

The ERI Model: Stress and Health

Initiated by Johannes Siegrist, the former Director of this Institute, in 1996, an extensive research program of this Institute has been – and continues to be – concerned with empirical research on associations of stressful work with health-related outcomes. In short, ERI (effort-reward imbalance) represents a theoretical model, rooted in sociological and social psychological research on social exchange, with explicit links to psychobiological stress theory. It aims at explaining adverse health effects of costly transactions in core social roles (paid and unpaid work, educational work, engagement in close social relationships) defined by a lack of reciprocity between efforts spent and rewards received in turn ('high cost/low gain' conditions). If experienced as a violation of the principle of just exchange, these conditions cause negative emotions and sustained stress responses, impairing health in the long run.

Importantly, ERI in terms of a health-adverse psychosocial work environment, measured by a psychometrically validated tool, has received wide interest and application among international researchers in social and occupational epidemiology, psychology, and in biomedical and clinical research. The questionnaire measuring ERI at work is available in a number of languages. It has been implemented in several epidemiologic cohort studies, and it is used as a monitoring tool for workplace health promotion in organizations. As a conceptual extension, ERI has also been operationalized to assess failed reciprocity in household and family work, in educational work, and in close social relationships.

This text starts by a short *section 1* describing the theoretical framework, followed by an extensive *section 2* on measurement, data analysis, and application of the questionnaire in international research. This section is composed by a PDF document (2.1) on the measurement of ERI at work, and by a short description of three further ERI questionnaires (measuring failed reciprocity in household and family work, in close social relationships, and in educational work (2.2) (with links). In addition, a table displaying an overview of major international longitudinal studies measuring ERI at work is provided (2.3).

In *section 3*, information on empirical research evidence on associations of ERI with a variety of health outcomes is given, focusing on systematic reviews and meta-analyses, narrative reviews, and books. In view of a large amount of original papers dealing with this topic, readers are referred to the published literature, using data bases such as PubMed, PsycINFO, Scopus, Web of Science.

The final *section 4* contains important information on copyright and administration, and it presents the questionnaire 'ERI at work' in several available languages (with links).

1. Theoretical framework

1.1 The model's hypotheses

This conceptual approach focuses on a fundamental, evolutionary stable principle of exchange in costly social transactions, the norm of reciprocity (Gouldner 1960). Persons providing an activity that has some utility to other persons expect an equivalent return according to the notion of just exchange. Violations of this principle cause adverse effects, such as strong negative emotions arousing bodily stress responses, thoughts and actions of revenge, or even

disruption of social relationships. Contracts have been developed to secure equivalence of return in costly transactions. The work contract is of crucial importance, given the eminent role of continued labour market participation in people's life. In essence, it regulates the exchange between efforts delivered by employees and rewards provided by the employer. The model of effort-reward imbalance at work assumes that contractual promises are often not met in everyday work, such that workers are exposed to high effort without receiving adequate reward in return. Importantly, three basic types of reward are transmitted, salary or wage (financial reward), career promotion or job security (status-related reward), and esteem or recognition (socio-emotional reward). Continued experience of 'high cost/low gain' at work frustrates basic reward expectations, compromising workers' self-esteem and causing sustained psychobiological stress reactions with adverse long-term effects on mental and physical health (Siegrist 1996).

According to the model, distinct extrinsic and intrinsic constraints prevent workers from avoiding this imbalance, thereby increasing their risk of developing a stress-related disorder. Extrinsic constraints include lack of alternative choice in the labour market (e.g. due to poor skill level, advanced age, restricted mobility) and forced competition within one's job (e.g. due to organizational downsizing, restructuring, technological change). In a competitive labour market, unbalanced high effort is often expended as a strategic choice to improve future promotion prospects in occupational trajectories. While the level of effort spent depends on extrinsic demands it is also influenced by the working person's motivation. This model defines one such motivation, a pattern of excessive work-related commitment ('over-commitment') as an intrinsic constraint, maintaining continued experience of effort-reward imbalance at work.

