

Work and Health

Session 4

Hour # 1

The Modern Concept of Stress

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The beginnings of modern stress research - emergence of stress concept

- most existing stress theories were developed to describe the reactions of organisms to acute stress in situations threatening biological survival.
- *e.g., Walter Cannon 1914 - one of first physiologists to study stress looked at fight/flight responses.*
- many of the initial stressors studied were uncontrollable events to the subjects
- The focus has been on the response of an individual to an environmental stressor

Terminology in stress research

There is much confusion over the use of terms

- *Stressors refers to specific exposures that produce a stress response of some sort*
 - 1) Physicochemical stressor - external environment represented by "nature." (e.g., heat, cold, chemicals, etc.)
 - 2) Social stressor - the "social environment" (e.g. work organization)
 - 3) Biological stressor - the internal environment.
 - 4) Mental stressor - psychological condition such as pleasantness and unpleasantness.
- *Stress refers to the response of the organism to various stimuli. That different stimuli may produce different responses in different people*
 - Stress responses may be psychological as well as physiological.
 - Sometimes there can be a physiological response to a stressor without a concomitant conscious recognition of an emotional response
 - Many of the key demands on the individual are invisible

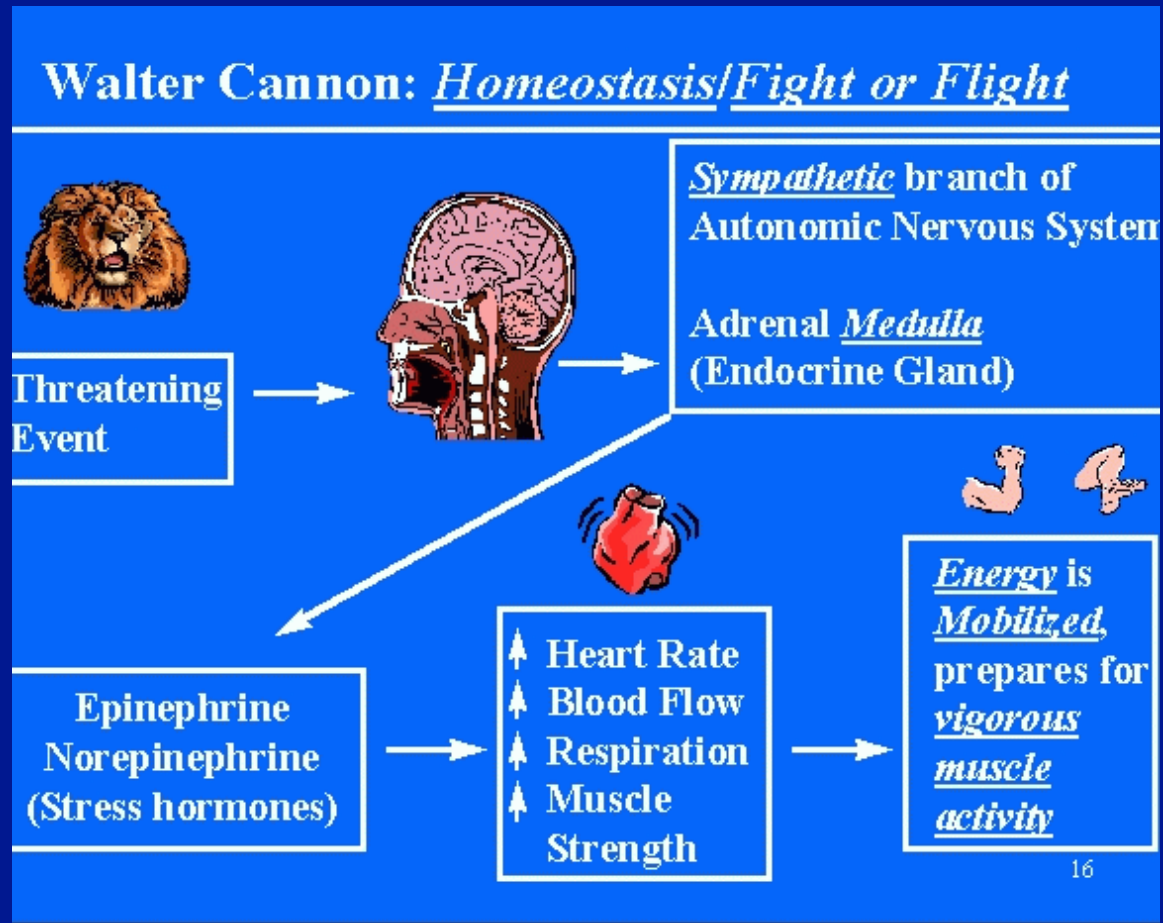
Terminology Cont:

- *Strain is frequently used interchangeably with stress in the literature*
- *However, there is an element of duration, chronicity and severity associated with strain as opposed to stress*
- *We reserve the use of the word “stressor” to refer to environmental factors.*
- *Be aware that not all stressors are always recognized and reported as stress by exposed individuals*

The fight/flight reaction model (defense reaction) – the work of Walter Cannon

- Research on the sympathetic adrenal-medullary (SAM) system has its roots in the work by Walter B. Cannon in the beginning of this century (Cannon, 1914).
- On the basis of animal experiments, he described the fight-or-flight response or the emergency function of the adrenal medulla. This defense reaction prepares the body for battle.
- The SAM system is activated when the individual is challenged in its control of the environment. Via the hypothalamus and the sympathetic nervous system, psychological stress stimulates the adrenal medulla to secrete the two catecholamines, epinephrine (adrenaline) and norepinephrine (noradrenalin), into the blood stream.
- The defense reaction is a response to threat when the organism has some control in responding, and actually has the chance to fight or flee.

The Defense Reaction/Response



A role for the defense response in disease

- **Levi points out that many common threats and challenges of social situations including work will elicit the defense response.**
- **Since most of these situations are often chronic and are not resolved by a fight-or-flight reaction, a prolonged state of “visceral-vascular readiness” is likely to emerge. A concept developed by Robert Elliot an American Cardiologist**
- **When this mobilized energy is not discharged it is harmful resulting in elevations in catecholamine excretion and increased BP typical of the defense response.**
- **Henry (1994) states: "chronic arousal of the defense response with catecholamine and renin release provides a physiological mechanism giving rise to sustained hypertension" .**

Homeostasis (why the body doesn't careen out of control)

- Cannon developed the concept of homeostasis, and popularized it in his book *The Wisdom of the Body*, published in 1932 by W. W. Norton, New York.
- Cannon presented four propositions to describe the general features of homeostasis:
 - Constancy in an open system, such as our bodies represent, requires mechanisms that act to maintain this constancy or steady state (e.g. way glucose concentrations, body temperature and acid-base balance were regulated).
 - Steady-state conditions require that any tendency toward change automatically meets with factors that resist change. An increase in blood sugar results in thirst as the body attempts to dilute the concentration of sugar in the extracellular fluid.
 - The regulating system that determines the homeostatic state consists of a number of cooperating mechanisms acting simultaneously or successively. Blood sugar is regulated by insulin, glucagons, and other hormones that control its release from the liver or its uptake by the tissues.
 - Homeostasis does not occur by chance, but is the result of organized self-government.

Hans Selye's "General Adaptation Syndrome"

Stress is a biological response caused by all noxious stimuli (nonspecificity):

Alarm



Resistance



Exhaustion

Adrenal Cortex
(Endocrine Gland)



Cortisol
(Stress Hormone)



Triad of Changes:

- Thymus
- Ulcers
- Adrenal Cortex

Origins of General Adaptation Syndrome

- As a medical student, Selye noticed that patients with quite different illnesses shared many of the same symptoms, such as muscle weakness, weight loss, and apathy.
- In the 1930s Selye studied the reactions of laboratory rats to a variety of physical stressors, such as heat, cold, poisons, strenuous exercise, and electric shock.
 - Found that the different stressors all produced a similar response: enlargement of the adrenal glands, shrinkage of the thymus gland (a gland involved in the immune response), and bleeding stomach ulcers.
- Selye proposed a three-stage model of the stress response, which he termed the *general adaptation syndrome*.

The Three Stages of G.A.S.

