Psychometric properties
of the Effort-Reward Imbalance Questionnaire

Johannes Siegrist[*], Jian Li, Diego Montano,
Centre for Health and Society, Faculty of Medicine, Heinrich-Heine-University Duesseldorf, Germany

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[*] johannes.siegrist@med.uni-duesseldorf.de

1. Introduction: Measurement of the effort-reward imbalance

In principle, different measurement approaches towards assessing ERI are feasible. To some extent, contextual information (e.g. job descriptions, level of salary, career mobility, job loss) can be used. However, core aspects of the model concern experiences and perceptions of working people. Therefore, self-report data are of core importance. These data can be acquired through qualitative interviews, ecological momentary assessments, standardized questionnaires or structured interviews. In large scale social epidemiological research an economic measure in terms of a psychometrically well justified standardized questionnaire has proven to be particularly useful.

In this tradition, the ERI model has been operationalized as a standardized self-report measure consisting of three psychometric scales: effort, reward, and over-commitment [1]. There are two versions of the ERI questionnaire: the original or long version, which consists of 22 Likert-scaled items, and the short version of 16 items. The shorter version of the original questionnaire is more easily applicable in large scale epidemiologic investigations.

2 Construction of scores

2.1 Long version

2.1.1 Effort scale

Effort is measured by five or six items respectively that refer to demanding aspects of the work environment: ERI1-ERI6. The 5-item version excluding physical load (item ERI5) has been found to be psychometrically appropriate in samples characterized predominantly by white collar jobs whereas the 6-item version was appropriate in blue collar samples and occupational groups with manual workers.

All questions refer to the present respectively last occupation and subjects are asked to indicate how far the items reflect their typical work situation. The rating procedure is defined as follows with higher ratings pointing to higher efforts (see table 1): (1) strongly disagree, (2) disagree, (3) agree, and (4) strongly agree.

Table 1: 4 point Likert scale answer format in the ERI-Questionnaires.

Strongly disagree	□	(1)
Disagree	□	(2)
Agree	□	(3)
Strongly agree	□	(4)

It should be noted that the Likert scale answer format has been changed from a two-step procedure with five categories (see table 2) to a one-step procedure with only four categories (see table 1) as suggested by [2] (see also [3]). Psychometric analyses revealed no substantial differences between these two procedures, but response rates were substantially higher in the one-step procedure (e.g. [4]). We therefore recommend to use this latter approach. We are aware that the absolute scale scores are no longer strictly comparable between the scoring formats. In Section 4 we describe an adjustment procedure for comparing scores across studies and present some reference data.

Table 2: Former 5 point Likert scale answer format of the ERI-Questionnaires. Not recommended.

Disagree	□	(1)
Agree, and I am not at all distressed	□	(2)
Agree, and I am somewhat distressed	□	(3)
Agree, and I am distressed	□	(4)
Agree, and I am very distressed	□	(5)

A sum score of the 4-point Likert ratings is computed as the unidimensionality of the effort scale has been documented (see table 3). A total score based on the five items measuring extrinsic effort varies between 5 and 20 (or 6 and 24 with 6 items). The higher the score, the more effort at work is assumed to be experienced by the subject.

2.1.2 Reward scale

Reward is measured by ten 4-point Likert scaled items (items ERI7-ERI16) coded as in table 1. We postulate a three-factorial structure of the construct of occupational reward as given in Table 3. Therefore, a second-order factor analysis is expected to define a one-dimensional scale. The rating procedure is performed in analogy to the effort scale. Please be aware that the long version of the ERI-Questionnaire (ERI-L version 22.11.2012) has now only 16 items. In comparison with the previous version 29.08.07 of the ERI-Questionnaire we have merged the old items ERI7 ("I receive the respect I deserve from my superiors") and ERI8 ("I receive the respect I deserve from my collegues") into the new item ERI7 ("I receive the respect I deserve from my superior or a respective relevant person."). In this way, the long version of the ERI-Questionnaire can also be applied to self-employed or small proprietors using the same 4-point Likert scaled items. It should also be noted that the Likert scale answer format for the reward scale has also been changed from a two-step procedure with five categories (see table 2) to a one-step procedure with only four categories (see table 1).

After variable recoding procedures (see the coding of the ERI-Questionnaire Long Version in table 5 below), lower ratings point to lower rewards. A sum score of these ratings is computed which varies between 10 and 40. The lower the score, the fewer occupational rewards are supposed to be received by the person.

