



## **Ergonomics observation: development of efficient methods based on cognitive psychology**

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### *Background*

In ergonomics, a variety of observational methods are available for assessing postures, movements and external loads. The observer is required to make judgments under uncertainty in a cognitive process comprising three stages: encoding (apprehending what is to be evaluated in the observed situation), retention (maintaining information in memory), and response (delivering a judgment of the situation according to specified criteria). Cognitive demands differ widely between observational methods, and even depend on the context of the observation. Larger cognitive demands lead to larger uncertainty in judgment, and thus likely to larger variability in ratings between and within observers. This, in turn, reduces methodologic efficiency, since more data are then needed to reach a trustworthy result. The present paper presents a model for categorizing observational methods according to cognitive demands, as a basis for developing methods in ergonomics that optimize the use of human cognitive capacity.

### *Model*

We propose a model with two axes: stimulus and response difficulty. Stimulus difficulty refer to factors influencing encoding, while response difficulty addresses retention and response. Stimulus difficulty is mainly determined by visibility, locus of attention, and certainty at target encoding. Visibility may be low if a worker is only partly visible in a dark compartment, and large as when observing a worker in full daylight. Locus of attention may be compromised if a posture to be observed on-site occurs only rarely in a busy environment, while it is facilitated by observing from a video snapshot off-line on the computer. Certainty at encoding can be low if an observed posture is close to a preset threshold value, such as when deciding whether an arm elevated to 58° is above 60°, and high if the arm is instead pointing at 15°. Response difficulty depends on judgment criterion, attention and memory demands, and access to support tools. A judgment criterion may be highly subjective, such as rating whether a task is “repetitive”; or almost objective, as when estimating an angle. Memory demands are higher when the observer is required to remember and summarize postures for several minutes of work than when rating a snapshot. In some methods, the observer gets no support in rating, while others offer visual aids, such as illustrations of awkward postures. Both stimulus and response difficulty is likely modified by the observer’s personal characteristics, including previous experience, working memory capacity, and visuo-spatial ability.

### *Conclusion*

We hypothesize that observer variability increases with cognitive demands in a relationship modified by the capabilities of the observer. We therefore argue that a better understanding of the determinants of stimulus and response difficulty, and of the relationships between difficulty and observer variability would open for an informed development of efficient observation methods associated with minimized observer variability.

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