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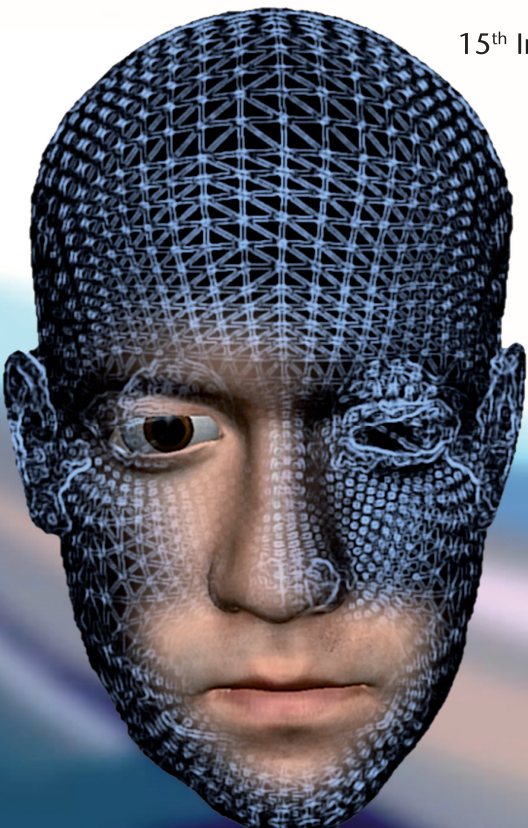

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Development and first validation of the PLBMR for lab-based microworld research

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Abstract.
In business and organisational psychology, microworlds and simulations are used in research to replicate real-world tasks which cannot be investigated "in vivo" due to their hazardous potential. For example, microworlds and simulations enable employee behaviour to be trained and investigated without being in the real physical location. To ensure that the observed behaviour mirrors the participants' authentic real-world performance and that they "dive" into the simulated task, "Presence" is recommended as a treatment check. In the current paper, a 6-item scale for measuring Presence for lab-based microworld research (PLBMR) is presented. The scientific roots of the questionnaire are briefly described as well as several validation steps. An exploratory factor analysis (N=88) led to a two-factor structure of the six items. This two-factor structure was confirmed in a sample with 233 participants, and in a third step, evidence for validity in terms of aspects such as authentic behaviour was found.

Keywords. Presence; measure; confirmatory factor analysis; simulation; questionnaire

Introduction

In business and organisational psychology research, microworlds and simulation environments are used to replicate the real world (e.g. Beaubien, & Baker, 2004), e.g. to investigate organisational factors affecting personnel development, leadership, teamwork and safety-related behaviour. In all such applications, but also in applications for education or entertainment in general, participants performing tasks in microworlds or acting in simulation environments ideally experience a feeling of "being" in the simulated world (Nash, Edwards, Thompson, & Barfield, 2000). Such a state is called *Presence* (e.g. Barfield et al., 1995). Presence is assumed to be the central factor indicating a realistic perception and performance in a simulation (Bystrom, Barfield, & Hendrix, 1999; Wirth et al., 2007). In the definition by the International Society of Presence Research, Presence is characterised as a "psychological state or subjective perception in which even though part or all of an individual's current experience is generated by and/or filtered through human-made technology, part or all of the individual's perception fails to accurately acknowledge the role of the technology in the experience" (ISPR, 2000, http://ispr.info/). In the last few years, many subtypes of Presence have been defined, including, for instance, Spatial Presence or Social Presence.

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The present paper addresses the dimension of Spatial Presence: the feeling of being in the simulated environment rather than in the real, physical world (ISPR, 2000; Wirth et al., 2007) and the psychological immersion into the scenario: the perception is directed toward objects created by technology (ISPR, 2000). The present paper aimed at investigating Presence as a treatment check for the experience of being in a microworld as if it is the actual environment. For a detailed description see Frank (2013).

Although objective instruments for measuring Presence have also been developed, it has become customary to conceptualise Presence as a subjective feeling and perception which should be measured subjectively, e.g. by rating scales (e.g. Barfield, & Weghorst, 1993; Slater et al., 1994; Ijsselsteijn et al., 2000). The instrument introduced in the present paper, the PLBMR for lab-based microworld research, also affords subjectively rated measures of Presence.

Table 1 lists the instruments for measuring Spatial Presence which have been developed so far, which are referred to in order to develop our own instrument for measuring Presence in a lab experiment. For our purpose of measuring Presence in terms of being part of an organisational context as described below, several instruments could not be considered further due to the fact that their psychometric properties are not adequately reported (see also Youngblut and Perrin, 2002; Slater, 1999; van Baren and Ijsselsteijn, 2004) or due to their length (instruments with more than 20 items were excluded).