- **alarm,**
 - *The alarm stage is a generalized state of arousal during the body's initial response to the stressor.*
 - *That this stage corresponds to the work of Cannon*
- **resistance,**
 - *In the resistance stage (or adaptation stage), the body adapts to the stressor and continues to resist it with a high level of physiological arousal.*
- **and exhaustion.**
 - *When the stress persists for a long time, and the body is chronically overactive, resistance fails and the body moves to the exhaustion stage. In this stage, the body is vulnerable to disease and even death.*

Selye's eustress vs. distress

- a certain amount of stress (arousal) is good
- whereas too much stress leads to "distress" and can result in pathology. The classic U shaped curve.
- this formulation looks only at the physiological response and not at the nature of objective stressors (see below re JCQ)
 - *John Mason has criticized GAS concept on basis that every individual and every situation is unique leading to "response specificity".*
- A critical task is to identify optimal levels of stimulation for a given work setting and task

Life event research emerged during the period of the 2nd WW

- **Reaction of soldiers to battlefield trauma led to:**
 - **Research on reactions among populations exposed to catastrophes such as earthquakes led in turn to**
 - **Focus on catastrophes in daily life such as divorce, death, etc. – Stressful life events literature.**

The Person-Environment (P-E) Fit model,

- developed in the early 1970s by researchers at the University of Michigan,
- states that strain develops when there is a discrepancy between the motives of the person and the supplies of the environment (job), or between the demands of the job and the abilities of the person to meet those demands.
- Motives include factors such as participation, income, and self-utilization.
- Demands include work load and job complexity
 - (*Caplan et al., 1975; Van Harrison, 1978; Baker, 1985*).

Type A Behavior

- Among the new developments that expand on and challenge the focus upon traditional “proximate” risk factors is the emergence of research into behavioral factors that might influence the development of CVD.
- A notable example has been the formulation of the coronary prone behavior concept –“Type A” behavior pattern (TABP) [Friedman, 1959].
- While initial study results from the Western Collaborate Group Study (WCGS) indicated that TABP was a strong independent predictor of CHD mortality [Rosenman, 1976], subsequent research has failed to substantiate the initial WCGS findings [Ragland, 1988].

Type A Behavior cont:

- **More recently hostility - a component of Type A behavior - has emerged as a possible risk factor for CVD [Williams, 1989].**
- **The importance of the Type A Behavior concept has not been so much in its contribution to the explanation of CVD, as in its laying the groundwork for the field of social psychology in which the impact of the social and psychological environment on the individual became subject matter for investigation in relationship to CVD.**
- **TABP was important as a stepping-stone, which led eventually to the investigation of the role of the workplace in CVD.**

Type A research findings – an example

- Male and female subjects first worked on a cognitive task under conditions of either low or high challenge followed by a physical exercise task.
- Heart rate, systolic blood pressure, diastolic blood pressure, subjective arousal, subjective fatigue, and preferred levels of challenge for subsequent tasks were assessed.
- The results indicated that subjects with high Hard-Driving scores reported lower subjective arousal while working on the cognitive tasks and preferred to work on more challenging cognitive and physical exercise tasks in a subsequent phase of the experiment.
- In contrast, subjects with high Hard-Driving scores, high Speed-Impatience scores, or high overall Type A scores did not evidence higher physiological arousal in response to either the cognitive or the physical exercise tasks.

The Effort-Distress Model

- **Marianne Frankenhauser and her colleagues in Sweden have confirmed the involvement of two neuroendocrine systems in the stress response**
 - the sympathoadrenal medullary system (which secretes the catecholamines, adrenalin and noradrenalin),
 - and the pituitary-adrenal cortical system (which secretes corticosteroids such as cortisol).
- **Under demanding conditions in the laboratory where the organism can exert control, i.e., in the face of controllable and predictable stressors (analogous to "active" work in the Karasek model), adrenalin levels increase, but cortisol decreases.**
- **Effort without distress is experienced.**

The Effort-Distress Model cont:

- In Frankenhauser's model, low demand-low control situations (analogous to Karasek's "passive" jobs or Seligman's concept of "learned helplessness" (1)) create feelings of depression and helplessness and elevated cortisol, although only mild elevations in catecholamines (26).

