model test criteria subsample description	<i>n</i>	Mean	<i>SD</i> ^a	χ^2 [22]	Critical χ^2 for $\alpha = .01$
Target risk value ^a	274	7.39	1.53	31.00	41.64
< 7.39 s	138	6.34	.77		
≥ 7.39 s	136	8.65	.99		
Sex	274	7.39	1.53	4.00	41.64
female	138	7.55	1.40		
male	136	7.66	1.53		
Age	274	7.39	1.56	10.00	41.64
< 39 years	159	8.16	1.48		
≥ 39 years	115	7.15	1.27		
Education ^b	274	7.39	1.53	33.00	41.64
ISCED 1–3	126	7.84	1.45		
ISCED 4–5	148	7.14	1.40		
Maximum speed on the highway	185	7.57	1.44	8.00	41.64
100–170 km/h	108	7.29	1.35		
171–280 km/h	77	7.97	1.47		
Average speed on the highway > 130 km/h	185	7.57	1.44	4.01	41.64
yes	77	7.78	1.48		
no	108	7.42	1.40		

Note. ^aThe values given represent the raw score divided by the number of items. ^bISCED (International Standard Classification of Education as defined by UNESCO).

Table 2. Correlations between the Vienna Risk-Taking Test Traffic (WRBTV), the scales of the Sensations Seeking Test, and the scales of the Inventory for Traffic-Relevant Personality Traits (*n* = 200)

	Sensation-seeking	Emotional stability	Responsibility	Self-control	Adventurousness
WRBTV (raw score)	.40**	-.10	-.13	-.28**	.34**
Sensation seeking		-.04	-.25**	-.40**	.74**
Emotional stability			.16*	.10	-.15*
Responsibility				.54**	-.35**
Self-control					-.37**

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

conditions. The Martin-Löf statistics for this partition yielded a χ^2 value of 6.0 for $df = 101$. The critical χ^2 value for $\alpha = .01$ was 136.97, while the critical χ^2 value for $\alpha = .05$ was 125.46. Thus, the empirical χ^2 values stayed below the critical values. The latencies of the situations are, therefore, once again suited to measuring a unidimensional latent trait regardless of the type of traffic situation (good vs. bad visibility) used.

The correlations between the Vienna Risk-Taking Test – Traffic, the sensation-seeking scale (Gniech et al., 1993), and the inventory for traffic-relevant personality traits (Herle et al., 2004) reveal data concerning the convergent validity of the measure. Confirming the hypotheses, the results show moderate, but significant correlations with sensation-seeking, self-control, and adventurousness (Table 2). The multiple correlation between risk-taking on the one hand, and the subscales of the inventory for traffic-relevant personality traits, as well as the sensation-seeking scale on the other amounted to .43 ($p < .001$). The correlation between the Vienna Risk-Taking Test – Traffic and maximum

speed on the highway was .32 ($p < .001$), and the correlation to average speed on the highway was .23 ($p < .005$).

Discussion

The aim of the study was to examine the dimensionality of the new video-based Vienna Risk-Taking Test – Traffic by Hergovich et al. (2005) using the latency model of Scheibelechner (1978, 1979, 1985) in order to test the assumption of the unidimensionality of respondents' subjectively accepted degree of risk (target risk value) in traffic situations assumed in the risk homeostasis theory developed by Wilde (1978, 1994; Burns & Wilde, 1995). The initial results of a pilot version of the test (Hergovich et al., 2005; Arendasy et al., 2005) were encouraging enough for us to expand the item pool.

The model tests implemented for the new item pool on

the basis of the classical separation criteria raw score, gender, age and education level, as well as the separation criteria maximum speed ever driven with a car on the highway and average driven speed on the highway indicated that the assumption of person-homogeneity made by the assumption of unidimensionality can be retained. A significant Andersen (1973) LRT for one of the partitioning criteria would have constituted a serious challenge for the assumptions regarding the generalizability of this personality trait over different subgroups of individuals made in the risk homeostasis theory by Wilde (1978, 1994; Burns & Wilde, 1995). Furthermore, the nonsignificant Martin-Löf statistic indicated that the latent trait measured can be generalized over two different traffic situations (passing maneuvers and speed choice situations vs. intersections) and over situations of varying visibility for the drivers sampled in the new measure. This result lends support to Wilde's (1978, 1994; Burns & Wilde, 1995) assumption about the generalizability of the latent personality trait target-risk value over different situations encountered in everyday road traffic. However, it must be stressed that many studies point to the pluridimensionality of the construct of risk-taking in traffic, which call into question the generalizability of our results (e.g., Ulleberg & Rundmo, 2002). The significant correlations with the sensation-seeking scales, the adventurousness scale, and self-control confirm the construct validity of the scale. Furthermore, the internal consistency (Cronbach's α) of the new version of the test resulting from the larger item-pool was slightly higher than for the pilot-version of the measure.

Altogether, the results obtained in this study not only provided further evidence regarding the dimensionality of the Vienna Risk-Taking Test – Traffic, but also confirmed two central assumptions of the risk homeostasis theory by Wilde (1978, 1994; Burns & Wilde, 1995) regarding its application to risk-taking in everyday traffic situations. This is a result of the theory-based item construction of this objective, video-based subtest. The availability of a measure such as this has the potential to enhance traffic safety through identification of potentially risky drivers who require additional restraints on specific aspects of their driving behavior.

Acknowledgments

The authors wish to thank Judith Voglsinger for gathering part of the data.

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