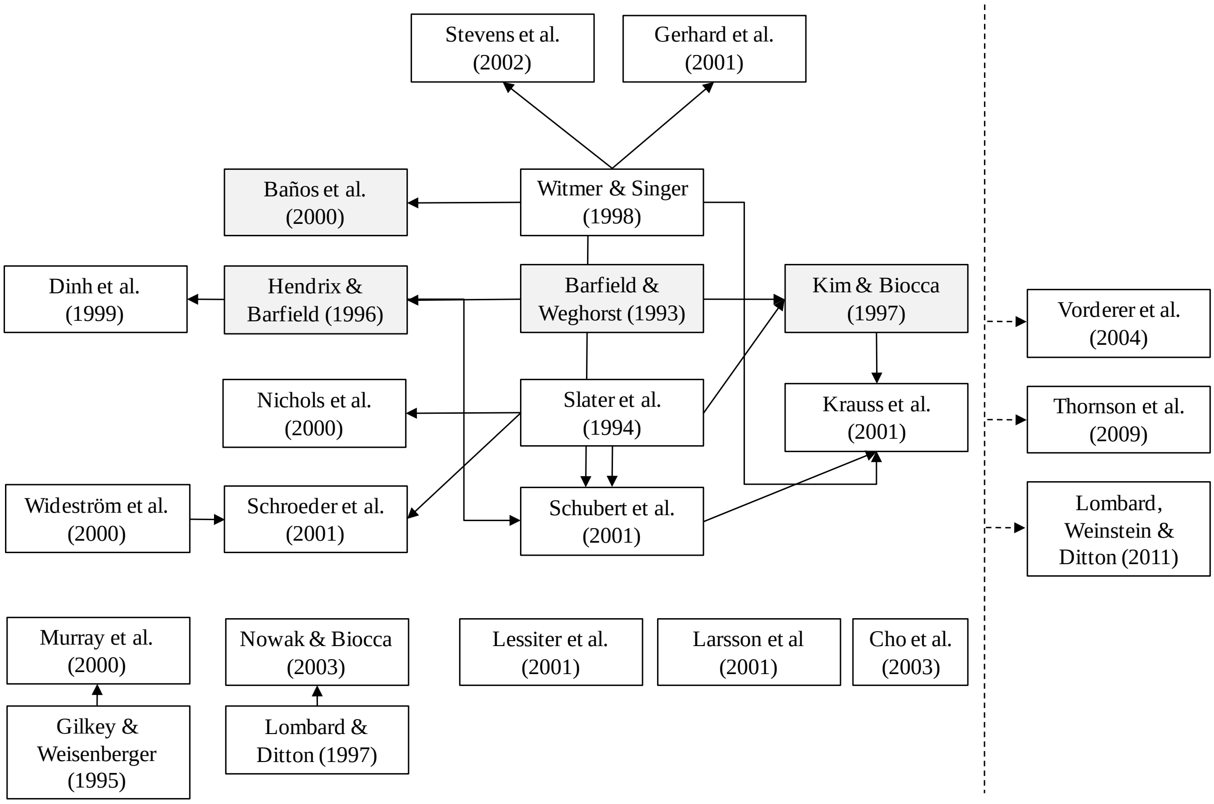

Figure 1. Connections between existing questionnaires: Arrows show the relation between questionnaires, dashed arrows show that the source of the questionnaire was not reported explicit, grey highlighted boxes indicate the questionnaires used in the present paper

In summary, none of the developed questionnaires have been persistently established in Presence research due to their various disadvantages and shortcomings (Thornson et al., 2009; Nichols et al., 2000). Thus, we developed an instrument suitable for microworlds with low immersion and quick-to-apply, which should be valid, reliable and sensitive.

Table 1. List of Presence measures to assess Spatial Presence, + = indications, such as for validity/reliability/sensitivity, are reported, - = indications are not reported

Authors	Name	Items	Validity	Reliability	Sensitivity
Barfield & Weghorst (1993)	-	10	+	+	+
Slater, Usoh & Steed (1994)	SUS	6	(-)	-	+
Hendrix & Barfield (1996)	-	2	+	+	+
Kim & Biocca (1997)	A Self-Report Measure of TelePresence	8	+	-	-
Lombard & Ditton (1997)[E]	-	103			
Witmer & Singer (1998)	PQ	32	-	+	(+)
Dinh, Walker, Song, Kobayashi & Hodges (1999)[E]	-	27			
Baños, Botella, Garcia-Palacios, Villa, Perpina und Alcañiz (2000)	Reality Judgement and Presence Questionnaire	18	-	+	-
Murray, Arnold & Thornton (2000)[E]	-	5+			
Nichols, Haldane & Wilson (2000)	-	9	+	+	+
Gerhard, Moore & Hobbs (2001)	-	19	(+)	-	+
Krauss, Scheuchenpflug, Piechulla & Zimmer (2001)[E]	-	42			
Larsson, Västfjäll & Kleiner (2001)	SVUP	19	+	-	+
Lessiter, Freeman, Keogh & Davidoff (2001)[E]	ITC-SOPI	44			
Schroeder et al. (2001)[E]	-	11			
Schubert, Friedmann & Regenbrecht (2001)	IPQ	14	+	+	-
Stevens, Jerrams-Smith, Heathcote & Callear (2002)[E]	OPQ	-			
Cho, Park, Kim, Hong & Lee (2003)	-	4	-	-	+
Nowak & Biocca (2003)[E]	-	29			
Vorderer et al. (2004)[E]	MEC-SPQ	32/48/64			
Thornson, Goldiez & Le (2009)[E]	TPI (Tendency toward Presence Inventory) *(Pretest)*	42			
Lombard, Weinstein & Ditton (2011)[E]	TPI (Temple Presence Inventory)	42			

[E] Questionnaires were excluded due to length and/or failure to report validity, reliability and sensitivity.