Allostasis

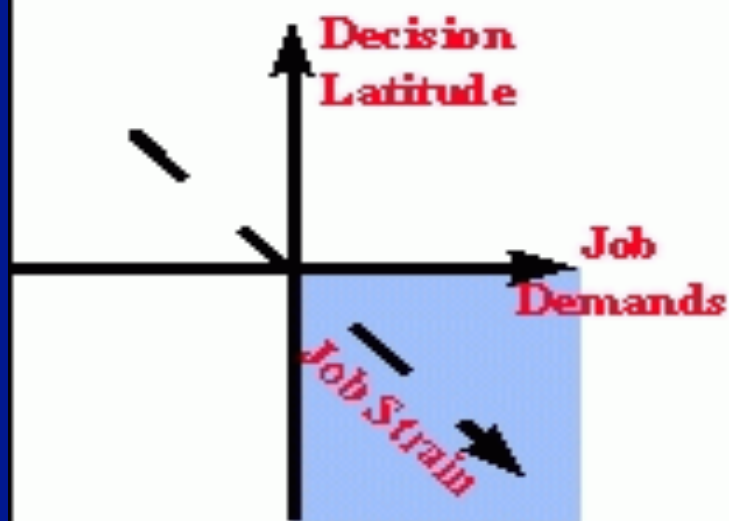
- Allostasis, meaning literally "**maintaining stability through change**" was introduced by Sterling and Eyer * to describe how the cardiovascular system adjusts to resting and active states of the body. As opposed to homeostasis "maintaining stability through constancy"
- This notion can be applied to many physiological mediators, such as the secretion of cortisol as well as catecholamines.
- The concept of "allostatic load" was proposed to refer to the wear and tear that the body experiences due to repeated cycles of allostasis as well as the inefficient turning-on or shutting off of these responses (22;26).
- As an example of allostatic load, the persistent activation of blood pressure in dominant male cynomolgus monkeys vying for position in an unstable dominance hierarchy is reported to accelerate atherosclerotic plaque formation (17).
- **Homeostasis and allostasis provide two different explanations of hypertension – as either 1) due to breakdown of homeostasis (internal dysregulation) or 2) an appropriate response to chronic stressors (allostasis)**

Comparison of Demand/control and GAS

- **What the level of arousal is where stress becomes harmful is not specified by Selye**
- **In demand/control model two axes are introduced – one of which the notion of control is critical in determining whether a given exposure or demand level is harmful.**
- **The demand/control model melds the two dimensions. And it is the combination of high demand and low control which is deleterious.**

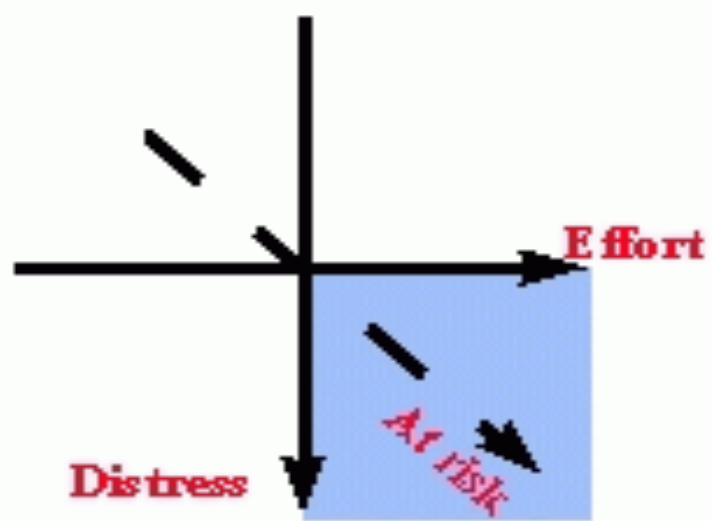
Comparison of Karasek and Frankenhaeuser Models

Karasek Model



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Frankenhaeuser Model



General Comments about these models

- **Most of these models abstract individual from their environment.**
- **Risk factor often seen as a fixed attribute (of the individual).**
- **Characteristic of Western medicine the focus is on studying individual reactions.**
- **Epidemiology has been a corrective to this by looking at populations and exploring characteristic group responses as opposed to individual ones.**

Two very different theoretical approaches to occupational stress and health research

- One position is defined by scientists who maintain that stressful experience at work is essentially an individual phenomenon determined by a person's psychobiological program, his or her learning history, appraisal, and coping resources,
 - *Limitation – it precludes any generalization beyond the level of individual variation (Cooper & Payne 1991).*

- A second position claims that the notion of stressful experience at work is amenable to scientific generalization, and that any generalization must reflect the complexity of a dynamic person-environment transaction operating at the macro-, the meso-, and the micro-social level (Kagan & Levi 1971).