Table 3: ERI-Questionnaire. Long version. Construction of scores.
Scales Items Range

Scales	Items	Range
Effort scale	ERI1 to ERI6	6 to 24
Reward scale	ERI7 to ERI16	10 to 40
Overcommitment scale	OC1 to OC6	6 to 24
Subscales of the reward scale:		
Esteem	ERI7 to ERI9, ERI14	4 to 16
Promotion	ERI10, ERI13, ERI15 and ERI16	4 to 16
Security	ERI11 and ERI12	2 to 8

Additional analyses using scores of the three sub-scales (esteem, promotion, and security) instead of the total reward score provide further meaningful information in theoretical and practical terms (see e.g. [5]).

2.1.3 Over-commitment scale

Over-commitment is measured by six items (items OC1-OC6) derived from an earlier test containing 29 items ([1]). Items range from 1 (low) to 4 (high over-commitment) (see table 4).

Table 4: 4 point Likert-scaled items for the "over-commitment" dimension.

OC1: I get easily overwhelmed by time pressures at work		
Strongly disagree	□	(1)
Disagree	□	(2)
Agree	□	(3)
Strongly agree	□	(4)

Note that item OC3 has to be reversed (see table 5). The scale score is computed by adding item values. Although the six over-commitment items load usually on a single factor, some studies report a stronger loading of OC1 on the effort factor (e.g. [6, 7]).

Table 5: ERI Questionnaire. Long version. Item coding

		Strongly disagree	Disagree	Agree	Strongly agree
ERI1	I have constant time pressure due to a heavy work load.	☐	☐	☐	☐
ERI2	I have many interruptions and disturbances while performing my job.	☐	☐	☐	☐
ERI3	I have a lot of responsibility in my job.	☐	☐	☐	☐
ERI4	I am often pressured to work overtime.	☐	☐	☐	☐
ERI5	My job is physically demanding.	☐	☐	☐	☐
ERI6	Over the past few years, my job has become more and more demanding.	☐	☐	☐	☐
ERI7	I receive the respect I deserve from my superior or a respective relevant person.	☐	☐	☐	☐
ERI8	I experience adequate support in difficult situations.	☐	☐	☐	☐
ERI9	I am treated unfairly at work. Reverse coding	☐	☐	☐	☐
ERI10	My job promotion prospects are poor. Reverse coding	☐	☐	☐	☐
ERI11	I have experienced or I expect to experience an undesirable change in my work situation. Reverse coding	☐	☐	☐	☐
ERI12	My employment security is poor. Reverse coding	☐	☐	☐	☐
ERI13	My current occupational position adequately reflects my education and training.	☐	☐	☐	☐
ERI14	Considering all my efforts and achievements, I receive the respect and prestige I deserve at work.	☐	☐	☐	☐
ERI15	Considering all my efforts and achievements, my job promotion prospects are adequate.	☐	☐	☐	☐
ERI16	Considering all my efforts and achievements, my salary / income is adequate.	☐	☐	☐	☐

2.2 Short version

2.2.1 Effort scale

Effort is measured by three 4-point Likert scaled items (ERI 1-3) coded as in table 7. To facilitate the measurement in future studies we recommend a consistent 4-point Likert scale (strongly disagree, disagree, agree, strongly agree) for all components of the questionnaire. A total score based on the three items measuring effort varies between 3 and 12 (see table 6).

Table 6: ERI-Questionnaire. Short version. Construction of scores.

Scales	Items	Range
Effort scale	ERI1 to ERI3	3 to 12
Reward scale	ERI4 to ERI10	7 to 28
Overcommitment scale	OC1 to OC6	6 to 24
Subscales of the reward scale:		
Esteem	ERI4 and ERI8	2 to 8
Promotion	ERI5, ERI9 and ERI10	3 to 12
Security	ERI6 and ERI7	2 to 8

2.2.2 Reward scale

Reward is measured by seven items (ERI4-ERI10). A sum score of these items varies between 7 and 28. The score coding for the reward scale is reproduced in table 7. The lower the score, the fewer occupational rewards are supposed to be received by the person.

2.2.3 Over-commitment scale

Because the over-commitment questionnaire was already the result of a previous psychometrically validated reduction capturing the essence of this personal pattern of coping with work, it was included without further change into the short version.

2.3 ER-ratio

The established procedure of data analysis consists in estimating the association of single scales, and eventually their interaction, with outcomes of interest. In this context and in accordance with a core theoretical assumption, it was proposed that the interaction of the effort and reward scales in terms of a ratio may capture the imbalance between efforts and rewards at the individual level. The quantification of imbalance at the individual level provides important additional information with a single indicator. This procedure is comparable to the use of synthetic measures in epidemiological studies (e.g. Body Mass Index, see [8, 9] for methodological discussion).

To compute the ER-ratio, the effort score is put in the enumerator and the reward score in the denominator:

$$ER = \frac{E}{Rxc}$$

where E is the effort score, R the reward score, and c a correction factor that adjusts for the unequal number of items of the effort and reward scores.