Table 2. Items of the PLBMR in German and English

Item	German	Translated into English for this paper
P1	Ich habe mich als Teil der AWAsim-Welt gefühlt	I felt like I was part of the WaTrSim world
P2	Die Simulationswelt hat bei mir Emotionen (z.B. Ärger, Traurigkeit, Zufriedenheit) ausgelöst	The simulation world triggered my emotions (e.g. anger, sadness, satisfaction)
P 3	Die Arbeit mit der AWAsim-Welt war für mich zufriedenstellend	Working in the WaTrSim world was satisfying for me
P 4	Während ich die Anlage bedient habe, habe ich zwischenzeitlich vergessen, dass ich an einer Studie teilnehme	While operating WaTrSim, I forgot for the time being that I was taking part in a study.
P 5	Die Arbeit in der AWAsim-Welt war für mich langweilig (-)	Working in the WaTrSim world was boring for me (-)
P 6	Während ich die Anlage bedient habe, bin ich gedanklich in die AWAsim Welt eingetaucht	While operating WaTrSim, my thoughts became immersed in the WaTrSim world

The PLBMR, which is introduced in this paper, aims to combine aspects of the existing questionnaires which were assumed to be most established and widely used (Figure 1): Kim and Biocca (1997, which is based on the work of Slater et al., 1994), on the scale attention/absorption by Baños et al. (2000, based on Witmer & Singer ,1998), on the work of Barfield and Weghorst (1993) and on Hendrix and Barfield (1996) into one short 6-item questionnaire based on the guideline for Presence questionnaires (Lessiter et al., 2001).

The PLBMR addresses Presence in the context of lab-based microworld research in which participants need to be present in an organisational setting where variables such as leadership, management decisions, safety climate or other organisational factors affect the behaviour of the individual employee. *The PLBMR should therefore measure the Presence in microworlds and the Presence of being an employee, worker or organisational member of the simulated organisation.* This was necessary because a coverstory was used to compensate the assumed low immersion of the microworld (Klimmt, & Vorderer, 2003). The research conducted in lab-based microworld simulations is also called research in special-purpose settings (Stone-Romero, 2011), in which inferences about cause in organisational contexts are more justified than in non-special-purpose settings, such as field studies (Stone-Romero, 2011). *Our special-purpose setting mirrors a production plant with hazardous potential in which the workers need to actively contribute to workplace safety and the overall safety of the plant.* The developed PLBMR was designed to briefly assess Presence in a low-immersive microworld. Consequently, most of the existing questionnaires did not fully match these requirements (e.g. analysed in high-immersive applications only, too many items or no psychometrics available cf. Table 1).

The developed PLBMR has 6 items, which are all rated on a 6-point Likert scale from 1 ("totally disagree") and 6 ("totally agree"), as listed in Table 2.

The validation procedure

In the present paper, the factor structure, reliability, and first findings concerning the sensitivity and validity of the PLBMR were analysed in different samples. First, the PLBMR items were analysed regarding their factor structure by performing an exploratory factor analysis (EFA), and second, a confirmatory factor analysis (CFA) was performed, followed by an analysis of relationships to relevant criteria.

Validation study 1 - Exploratory Factor Analysis

Participants

In 2012, 88 participants (47 female) took part in an experiment in which the microworld Wastewater Treatment Simulation (WaTrSim; Burkolter, Kluge, Grauel, & German, 2009) was used to investigate different organisational actions that were taken to support skill retention in the context of a production plant with high levels of automation and longer periods of non-use (see section on Validation). Participants were recruited by internet advertisement and flyers at the University of Duisburg-Essen (the recruitment procedure was similar for all subsequent studies). Participants were students from the engineering department and their average age was M=21.36 (SD=2.70, Range=18–31). In this study, as well as in all studies reported here, the general cognitive abilities measured with the "Wonderlic Personnel Test" (Wonderlic Inc, 2002) were M=26.30 (SD=4.83, Range=16–43; possible score of 50 points). The average rated Presence was M=3.44 (SD=0.78).