In an analytical perspective, the challenge of this latter position consists in a meaningful reduction of complexity, that is in a theory-driven selective emphasis on specific situational and person characteristics that elicit or enhance stressful experience at work.

Systems approaches

e.g., Levi and Kagan

- Looks at individual in a social context.
- **Lennart Levi writes, "Briefly , then, we need to study over time the whole person interacting with his or her whole environment, A conceptual model of such a worker-workplace ecosystem can serve as a basis for research approaches as well as for therapeutic and preventive interventions.**

Who is Lennart Levi and why should we know his name?

Professor *Lennart Levi* , M.D., Ph.D. He became Sweden's first Professor of Psychosocial Medicine at the Karolinska Institute in 1978.

- Forty years ago he founded the Karolinska's Department of Stress Research, Since its founding in 1980, he directed the National Swedish Institute for Psychosocial Factors and Health (IPM) until his retirement in 1995. Before and after his retirement in 1995, he has been a key figure in both WHO's ILO's and EU's activities in this field.
- His nearly 300 scientific papers and books in many languages have influenced scientists, ourselves included, as well as decision makers, in many organizations and countries.
- His initial research focused on the fundamental aspects of stress and the impact on working people. The studies that he published with co-workers on the physiological effects of piece work and work at night in the 1960s and 1970s were influential.
- Later work emphasized the public health aspects of work stressors, their prevention and amelioration. He played a key role in the passage of the Swedish Work Environment Act in 1977.
- Dr. Levi is still an active and important figure able to translate research into public policy.

Figure 1. A theoretical model for psychosocially mediated disease (Kagan and Levi, 1975).