The model is composed of two extrinsic components, effort and reward, and an intrinsic component, 'over-commitment'. The following hypotheses define the links between stressful work and elevated risks of disease. First, each component, high effort, low reward, and high over-commitment, exerts separate effects on the health outcome under study, reflecting a dose-response relationship. Concerning reward, this holds true for each one of its sub-components as well. Second, the effect size on health produced by the combined exposure to high effort and low reward exceeds the effect size of each single component. Third, over-commitment moderates the effect size of effort-reward imbalance on health, with a higher level increasing the risk. A further hypothesis maintains that the effect size on health due to the imbalance between high effort and low reward exceeds the effect size due to the imbalance between low effort and high reward, in accordance with the theory of loss aversion (Kahneman & Tversky 1979; Hobfoll 1989). A graphical representation of the model is depicted in Figure 1.

Figure 1

1.2 Distinct theoretical features of the model

While this theoretical model is rooted in sociological and social psychological research on social exchange and equity (Blau 1964; Adams 1965), its original, distinctive features need to be emphasized. First, the significance of social reciprocity for health is restricted to costly exchange in core social roles, primarily the work role and family roles. With this focus on sociological role theory (Merton 1968), the model analyses links of opportunities and constraints at the macro-and meso-social level (e.g. labour market, work organization) with individual experiences and biological responses. These links are mediated by stress-physiological processes, where the sustained experience of social reward deficiency activates distinct areas in the brain reward circuits that trigger physiological arousal in the organism with adverse long-term consequences for health (McEwen 2007; Schultz 2006; Siegrist 2016).

Second, in addition to a sociological and stress-theoretical extension of basic notions of psychological equity theory, this model also specifies the consequences of inequity. According to Adams (1965), the experience of inequity results either from high cost and low gain, or from low cost and high gain. In either case, adaptive responses are expected, but differential consequences are not predicted by theory. In contrast, in this model, adverse health risks are caused exclusively by 'high cost/low reward' conditions, while 'low cost/high effort' conditions do not seem to matter for health (for preliminary evidence, Li et al. 2019). Furthermore, psychological equity theory distinguishes between an extrinsic and an intrinsic standard of comparison in evaluating inequity. Whereas the first standard refers to distributive injustice, comparing own gains with respective gains of significant others, the second standard refers to injustice of exchange, weighing the person's costs of effort against their gains of reward. Whether these two types of reference standards produce different effects, has not been clearly elaborated. For instance, research on organisational justice, a concept with close links to equity theory (Greenberg & Cohen 1982), postulates adverse effects of distributive justice on health, without distinguishing differences between extrinsic and intrinsic standards (Greenberg 2010). In contrast, the effort-reward imbalance model accords primacy to the intrinsic reference standard, in accordance with the dominant principle of social reciprocity mentioned (see also Fehr & Fischbacher 2003). A further distinction of this model refers to the psychological expectancy value theory (Schönpflug & Batmann 1989). According to this approach, people generally react to high cost/low gain conditions either by leaving the respective context or by reducing their efforts in an attempt to minimize the imbalance. Yet, the model of effort-reward imbalance postulates continued preservation of this imbalance in the range of conditions defined above.

Finally, the effort-reward imbalance model complements the highly influential theoretical concept of stressful work in terms of high demand and low control in two relevant aspects (Karasek & Theorell 1990). First, whereas this latter model represents a 'black box' approach focusing on extrinsic components of job tasks ('psychological demands', 'decision latitude', 'skill discretion'; in a further conceptual development supplemented by 'social support at work'), the former model combines extrinsic elements of the work and employment context with intrinsic, personal elements, the motivational pattern of coping with work demands. Strengths and limitations of this extension have been discussed elsewhere (Theorell 2000; Siegrist & Li 2020). The second aspect concerns the differential focus on control versus reward at work. As mentioned, the former notion addresses primarily characteristics of the job task, whereas the latter notion includes aspects of the employment career (promotion prospects, job stability) as well as material and non-material aspects of compensation.