The microworld WaTrSim

WaTrSim has been used at the University of Duisburg-Essen in several experiments to investigate organisational actions taken as well as management decisions that address the safety-related behaviour of plant operators at the workplace, e.g. skill retention and the adherence to safety-related rules (e.g. von der Heyde, Brandhorst, & Kluge, 2013; Kluge, Burkolter, & Frank, 2012). In all studies reported below, participants operated WaTrSim (Burkolter et al., 2009). WaTrSim was developed in cooperation with experts in automation engineering at the University of Dresden, Germany, with the aim of achieving a realistic setting that depicts a process control task with high face validity (Kluge, Badura, & Rietz, 2013), and is a computer-based simulation of a plant for purifying industrial waste water. The operator's task in WaTrSim is to start up and control the plant, and the highest priority task is to maximise outcome goals and minimise the off-spec (Kluge et al., 2013). The actions of the operator must follow fixed and contingent sequences, while he or she closely monitors the parameters and considers the timing of the actions. The internal, convergent, and discriminant validity of WaTrSim have been empirically demonstrated (Burkolter et al., 2009).

"Presence" is required in our lab-based studies in order for participants to accept the "experimental story", e.g. being in the role of a control room operator, being responsible for plant safety. It is also required in order to accept orders from the "management", such as instructions concerning how to operate a machine or a plant, and in order to induce the participants' feeling of being in a dilemma between achieving the goal of a safe production and achieving the goal of high personal earnings. In terms of participants' acceptance of the story and their immersion into the organisational setting, it would not be possible for the effect of the experimental treatment to unfold without being present.

For the EFA, the PLBMR data were used from a previous experiment which investigated organisational actions to support skill retention (henceforth called skill retention). The organisational actions taken were divided into practice-oriented actions and actions in which the skill level was "checked" and assessed explicitly. In this study, Presence was required to ensure that the participants accepted the explanation for why they were being tested while in the role of a control room operator (for further details, see Kluge & Frank, accepted).

The instrument to measure Presence in lab-based microworld research

Presence in lab-based microworld research was measured with the newly developed "PLBMR", which consists of six items rated on a six-point Likert scale from 1 ("I totally dis agree") to 6 ("I totally agree"). The questionnaire was applied in German and was filled in by each participant after the end of the experiment.

Table 3. Factor loadings and reliabilities of two factors and the items (*N*=88).

Item Nr.	Item	Factor	
		1.	2.
1. Factor: Spatial Presence			
P1	I felt like I was part of the WaTrSim world	**.557**	.500
P2	The simulation world triggered my emotions (e.g. anger, sadness, satisfaction)	**.703**	.086
P4	While operating WaTrSim, I forgot for the time being that I was taking part in a study	**.768**	-.048
P6	While operating WaTrSim, my thoughts became immersed in the WaTrSim world	**.663**	.382
2. Factor: Satisfaction			
P3	Working in the WaTrSim world was satisfying for me	-.121	**.895**
P5	Working in the WaTrSim world was boring for me (-)	.363	**.618**
Eigenvalue		2.48	1.08
% of variance		41.41	18.06
α		.692	.482

Results

An exploratory factor analysis (EFA) was conducted using SPSS 21. The principal component analysis and varimax rotation were conducted with six items. The Kaiser-Meyer-Olkin criterion shows an acceptable sample size (KMO=.7461; Kaiser & Rice, 1974), and Bartlett's test of sphericity indicated an adequate item correlation for a principal component analysis ($\chi^2(15)=89.35$, $p<.001$). Two components showed Eigenvalues above Kaiser's criterion of 1 and together explained a variance of 59.47%. Based on Kaiser's criterion and scree plots, these two factors were used in the final analysis. Table 3 shows the factor loadings after rotation. The items that cluster on the same factor suggest that factor 1 represents "Spatial Presence" (Cronbach's α=.69) and factor 2 "Satisfaction" (Cronbach's α=.48). The reliability for the PLBMR with six items was Cronbach's α=.707. In addition, the total score of PLBMR scale correlated positively with the two factors (Factor Spatial Presence: r=.768, $p<.001$; Factor Satisfaction: r=.637, $p<.001$).

Validation study 2 - Confirmatory Factor Analysis

Method

A confirmatory factor analysis (CFA) was conducted with Amos 21 to confirm the two-factor structure with a sample comprising four subsamples. Two studies ("skill retention with eye tracking" and "ordinary work day", henceforth called SREY and OWD) investigated organisational actions taken to support skill retention in a highly automated production context (Greve & Kluge, 2012; Miebach, 2013). In these two studies, the *PLBMR was required to assess the importance of skill retention as a crucial aspect of their work as a plant operator responsible for workplace safety.*

The other two studies ("violations-short" and "violations-long") investigated organisational actions taken to increase the adherence to safety-related rules in order to improve workplace safety (von der Heyde, Brandhorst, & Kluge, 2013). In the "violations-short" study, participants acted in the role of a control room operator and *needed to accept the experimental story that violating a mandatory rule could cause a deflagration, which could subsequently damage the plant or cause severe injuries to the local inhabitants.* The experimental procedure lasted for two hours (von der Heyde et al., 2012). The "violations-long" study required the participants to assume the role of an operator who has to take care of the plant for 48 weeks (simulation runs for five hours).