For instance, if E contains 5 items and R contains 11 items, c, the correction factor is 5/11=0.454545.With this formulation, the interpretation of the ER-ratio is facilitated for descriptive purposes. For ER = 1, the person reports one effort for one reward, for ER < 1, there are less efforts for each reward, and for ER > 1, the person reports more efforts for each reward.

Please be aware that the cut-off point of ER = 1 does not represent a clinically validated threshold. We propose to use the ER-ratio either as continuous variable or as categorical variable based on the quantiles of the distribution (e.g. quartiles, see for example [10, 11]).

Table 7: ERI-Questionnaire. Short version. Item coding.

		Strongly disagree	*Disagree*	*Agree*	*Strongly agree*
ERI1	I have constant time pressure due to a heavy work load.				
ERI2	I have many interruptions and disturbances while performing my job.				
ERI3	Over the past few years, my job has become more and more demanding.				
ERI4	I receive the respect I deserve from my superior or a respective relevant person.				
ERI5	My job promotion prospects are poor. Reverse coding				
ERI6	I have experienced or I expect to experience an undesirable change in my work situation. Reverse coding				
ERI7	My job security is poor. Reverse coding				
ERI8	Considering all my efforts and achievements, I receive the respect and prestige I deserve at work.				
ERI9	Considering all my efforts and achievements, my job promotion prospects are adequate.				
ERI10	Considering all my efforts and achievements, my salary / income is adequate.				
OC1	I get easily overwhelmed by time pressures at work.				
OC2	As soon as I get up in the morning I start thinking about work problems.				
OC3	When I get home, I can easily relax and 'switch off' work. Reverse coding				
OC4	People close to me say I sacrifice too much for my job.				
OC5	Work rarely lets me go, it is still on my mind when I go to bed.				
OC6	If I postpone something that I was supposed to do today I'll have trouble sleeping at night.				

3 Psychometric information

3.1 Original version

3.1.1 Scale reliability

Published data document satisfactory internal consistency in terms of Cronbach's α (usually α > 0.70) of the three scales of effort, reward and over-commitment. Test-retest-reliability has been analysed in several studies so far with satisfactory results [6, 12, 13]. More recently, multiple assessment of scales has been conducted, using 'Ecological Momentary Assessment' technique documenting a strong correlation between the summary estimate based on the self-administered questionnaire and the momentary estimate based on EMA technique (see table 2 in [14]).

3.1.2 Factorial structure

Exploratory and confirmatory factor analyses were conducted with satisfactory results. In particular, confirmatory factor analyses based on data from five international samples resulted in a good model fit for the unidimensional "effort" and "over-commitment" scales and the three factorial structure of the "reward" scale. Goodness of fit was assessed by the GFI- and the AGFI-index, in addition to Chi-square and root-mean square residual. For details see [1]. These results were replicated and further validated in several third order confirmatory factor analyses (e.g. [15, 4, 6]). Figure 1) demonstrates the theoretically postulated structure of scales for the short version.

3.1.3 Convergent validity

Several studies have documented the independent explanatory power of the ER scales compared to the scales of the demand-control-model [16] despite the fact that the scales 'demand' and 'effort' show modest to strong correlations (ranging between r = 0.30 and r = 0.60; [17, 18], among others). Independent explanatory power of the ER scales was also demonstrated in case of the model of organizational injustice [19].

3.1.4 Discriminant validity

Significant differences in mean scores of effort, reward and over-commitment according to gender, age, socio-economic status, and other socio-demographic characteristics were observed in a large number of studies. We cannot give here a comprehensive review but, as an example, Wahrendorf et al. (2012) point to the social gradient of effort-reward imbalance (ERI) [20].

3.1.5 Criterion validity

See 'Selected publications on research evidence' on our website http://www.uniklinik-duesseldorf.de/med-soziologie.

3.1.6 Sensitivity to change over time

Importantly, several studies reported convincing sensitivity of the scales to indicate real changes over time [21, 6, 13].

3.2 Short version

3.2.1 Scale reliability

In a study by Leineweber et. al. (2010) all Cronbach's α coefficients are equal to or higher than 0.80 (effort =0.80, reward = 0.84, over-commitment=0.85), indicating a satisfying internal consistency. Item-total correlations varied between 0.55 (0.42 for corrected item-total correlation) and 0.86 (0.78 for corrected item-total correlation) and were all above the threshold of 0.30. In another study [3] all