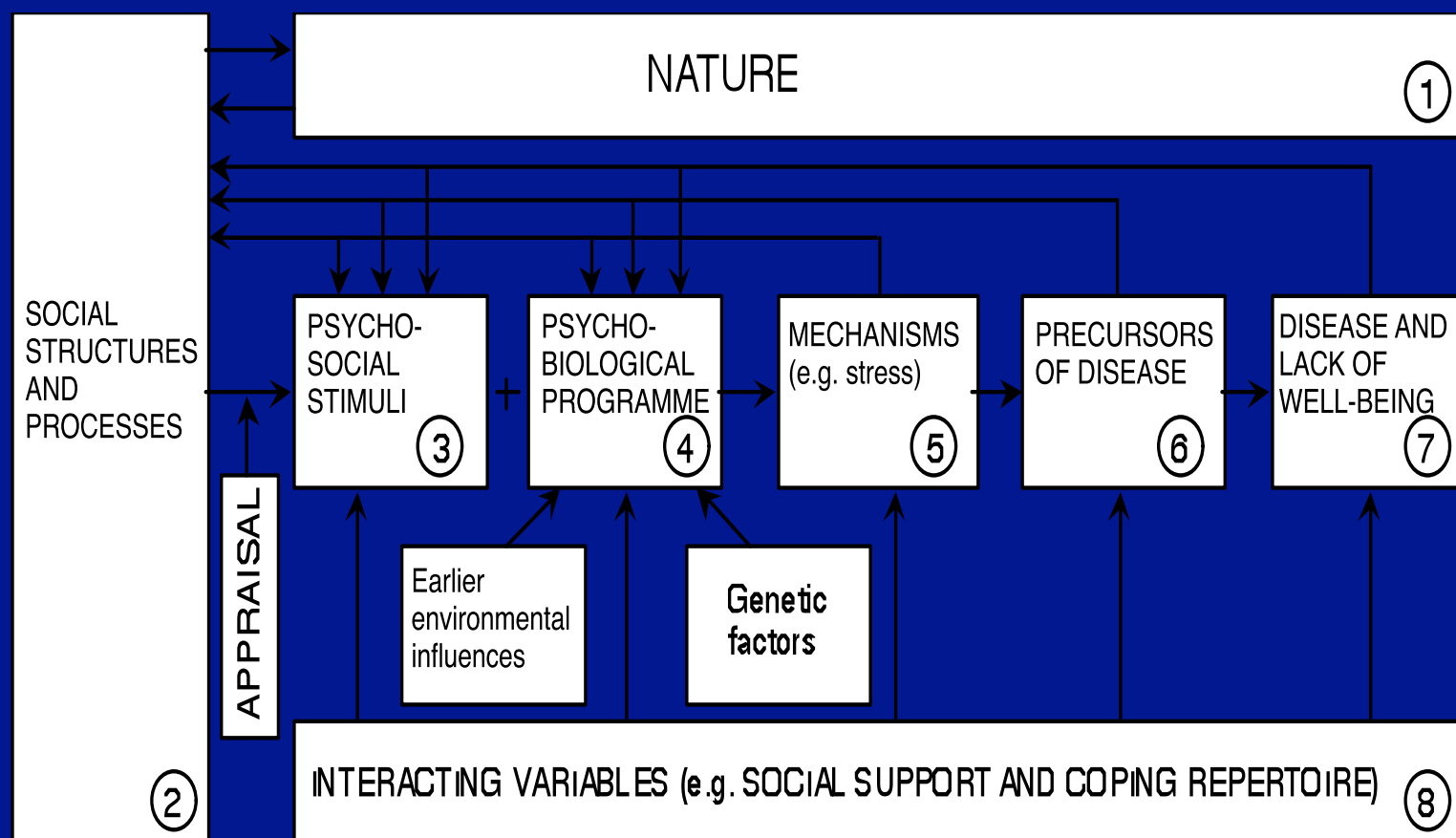


Figure 1. A theoretical model for psychosocially mediated disease (Kagan and Levi, 1975). For explanation, see text.

Introduction to Effort-Reward Imbalance Model

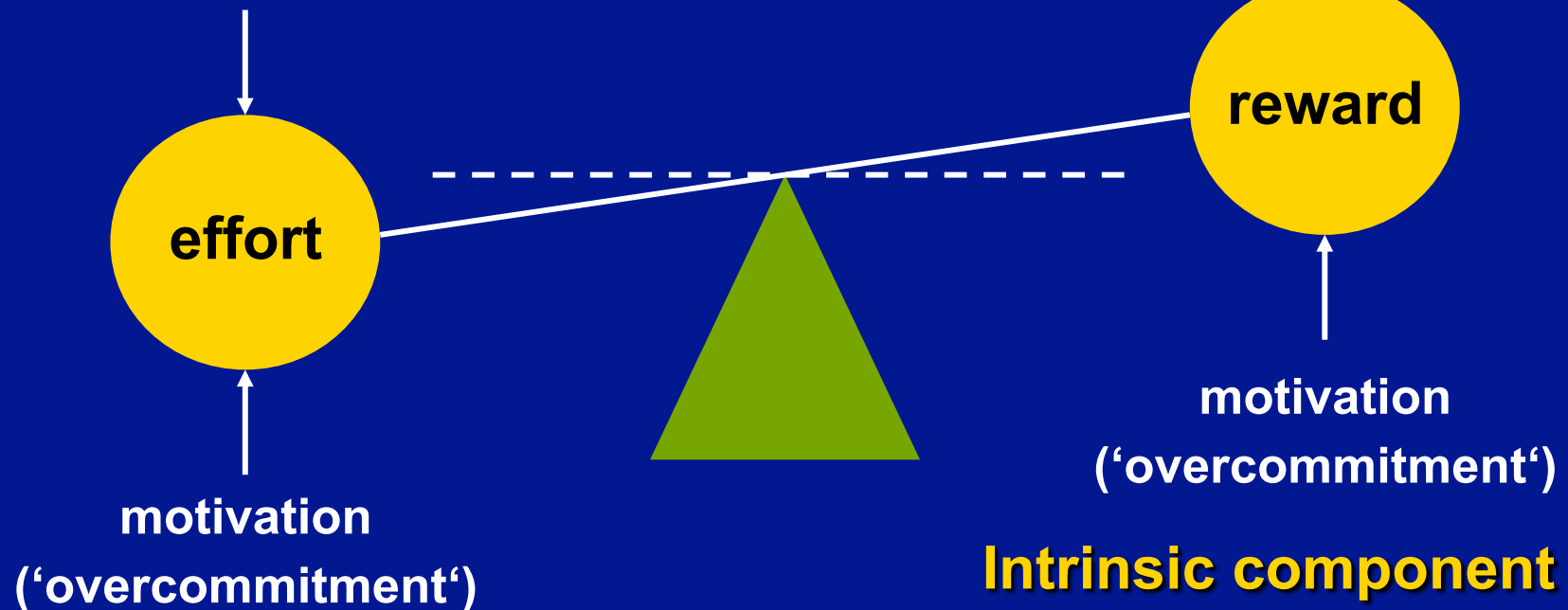
- Dr. Johannes Siegrist – Professor and Director, Department of Medical Sociology, University of Dusseldorf, Duesseldorf, Germany
- Dr. Richard Peter
- Creators of Effort-Reward Imbalance Model