The operator in this experimental story needs to be "present" in an induced goal conflict. This conflict consists of a trade-off between a high salary and safety. In contrast to the "violations-short" study, the "violations-long" study introduces safety audits in which operators are monitored regarding their compliance with the mandatory procedure. In both studies, *Presence is required in order for participants to actually experience the goal conflict and to accept the management decisions, such as the safety audits, as being realistic*.

Participants

233 students (74 female) participated in the studies introduced briefly above, in which WaTrSim was used in 2012 and 2013. Participants' average age was M=22.06 years (SD=3.25, Range=18 – 36). All participants were students (96% students of the engineering department). The average Presence level was M=3.39 (SD=0.96).

Instruments

The two-factor structure of the six-item PLBMR as described in Table 2 was analysed by performing a CFA.

Results

For the two-factor CFA, the χ^2 statistic proved to be significant ($\chi^2(8)=22.34$, p=.004). The ratio of $\chi^2/df=2.79$ indicated an acceptable model fit (Carmines & McIver, 1981). The fit indices CFI=.95 and SRMR=.05 indicated a good model fit and RMSEA=.08 indicated an acceptable model fit for the two-factor model (Hu & Bentler, 1999; Brown, 2006). The standardised loadings and residuals are shown in Figure 2. In addition, the two factors correlate significantly with each other (r=.305, p<.001) and indicate satisfactory reliabilities (factor Spatial Presence: α=.67, factor Satisfaction: α=.65, PLBMR: α=.68).

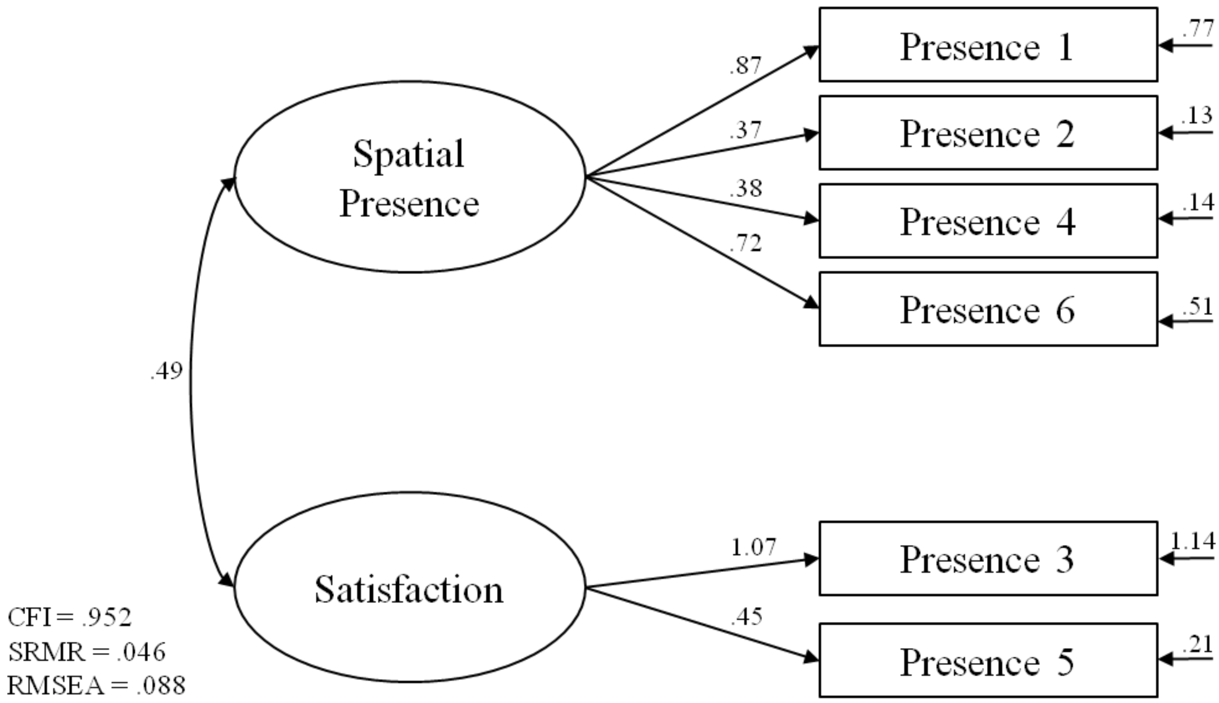

Figure 2. Standardised factor loadings and residuals of the model (N=233)

Table 4. Descriptive Statistics for studies skill retention, SREY, OWD, violations-short and violations-long

Study	N (female)	Age *M* (*SD*, Range)	GMA (max. 50) *M* (*SD*)	Presence M 1 *M* (*SD*)	Presence M 2 *M* (*SD*)
Skill Retention	88 (47)	21.36 (2.70, 18–31)	26.30 (4.83)	3.44 (0.78)	
SREY	11 (1)	23.73 (2.69, 21–30)	29.91 (5.13)	3.50 (0.71)	
OWD	25 (15)	20.68 (2.36, 18–30)	25.96 (4.63)	3.23 (0.84)	2.78 (0.93)
Violation-short	26 (7)	22.84 (2.80, 19–30)	27.96 (6.04)	3.72 (0.91)	
Violatinos-long	149 (36)	21.33 (2.41, 18–33)	28.46 (6.40)	3.31 (0.94)	