Experiences of control and reward may also differ to some extent if emotional and stress-physiological reactions are explored (Theorell 2016). However, it is important to assert that the two models were shown to provide independent predictions of stress-related disease risks of similar strength (Duchaine et al. 2021; Niedhammer et al. 2021). Furthermore, combining both models was shown to increase the effect size of health risks if compared to separate estimates (Juvani et al. 2018).

In conclusion, the effort-reward imbalance model represents an original theoretical contribution to research on health-related effects of adverse psychosocial work environments. While complementing established concepts it is also open to further developments, including an integration into more comprehensive approaches.

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2. Measurement and data analysis

2.1 Measuring effort-reward imbalance (ERI) at work

2.2 Measuring ERI beyond paid work

2.2.1 Household and family work

In the traditional definition of gender roles, unpaid household and family work has been attributed to women, and this trend still prevails in economically advanced societies. The extension of the model's theoretical notions to this type of costly social exchange and its measurement by psychometrically validated scales was accomplished by Stephanie Sperlich, Richard Peter and Siegfried Geyer (2012). Later, a German version (Sperlich & Geyer 2015a) and a Brazilian-Portuguese version of the questionnaire (Vasconellos et al. 2016) were published. Although this measure was exclusively used among women in childcare responsibility, it was tested among fathers attending a family-focused rehabilitation more recently, with satisfying psychometric properties (Sperlich et al. 2016).

The questionnaire is composed by three factors, 'effort' (8 items), 'reward' (11 items), and 'over-commitment' (4 items). Whereas 'effort' and 'over-commitment' were expected to represent a uni-dimensional structure, 'reward' was composed by four dimensions, (1) affection from children; (2) recognition from partner; (3) intrinsic value of family and household work; and (4) societal esteem. The item content of the two uni-dimensional scales follows closely the respective notions related to paid work, while the content of reward items differs markedly, given the relevance of socio-emotional rather than social status-related aspects. In confirmatory factor analysis the theoretical structure of the construct was reproduced, with satisfactory fit indices (Sperlich et al. 2012). In addition to single scale scores, an effort-reward ratio has been proposed to quantify the imbalance between effort and reward at individual level.

Several reports document associations with indicators of poor mental health among women (as summary, Sperlich & Geyer 2016) and among men (Sperlich et al. 2016). Furthermore, a mediating effect of effort-reward imbalance in household and family work in the association of socioeconomic position (education) with health (somatic complaints) was demonstrated (Sperlich & Geyer 2015b). In summary, there is solid evidence of the value of extending the theoretical model beyond the context of paid work. Future research is expected to apply the construct in prospective investigations and in intervention studies.

Link English version/ German version

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2.2.2 Close social relationships

Different from the work role, these types of social exchange are mainly realized in private contexts, with less pervasive demands and with a lack of material rewards or social control. Nevertheless, even in relationships defined by affection, appreciation, and altruism, unfair, unbalanced exchange and recurrent disappointments may occur, resulting in reduced mental health and well-being. With a focus on partnership and parent-child relationships, a short questionnaire was developed to assess these experiences in dyadic exchange. Based on eight Likert-scaled items, it represents a three-factorial structure. The first scale relates to the quality of partnership, the second scale concerns exchange with one's child or children (appreciation, difficulties with educational efforts), and the third one addresses negative life events, such as severe disappointments in intimate relationships.

The three-factorial structure of the questionnaire was confirmed in five different samples in Germany, United Kingdom, and United States of America, including middle-aged and older population groups. Associations of failed social reciprocity with reduced mental health, measured by depressive symptoms and poor self-rated health, were observed. These links were generally stronger in case of partnership quality and intimate exchange than in case of children, and they were more pronounced among women (Knesebeck et al. 2003; Knesebeck et al. 2004; Knesebeck et al. 2009). In the British Whitehall II study, reduced mental health and sleep disturbances were more consistently related to failed reciprocity than other indicators of self-reported health (Chandola et al. 2007).