Cronbach's α coefficients were higher than 0.70, suggesting satisfactory internal consistency (Cronbach's alpha of 0.74 for "effort", 0.79 for "reward", and 0.79 for "over-commitment"). Further, all item-total correlation coeffcients were above the threshold of 0.30, indicating considerable consistency of items defining respective scales (see also [22]).
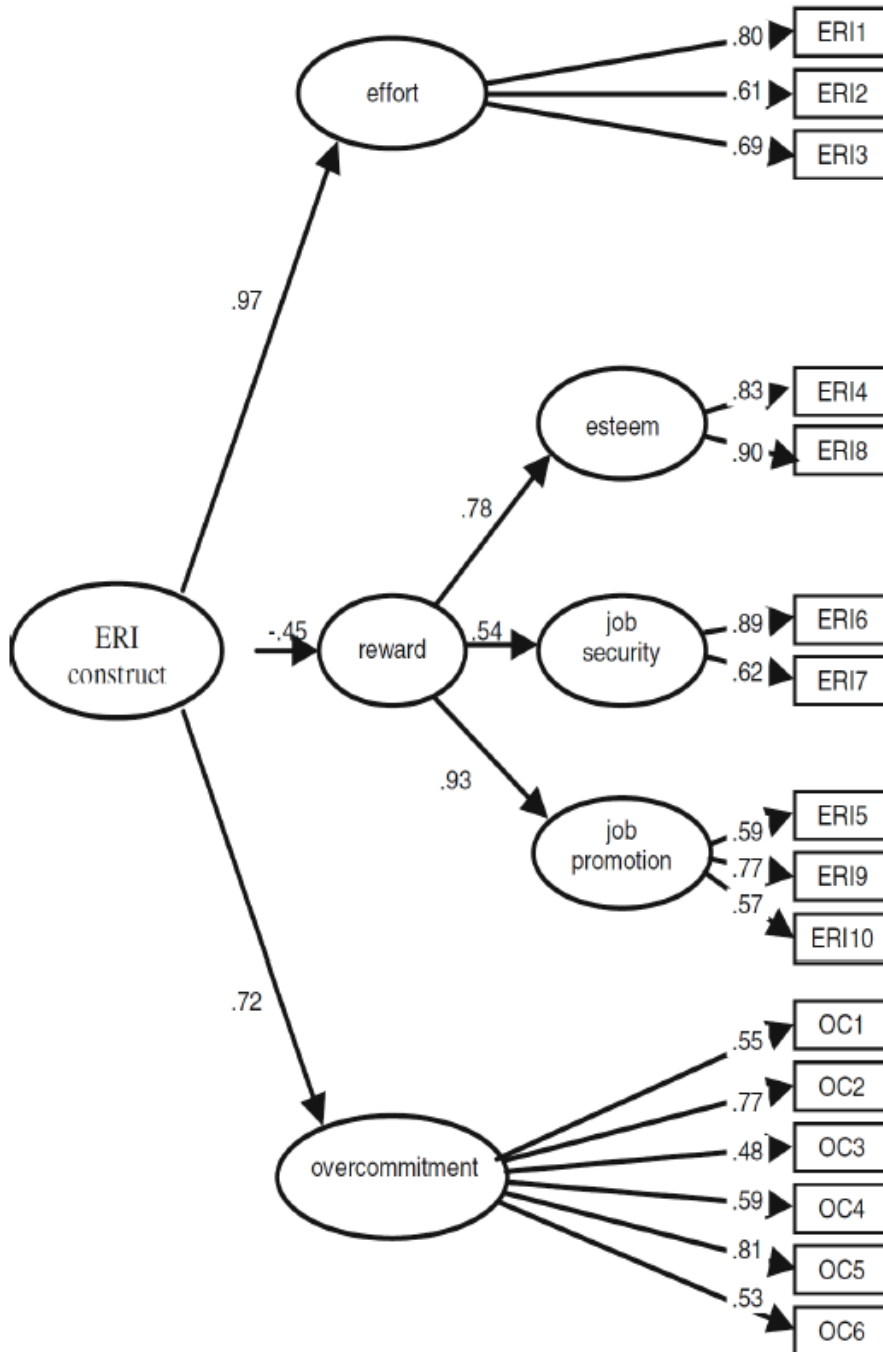

Figure 1: Factorial structure of the effort-reward imbalance model. Source: [3].

3.2.2 Factorial Structure

The ER scales were tested with confirmatory factor analysis (see Figure 1 which represents the second-order model testing the theoretical structure, RMSEA = 95% CI 0.057 - 0.060). This factorial structure was replicated in other studies (e.g. [23]).

3.2.3 Discriminant validity

Again, as indicated for the long version (see Section 3.1.4), the short version scales demonstrated discriminant validity in several studies published so far (e.g. [23, 22, 24, 3]).

3.2.4 Criterion validity

Published studies so far document criterion validity of the short scales with regard to several health measures (see 'Selected publications on research evidence' on our website http://www.uniklinik-duesseldorf.de/med-soziologie).

3.3 Updated references

Between 2014 and 2019 a number of new studies on psychometric properties of the ERI scales were published, and additional information on psychometric validation in different languages is available. Although not fully consolidated, major publications are listed in the References [25 – 43].

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