Note: GMA = General Mental Abilities

Additional analysis for indicating validity

Methods

We analysed the convergent, internal validity and sensitivity and calculated the retest reliability for the PLBMR. For the analyses, we conducted Pearson correlations, regressions and ANOVAS with data from the five studies introduced above, all of which used WaTrSim: The first study investigated organisational actions taken to support skill retention in which attention and effort were also measured as criteria. The skill retention was also investigated in SREY study. The third study simulated an ordinary work day (OWD, see section Validation 2-CFA), which was used to analyse the retest reliability. The remaining studies addressed the impact of organisational actions taken to increase workplace safety. In this latter study, participants also rated the degree of the authenticity of their own behaviour. In addition, we used all five studies (skill retention, SREY, OWD, violations-short and violations-long) to analyse sensitivity.

As introduced above, all studies required an "experimental story" in order to make the experimental treatment more relevant and significant. This was considered as important for the internal validity of the experiment.

Participants

Across all listed studies (*N*=299, see above), the Presence level was *M*=3.38 (*SD*=0.88) and all participants were engineering students. The participants of the five studies are described in Table 4.

Criteria for Validation

We assumed a relationship between the degree of PLBMR and the degree of attention and performance in terms of "effort" in study skill retention and authentic behaviour in the violations-long study. In addition, we assumed a difference between the degree of PLBMR in all experiments (described in sections Validation 1-EFA and Validation 2-CFA) due to their varying experimental story – design and physical and cognitive fidelity.

Attention: Attention was assessed by an adapted version of the scale "attention/concentration" (Cronbach's α=.83, Kluge, 2004) and was rated on a Likert scale ranging from 1 ("I totally disagree") to 6 ("I totally agree"). The average attention level was M=5.21 (SD=0.67)

Effort: Effort was measured with three items (Cronbach's α=.54) on a Likert scale ranging from 1 ("I totally disagree") to 5 ("I totally agree"), with items such as "I tried hard to recall the start-up procedure". The average effort level was M=3.89 (SD=0.71).

Authentic behaviour: Behaviour was measured with the item "I acted in the simulation world like I would do in a comparable real situation" on a Likert scale ranging from 1 ("I totally disagree") to 6 ("I totally agree").

For measuring Presence, the six-item PLBMR version was used as introduced above (Table 2). The average level was M=3.30 (SD=1.63).

Results

Convergent Validity:

For the skill retention study, significant small to medium correlations between attention and the PLBMR (r=.306, p=.004) and effort and PLBMR (r=.230, p=.031) were found.

Retest Reliability:

For the OWD study, a Pearson correlation showed that the items of the PLBMR measured at two time points correlated significantly (see Table 5)

External Validity:

In the violations-long study (N =149), results showed a small to medium relationship between the PLBMR and the ratings concerning authentic behaviour (r=.333, p<.001). A regression analysis showed a significant effect of the PLBMR on the criterion authentic behaviour (B=.192, $SE(B)$=.045, $ß$=. 333, T=4.28, p<.001), which explained 11.1% of the variance (F(1,147)=18.28, p=< .001).

Sensitivity:

Comparing Presence in all studies, overall, the Presence was experienced similarly in all studies and no significant differences were shown (F(4,298)=1.55, p=.187, η^2_p=.021). Nevertheless, the post-hoc test (LSD) showed a significantly higher Presence level in the violations-short study than in the violations-long study (*Mean difference*=.412, SD=.189, p=.028), as well as a significantly higher level in the violations-short study than in the OWD study (*Mean difference*=.491, SD=.246, p=.047).

Discussion

The present study identified the two factors Spatial Presence and Satisfaction for the six-item PLBMR in an EFA and CFA, and showed satisfactory reliabilities. First indications in support of the convergent and external validity, retest reliability as well as the sensitivity of the PLBMR were shown. In contrast to many existing questionnaires which only report limited validity-, reliability or sensitivity criteria or which are not quick-to-apply (Table 1), the PLBMR meets all the criteria.

Implications for further research

The PLBMR was tested in a German-speaking area with samples including students; thus, an adaptation for other languages needs to be tested. Additionally, the PLBMR has been applied to organisational research with mainly one microworld (WaTrsim), which can be assumed to be a low-immersive microworld compared, e.g., to Virtual Reality Applications.