Whereas these findings were restricted to cross-sectional data, a French study tested the prospective link of failed social reciprocity with reduced mental health. In the Gazel cohort, the two scales of partnership quality and intimate exchange were explored, and higher scores of stressful exchange were associated with an elevated level of poor mental health two years later (Wahrendorf et al. 2010).

In conclusion, despite the obvious differences of stressful experience between work and private life, preliminary knowledge confirms that a balanced exchange between efforts and rewards in cooperative close social relationships matters for mental wellbeing. It should also

be mentioned that while the two concepts ‘reciprocal social exchange’ and ‘social support’ are closely linked, their notion and their effects are distinct (Chandola et al. 20107).

Link English version / German version

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2.2.3 Educational work

Educational achievements have a major impact on labor market access and on the quality of jobs in adulthood. Therefore, efforts expended in secondary and tertiary educational settings matter for students’ everyday experience. Decisive rewards related to these efforts are often postponed to stages of promotion and graduation, but more imminent rewards concern the appreciation of students’ achievements by significant others, specifically teachers and school mates. To assess these experiences, a questionnaire was developed to identify effort, reward, and over-commitment in educational work, specifically in students of secondary education. Again, Likert-scaled items were proposed to assess effort (5 items), reward (11 items), and over-commitment (3 items), mirroring the original conceptual notions. In a first study conducted in a group of 1004 Chinese students in grades 7 through 12, exploratory and confirmatory factor analyses revealed a four-factorial construct, with effort, over-commitment and two reward-related factors (esteem and educational prospects vs. academic performance). Furthermore, effort-reward imbalance at school was related to reduced self-reported health, in particular among female students (Li et al. 2010). Two more investigations in adolescent school settings in China supported these original results, pointing to associations with depressive symptoms (Guo et al. 2014) and suicidal ideation (Shang et al. 2014). A further

study conducted in Sweden (Laftman et al. 2015) underlines the transcultural application of this tool. Furthermore, effort-reward imbalance at school was related to fatigue in a study in Japan (Fukuda et al. 2010).

Even more intense learning and training efforts are required from University students, with closer links to future professional performance. Hence, a more specific assessment tool matching this condition is desirable. In fact, in 2017, such a tool was developed and tested in a group of medical students in Germany, with three items measuring effort, six items measuring reward, and five items measuring over-commitment. Findings of confirmatory factor analysis confirmed the three-factorial structure of this approach (Wege et al. 2017). Research exploring criterion validity and replicating the psychometric properties is currently under way.

Links English version / German version

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2.2.4 Summary

In three domains of recurrent activity performed in a relevant context of social exchange, household and family work, agency related to partnership and children, and educational work in school and University settings, the basic notion of inequity in social exchange has been analyzed, based on scales that mirror the three core factors of the original tool. Overall, this

extension of the concept beyond the dominant role of paid work lends support to the idea that inequity in social exchange matters for health and wellbeing even if efforts and rewards are less formalized and less pervasive. Additional evidence of this claim comes from investigations where failed social reciprocity was studied in voluntary work, caring, and informal work. Unfortunately, in these cases the notion was measured by two single items rather than by psychometrically established scales (Wahrendorf et al. 2006). Nevertheless, findings from several cross-sectional and prospective studies demonstrated reduced mental health and poor quality of life among early old age populations who were engaged in these activities without experiencing adequate reward (Wahrendorf et al. 2006; Siegrist and Wahrendorf 2009; McMunn et al. 2009; Zaninotto et al. 2013). Although this knowledge is less robust and less extensive than the one related to the work role, it documents the general significance of a universal element of interpersonal exchange, the norm of social reciprocity (Gouldner 1960).