The model of effort-reward imbalance (J. Siegrist 1996)

Extrinsic components

- labour income
- career mobility / job security
- esteem, respect

demands / obligations



Threat-avoidant vigilant work

- Jobs which require a high level of vigilance in order to avoid disastrous consequences, which could occur with a momentary lapse of attention or a wrong decision
- Prominent feature of some high CVD risk jobs:
 - bus drivers (most consistent evidence of elevated CVD risk)
 - taxi and truck drivers
 - air traffic controllers
 - sea pilots
- Experimental animal studies:
 - Association between performance of threat (shock) avoidance tasks and cardiac electrical instability
- Limited number of epidemiologic studies

Belkić K, Landsbergis P, Schnall P, Baker D, Theorell T, Siegrist J, Peter R, Karasek R. Psychosocial factors: Review of the empirical data among men. *Occupational Medicine: State of the Art Reviews* 2000;15(1):24-46.³¹

Professional drivers: The most consistent evidence of elevated CVD risk

- 34 of 40 studies confirm the increased risk of CHD and HTN among professional drivers, particularly urban transit operators. For example:
- Gothenberg, Sweden
 - 103 middle-aged male mass transit drivers, after 11.8 yrs f/u
 - OR = 3.0 (95% CI=1.8 - 5.2) for incident CHD compared to 6,596 men from other occupations, adjusted for age, serum cholesterol, BP, smoking, BMI, diabetes, CHD family Hx, leisure and work physical activity, demographics
- Denmark
 - Objective work load (traffic intensity) and acute MI incidence among bus drivers
 - Copenhagen: RR = 2.7 (95% CI = 0.9 - 7.6) for high versus low traffic intensity
 - In the provinces: RR = 3.4 (1.2 - 9.5) for high versus low traffic intensity
- San Francisco
 - 274 transit operators on 27 different transit lines and 4 different vehicle types

Tuchsen P. High-risk occupations for cardiovascular disease. *Occupational Medicine: State of the Art Reviews* 2000;15(1):57-60.

Belkic K, Emdad K, Theorell T. Occupational profile and cardiac risk: possible mechanisms and implications for professional drivers. *International Journal of Occupational Medicine and Environmental Health* 1998;11: 37-57.

Greiner B, Krause N, Ragland D, Fisher J. Occupational stressors and hypertension: a multi-method study using observer-based job analysis and self-reports in urban transit operators. *Social Science and Medicine* 2004;59:1081-1094.

pressure

■ Self-reports on job stressors: job barriers and time

Aren't we also being reductionistic when we focus on specific work related variables in our proposed model?

- *We search for a fuller model with greater explanatory power than traditional medical explanation*
 - We attempt to include psychological and physiological processes in our research (traditional risk factors)
- *The task of the course is to try and demonstrate the importance of the role of social factors, especially work, in contributing to illness*
- *We focus on the workplace for several reasons*
 - The workplace is “a major source of social stress that may eventuate in disease” - Reeder 1973
 - Many of its stress producing factors are objective, quantifiable and potentially controllable
 - Their social nature make interventions pertinent to a large number of individuals, raising the possibility of designing work so that is not harmful but on the contrary is health promoting

End of Session #1

Comparison of Job strain and Effort-distress model

- Workload is common to both though
 - *JS model measures job demands while*
 - *E-D model is looking at task demands in laboratory setting controlled by experimenter*
- Personal control and workload are key concepts in both models. However,
 - *E-D model control is over a laboratory procedure*
 - *JS model control is task level having to do with work*
 - *Job strain model builds on external work situation (decision latitude)*
 - *By incorporating a measure of work situation the D-C model is applicable to epidemiologic studies so that hypothesis testing is possible on working populations*
- Effort distress model includes a psychological dimension (distress) as well as a physiological response
- The distress condition of the E-D model corresponds strongly to the high strain condition of the job strain model
- ED model informs the DC model in critical ways