Table 5. Pearson correlation for Study 2 between items of Presence at two measurement points (T1 and T2) (*N*=25)

	1	2	3	4	5	6	7	8	9	10	11
T1											
P1 (1)	-										
P2 (2)	.681**	-									
P3 (3)	.367	.190	-								
P4 (4)	.231	.290	-.109	-							
P5 (5)	.342	.094	.379	.274	-						
P6 (6)	.654**	.607**	.184	.405*	.241	-					
T2											
P1 (7)	**.645****	.642**	.287	.321	.225	.499*	-				
P2 (8)	.392	**.689****	.023	.483*	.205	.366	.632**	-			
P3 (9)	.317	.427*	**.666****	.183	.416*	.326	.609**	.403*	-		
P4 (10)	.251	.274	-.128	**.706****	.177	.233	.536**	.576**	.290	-	
P5 (11)	.223	.100	.384	-.122	**.627****	.028	.348	.241	.608**	.132	-
P6 (12)	.158	.332	.317	.041	.081	**.287**	.593**	.386	.658**	.343	.400*

Nevertheless, the results showed that Presence in such special-purpose settings (Stone-Romero, 2011) can be enhanced by experimental stories and the introduction of organisational factors that can compensate for low immersion (Klimmt & Vorderer, 2006). Future research should apply the PLBMR in high-immersive simulation environments using different samples (Welch et al., 1996; Slater et al., 1994) and compare the PLBMR with additional objective measures (Ijsselsteijn et al., 2000).

As a practical implication, we consider the PLBMR to be a useful and quick-to-apply treatment check in microworlds for measuring the Spatial Presence level. However, future studies are required to verify the results found in the present study.

References

Baños, R.M., Botella, C., Alcañiz, M., Liaño, V., Guerrero, B., & Rey, B. (2003). Immersion and Emotion: Their Impact on the Sense of Presence. Cyberpsychology & Behavior, 6, 467–476.

Barfield, W., & Weghorst, S. (1993). The Sense of Presence within Virtual Environments: A Conceptual Framework. In G. Salvendy and M. Smith (Eds.), Human-computer interaction: Applications and case studies (pp. 699-704). Amsterdam: Elsevier.

Beaubien, J.M., & Baker, D.P. (2004). The use of simulation for training teamwork skills in health care: how low can you go? Quality and Safety in Health Care, 13, i51-i56.

Brown, T.A. (2006). Confirmatory factor analysis for applied research. New York: Guilford Press.

Burkolter, D., Kluge, A., German, S., & Grauel, B. (2009).Wastewater Treatment Simulation (WaTrSim): Validation of a new process control simulation tool for experimental training research. Proceedings of the Human Factors and Ergonomics Society, 1969-1973.