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2.3 Overview of measures of ERI at work in major longitudinal epidemiologic studies

Study (country)	Measure	Publication
<i>France</i>		
CONSTANCES	Original (S) * (3 E, 7 R, 6 OC)	Siegrist et al. (2019)
GAZEL	Original (L) * (5 E, 11 R, 29 OC)	Niedhammer et al. (2000); Siegrist et al. (2004)
Santé, Itineraire Professionnel	SIP Proxy (3 D/E; 1 R)	Niedhammer et al. (2015)
<i>Germany</i>		
Heinz Nixdorf Recall Study	Original (L) (5 E, 11 R, 29 OC)	Dragano et al. (2008)
SOEP	Original (S) * (3 E, 7 R, 6 OC)	Siegrist et al. (2009)

National Cohort Study	Original (S) * (3 E, 7 R, 6 OC)	
lidA study of older workers	Original (L) (6 E, 11 R, 6 OC)	Peter et al. (2016)
<i>United Kingdom</i>		
Whitehall II		
Phase 1; 1985-88	Proxy* (5 E, 10 R, 1 OC)	Kuper et al. (2002)
Phase 1: 1985-88	Proxy (10 E/OC, 2 R)	Bosma et al. (1998)
Phase 5 (1997)	Original (6 E, 11 R, 6 OC)	Kuper et al. (2002)
ELSA	Original (2 E, 5 R)	Hintsa et al. (2015), Dragano et al. (2011)
<i>Denmark</i>		
Danish Work Environment Cohort (DWECS)	Proxy (4 E, 7 R)	Rugulies et al. (2009)
<i>Finland</i>		
Finnish Public Sector Study (FPS)	Proxy (1 E, 3 R)	Juvani et al. (2014)
10-Town Study	Proxy (1 E, 3 R)	Kouvonen et al. (2005)
Finnish Hospital Personnel Study	Proxy (1 E, 3 R)	Kivimäki et al. (2007)
Young Finns study	Original* (5 E, 11 R)	Törnroos et al. (2015)
North Finland Birth Cohort Study	Original (3 E, 7 R, 6 OC)	Freni-Sterrantino et al. (2022)
<i>Sweden</i>		
WOLF-Norrland	Original* (6 E, 5 R)	Siegrist et al. (2004); Fahlen et al. (2004)
SLOSH Study	Original (s) * (3 E, 7 R, 6 OC)	Leineweber et al. (2010)
<i>Belgium</i>		
SOMSTRESS	Original (5 E, 11 R, 6 OC)	Godin et al. (2005), Siegrist et al. (2004)
<i>Eastern Europe</i>		
HAPPIE	Original (L) (5 E, 11 R)	Pikhart et al. (2001)
<i>Europe</i>		
SHARE	Original (2 E, 5 R)	Siegrist et al. (2006); Dragano et al. (2011)
IPD-Work consortium	Proxy* (2 E, 5 R)	Siegrist et al. (2014)
<i>Canada</i>		
PROspective Quebec study (PROQ)	Original (4 E/D, 11 R)	Trudel et al. (2018)
Quebec Public Insurance study	Original (4 E/D, 11 R, 6 OC)	Gilbert-Ouimet et al. (2012)
Prospective study post.MI patients	Original* (9 D/E, 9 R, 6 OC)	Aboa-Eboulé et al. (2011)
Alberta prospective study	Original (S) (5 E, 11 R)	Nigatu & Wang (2018)
Longitudinal cohort working population Alberta (LCWPA)	Original (S) (5 E, 11 R)	Wang et al. (2012)
<i>USA</i>		

MIDUS	Proxy measure* (10 E, 7 R)	Li et al. (2021)
Health and Retirement Study (HRS)	Proxy measure (2 E, 5 R)	Mutambudzi et al. (2018)
Intervention studies		
<i>Canada</i>		
Health care professionals intervention	Original (9 D/E, 11R)	Bourbonnais et al. (2011)
White collar intervention	Original (4 D/E, 11 R)	Trudel et al. (2021)
<i>Germany</i>		
Psychiatrists study	Original (L) (5 E, 11 R, 6 OC)	Beschoner et al. (2021)
<i>Abbreviations:</i> D/E = Demand (items from the JCQ tool (Karasek et al. 1998) used as proxies for E = Effort; L = Long version; OC = Over-Commitment; R = Reward; S = Short version		
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