Bystrom, K.E., Barfield, W., & Hendrix, C. (1999). A Conceptual Model of the Sense of Presence in Virtual Environments. Presence: Teleoperators & Virtual Environments, 8, 241-244.
Carmines, E.G., & McIver, J.P. (1981). Analysing models with unobserved variables. Analysis of covariance structure. In G.W. Bohrnstedt and E. Borgatta (Eds.), Social Measurement: Current Issues (pp. 65–115). Beverly Hills: Sage.
Cho, D., Park, J., Kim, G., Hong, S., Han, S., & Lee, S. (2003). Dichotomy of Presence Elements: The Where and What. Proceedings of the IEEE Virtual Reality, 273-274.
Draper, J.V., Kaber, D.B., & Usher, J.M. (1998). TelePresence. Human Factors, 40, 354–375.
Frank, B. (2013). Entwicklung und erste Validierung des Fragebogens zur Messung von Presence als Treatment-Check in laborbasierter Forschung mit Mikrowelten (PLBMR) [Development and first validation of the questionnaire Presence in lab-based microworld research (PLBMR)]. Master thesis, University of Duisburg-Essen.
Gerhard, M., Moore, D., & Hobbs, D. (2001). Continuous Presence in Collaborative Virtual Environments: Towards the Evaluation of a Hybrid Avatar-Agent Model for User Representation. Proceedings of the International Conference on Intelligent Virtual Agents, 137-153.
Greve, J., & Kluge, A. (2012). Die Messung von Mental Workload und Situation Awareness während des Erlernens einer komplexen Prozesskontrolltätigkeit im Rahmen einer Eyetracker-Untersuchung. Kognitive Systeme, 1, http://duepublico.uni-duisburg-essen.de/go/kognitivesysteme/2013/1.
Hendrix, C., & Barfield, W. (1996). Presence within Virtual Environments as a Function of Visual Display Parameters. Presence: Teleoperators and Virtual Environments, 5, 274-289.
Hu, L.-T., & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling A: Multidisciplinary Journal, 6, 1-55.
International Society of Presence (2000). The Concept of Presence: Explication Statement. Retrieved 23.05.2013 from http://ispr.info/.
Ijsselsteijn, W.A., de Ridder, H., Freeman, J., & Avons, S.E. (2000). Presence: Concept, Determinants, and Measurement. International Society for Optics and Photonics, Humans Vision & Electronic Imaging, 520-529.
Nash, E.B., Edwards, G.W., Thompson, J.A., & Barfield, W. (2000). A Review of Presence and Performance in Virtual Environments. International Journal of Human-Computer Interaction, 12, 1-41.
Nichols, S., Haldane, C., & Wilson, J.R. (2000). Measurement of Presence and Its Consequences in Virtual Environments. International Journal of Human Computer Studies, 52, 471-491.
Kaiser, H.F., & Rice, J. (1974). Little Jiffy, Mark IV. Educational and Psychological Measurement, 34, 11-117.
Kim, T., & Biocca, F. (1997). TelePresence via Television: Two Dimensions of TelePresence May Have Different Connections to Memory and Persuasion. Journal of Computer-Mediated Communication, 3, http://jcmc.indiana.edu/vol3/issue2/kim.html.
Klimmt, C., & Vorderer, P. (2003). Media Psychology "Is Not Yet There": Introducing Theories on Media Entertainment to the Presence Debate. Presence: Teleoperators & Virtual Environments, 12, 346-359.
Kluge, A., Badura, B., & Rietz, C. (2013). Communicating production outcomes as gains or losses, operator skill and their effects on safety-related violations in a simulated production context. Journal of Risk Research, 1-8.
Kluge, A., Burkolter, D., & Frank, B. (2012). "Being prepared for the infrequent": A comparative study of two refresher training approaches and their effects on temporal and adaptive transfer in a process control task. Proceedings of the Human Factors and Ergonomics Society Annual Meeting September 2012, 56, 2437-2441.
Kluge, A., & Frank, B. (accepted). Counteracting skill decay: Four refresher interventions and their effect on skill retention in a simulated process control task, Ergonomics.
Larsson, P., Västfjäll, D., & Kleiner, M. (2001). The Actor-Observer Effect in Virtual Reality Presentations. CyberPsychology and Behaviour, 4, 239-246.
Lessiter, J., Freeman, J., Keogh, E., & Davidoff, J. (2001). Across-Media Presence Questionnaire: The ITC-Sense of Presence Inventory. Presence: Teleoperators and Virtual Environments, 10, 282–297.
Miebach, J. (2013). The impact of work experience on skill retention of complex work tasks in high risk working environments - an experimental study in a simulation environment. Master thesis, University of Duisburg-Essen.
Stone-Romero, E.F. (2011). Research strategies in industrial and organisational psychology: nonexperimental, quasi-experimental, and randomized experimental research in special purpose and nonspecial purpose settings. In S. Zedeck (Ed.), APA Handbook of Industrial and Organisational Psychology. Volume 1, Building and Developing the Organisation (pp. 37-72). Washington, DC: APA
Schramm, H., Gysbers, A., Hartmann, T., Klimmt, C., Laarni, J., Ravaja, N., Sacau, A., Baumgartner, T., & Jäncke, P. (2004). MEC Spatial Presence Questionnaire (MEC-SPQ) Short Documentation and Instructions for Application. Available online http://academic.csuohio.edu/kneuendorf/frames/MECFull.pdf (25.06.2013)
Schubert, T., Friedmann, F., & Regenbrecht, H. (2001). The Experience of Presence: Factor Analytic Insights. Presence: Teleoperators & Virtual Environments, 10, 266-281.
Slater, M. (1999). Measuring Presence: A Response to the Witmer and Singer Presence Questionnaire. Presence: Teleoperators & Virtual Environments, 8, 560–566.
Slater, M., Usoh, M., & Steed, A. (1994). Depth of Presence in Virtual Environments. Presence: Teleoperators and Virtual Environments, 3, 130-144.
Thornson, C.A., Goldiez, B.F., & Le, H. (2009). Predicting Presence: Constructing the Tendency Toward Presence Inventory. International Journal of Human-Computer Studies, 67, 62-78.
van Baren, J., & IJsselsteijn, W.A. (2008). Measuring Presence: A Guide to Current Measurement Approaches. IST-FET OMNIPRES project, 5, http://www.immersive-medien.de/sites/default/files/biblio/PresenceMeasurement.pdf.
von der Heyde, A., Brandhorst, S., & Kluge, A. (2013). Safety related rule violations investigated experimentally: One can only comply with rules one remembers and the higher the fine, the more likely the "soft violations". Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 57, 225-229.

von der Heyde, A., Presting, P., Kluge, A., & Badura, B. (2012). Social norms and their impact on safety-related rule violations in process control: Does it make a difference if operators are aware that residents will be injured? Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 56, 243-247.

Welch, R.B., Blackmon, T.T., Liu, A., Mellers, B.A., & Stark, L.W. (1996). The Effects of Pictorial Realism, Delay of Visual Feedback and Observer Interactivity on the Subjective Sense of Presence. Presence: Teleoperators and Virtual Environments, 5, 263–273.

Witmer, B.G., & Singer, M.J., 1998. Measuring Presence in Virtual Environments: A Presence Questionnaire. Presence, 7, 225–240.

Wirth, W., Hartmann, T., Böcking, S., Vorderer, P., Klimmt, C., Schramm, H., et al. (2007). A Process Model of the Formation of Spatial Presence Experiences. Media Psychology, 9, 493-525.

Wonderlic Inc, 2002. Wonderlic Personnel Test. Libertyville, IL: Author.

Youngblut, C., & Perrin, B. M. (2002). Investigating the Relationship Between Presence and Performance in virtual environments. IMAGE Conference, Arizona.